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An Optimal Foraging Model of Hunter-Gatherer Land Use in the Carson Desert

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Executive Summary

A predictive model of archaeological site distribution has been expanded to encompass jurisdictional domains of the U.S. Navy, the Bureau of Land Management, the U.S. Fish and Wildlife Service, the Bureau of Reclamation, the State of Nevada, Churchill County, and other entities charged with management of land and resources, either as agency missions or in compliance with Federal, State, and local mandate. A valid test of the Toedokado model against an independent sample of archaeological data remains an unfulfilled objective. Nevertheless, expectations have been generated about the distribution, abundance, and complexity of archaeological sites based on considerations of a habitat model. Administratively defined portions of the area of the model have been stratified according to the habitat model and a randomly selected 5% sample of them have been surveyed. Survey results assess how well model predictions correspond to the archaeological record observed in sample units.

Thus, the present assessment represents a *pilot study* of the predictive power of the model. Two hundred thirty-three cultural properties were observed, recorded, and evaluated as a consequence of pedestrian survey of 13,591 acres in NAS Fallon jurisdiction, including lands in BLM jurisdiction proposed for NAS Fallon withdrawal.

The model successfully predicts the archaeological complexity of 67% to 77% of sample units surveyed in 1989, 1993, and 1994; most predictive errors occur in sample units for which moderate archaeological complexity is expected. The model succeeds particularly well at predicting the absence of archaeological sites and the occurrence of sites with features. Pending adequate testing and refinement, the interim potential of the model as a management tool is clear.

We are fortunate, on occasion, to find a colleague who strides through life in shoes too big for anyone else to fill, but marking clear trails for others to follow. Christopher Raven was such a friend, to whom we dedicate this work.

ABSTRACT

This document expands and elaborates an earlier model (Raven and Elston 1989, Raven 1990) that predicted locations of prehistoric archaeology at Stillwater Marsh by analyzing the economic foraging potential of resource distributions therein. The present excercise encompasses the 2,300,000 acres of the ethnographic foraging territory of the Toedokado Paiute. Habitat types as derived from modern soil, range, vegetation, and wildlife descriptions approximate the resource landscape of this territory as it existed about A.D. 1850. Foraging opportunities available to ethnographic hunter-gatherers are evaluated in light of optimal foraging theory, an evaluation which serves to generate predictions about the archaeological record of habitat types. A preliminary survey of selected lands administered by three Federal agencies assays the predictive power of the model. The effects of paleoenvironmental variability on prehistoric foraging opportunities are modeled as well.

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ACKNOWLEDGEMENTS

Christopher Raven conceived and inspired this project. Ron Anglin (USFWS) saw its potential and found the wherewithal to make it happen. David Zeanah took the helm as Principal Investigator, constructed the model, conducted its assessment, and reported the endeavor. Robert Elston helped.

Eric Ingbar was crew chief for the 1993 field work, while James Carter served in that capacity in 1994. Brian Cooperrider, Janette Benjamin, Julia Hammett, Tim Hunt, Carl Lipo, Molly O'Halloran, and Monte Smith were crew members at one time or another. Cliff Creger of NAS Fallon participated in both field seasons to our great benefit. Maria Castellanos-Solá (Fundacao Biodiversitas of Brazil) volunteered a day of her time in the United States helping us record sites in the Carson Desert.

Once in from the field, Carter, Hammett, and Sharon Long encoded map data. Preparation of IMACS forms fell to Carter, aided by Scott Baxter, Long, and Smith. Too, Carter tackled the hydrology of the Carson Desert to good effect. Susan McCabe typed projectile points. Carter and Lipo constructed and manipulated databases necessary to the model. Lipo and O'Halloran prepared computer-generated and hand-made graphics. Elston analyzed areal photographs of landforms and vegetation; Elston, Dan Dugas, and Carter synthesized and interpreted paleoenvironmental data used herein. Ingbar analyzed the topographic landscape of the study area and produced the oversize habitat type map accompanying this report. Cashion Callaway served as copy editor and Kathy Nickerson engineered report production.

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Chapter 1. THE CONTEXT OF PREDICTING ARCHAEOLOGY IN TOEDOKADO TERRITORY

David W. Zeanah

In the late 1980s, Christopher Raven and Robert Elston (1989), at the request of the U.S. Fish and Wildlife Service, endeavored to predict archaeological site distributions within the confines of Stillwater Wildlife Management Area of west central Nevada. Relying on soil types and water sources to identify potential natural vegetation habitats of their study area, they isolated and evaluated plant foods within each habitat in light of experimental data on the energetic efficiency of exploitation by hunter-gatherers (Simms 1987) and, thus, ranked the habitats as hunter-gatherer foraging patches. In turn, they could predict how prehistoric hunter-gatherers should have used the study landscape based on assumptions derived from optimal foraging models. They expected the distribution of archaeological sites to mirror the distribution of prehistoric subsistence resources and, indeed they did, 85 percent of the time in a field test whereby a five percent sample of the Stillwater Wildlife Management Area was subjected to intensive archaeological survey (Raven 1990).

Encouraged by the predictive success of the Stillwater model, the U.S. Fish and Wildlife Service, on behalf of Naval Air Station Fallon (NAS Fallon), in 1993 solicited the present expansion of the model to encompass the entire ethnographic territory of the Toedokado (Cattail-Eater) Paiute, a matter of some 2,300,000 acres, or a ninefold increase in the area of the Stillwater model. The land mass of the model now extends far beyond administrative boundaries of U.S. Fish and Wildlife Service lands, to include those of at least eight more Federal, state, and local agencies, including much of Churchill County and small portions of Lyon and Pershing counties (Figure 1). Thus, the model has broad applicability as a research and resource management tool that crosscuts modern jurisdictional boundaries even though it has been field tested in less than 20% of the land area it addresses.

Context

The Carson Desert has been studied by archaeologists for more than a century (Russell 1885; cf. Fowler and Fowler 1990; Raven and Elston 1991). Much of that time has been devoted to deciphering the culture history of the area as represented by cultural remains from a few stratified cave sites (Loud and Harrington 1929; Heizer and Krieger 1956; Grosscup 1960). By the middle of the twentieth century, however, Carson Desert prehistorians began to debate the issue of spatial and temporal interplay between Great Basin hunter-gatherers and their arid environments. In particular, they inquired whether the prehistoric inhabitants of the Carson Desert specialized in the extraction of local palustrine resources (Heizer and Napton 1970; Napton 1969) or pursued an eclectic strategy of diverse upland and lowland habitat exploitation (Jennings 1964). It seemed obvious to prehistorians of the 1950s and 1960s that palustrine environments of the Carson Desert were exceptionally rich compared to alternative desert and mountain biotic zones because they were sufficiently watered to maintain dense biomass. Therefore, they thought that prehistoric hunter-gatherers with the option of exploiting marshes must surely have done so; moreover, the rich, reliable, fixed marsh resources must have encouraged semisedentary or sedentary occupation of lakeside encampments, a luxury denied occupants of more biotically impoverished Great Basin settings. Evidence for the intensive procurement and consumption of palustrine resources, recovered from cave sites (Heizer and Napton 1970), bolstered this "limnosedentary" model of hunter-gatherer adaptations, but published evidence for in situ lacustrine camp sites was lacking, although such sites had been investigated (Livingston 1986).

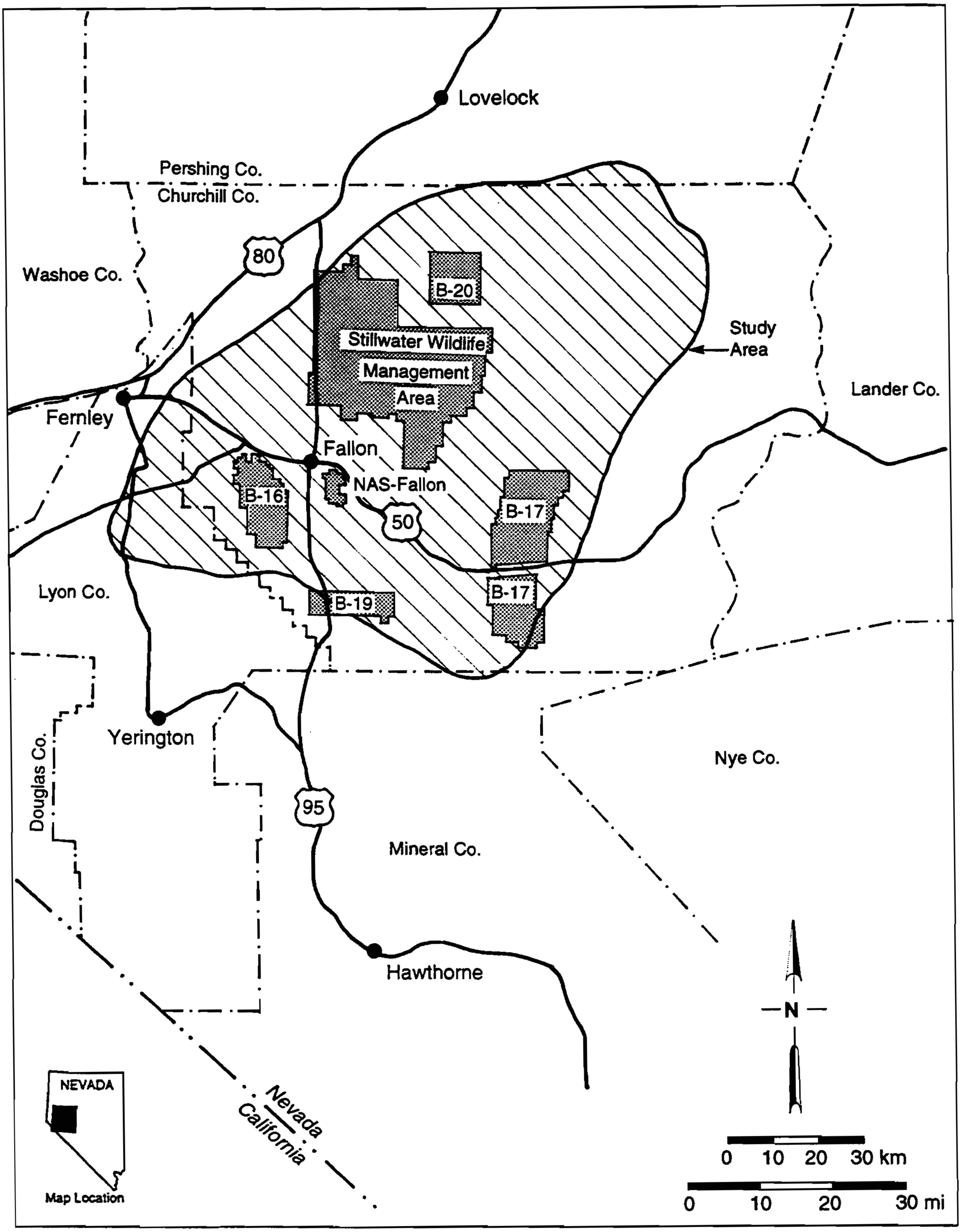

Figure 1. Vicinity of the study area (after Official Highway Map of Nevada, Nevada State Department of Transportation, 1989).

Armed with more sophisticated theoretical and analytical tools for interpreting hunter-gatherer adaptations, and a better understanding of the economic productivity of Great Basin resources, investigators of the 1970s and 1980s began to challenge the limnosedentary model, offering an alternative "limnomobile" model of hunter-gatherer ecology in palustrine settings (Thomas 1985:19–20). Kelly (1985) noted that much of the productive potential of marshes is inaccessible or prohibitively expensive for hunter-gatherer procurement. Kelly held that plant and animal resources of upland habitats were far more energetically profitable for human exploitation than their marsh counterparts, based on Simms' (1984) experimental data on the costs and benefits of Great Basin resource capture. However, the scarcity, dispersion, and unpredictability of upland resources would have encouraged hunter-gatherers to remain mobile. Consequently, marsh resources must have served as a reliable backup to fluctuations of energetically more profitable upland resources. By extension, hunter-gatherers should have settled in palustrine communities tethered to palustrine resources only when environmental stress depressed the abundance and reliability of upland resources.

Reexcavation of Hidden Cave and its interpretation as a logistic site type, one not necessarily associated with marsh-based sedentism, supported the limnomobile model (Thomas 1985:385-391). Concurrently, systematic transect survey of the Carson Desert failed to yield evidence of sedentary marsh exploitation, except possibly during climatically stressed periods near the end of the prehistoric era (Kelly 1985). Thus, by the mid-1980s, the available evidence began to suggest that the limnomobile model characterized hunter-gatherer palustrine adaptations in the Great Basin better than did the limnosedentary model.

But, unknown to latter day investigators, evidence of residentially stable palustrine exploitation lay buried 20-50 cm beneath the surface of Carson Sink. Catastrophic flooding from 1982 to 1987 scoured the sandy overburden to expose large, complex archaeological sites that contained pit structures, storage facilities, refuse middens, human burials, and diverse artifact assemblages; all traits of sedentary or semisedentary habitation (Rafferty 1985; Kelly 1992). Moreover, these sites contained abundant evidence of intensive exploitation of marsh resources (Raven and Elston 1988; Raymond and Parks 1989, 1990; Tuohy et al. 1987; Brooks et al. 1988). The new evidence that prehistoric hunter-gatherers had exploited Stillwater Marsh intensively for a long time through residentially stable settlement forced reconsideration of the role of marsh environments in Great Basin subsistence-settlement patterns.

It was this turn of events that prompted formulation of a predictive model of archaeological site locations in Stillwater Marsh (Raven and Elston 1989). Like Kelly (1985), Raven and Elston generated expectations from optimal foraging theory, and used Simms's (1987) resource rankings to evaluate the costs and benefits of reliance on marsh resources. However, they employed a more fine grained and sophisticated characterization of marsh habitats, one based on the potential natural vegetation communities associated with mapped soil units. This more detailed sketch of marsh habitats led Raven and Elston (1989:2) to develop the compelling argument that marsh environments were "the best foraging game in town" for hunter-gatherers seeking to extract a living from the Carson Desert.

Heretofore, restriction of the model to Stillwater Marsh limited its regional applicability. The marshes of Stillwater are rich foraging patches, but compared to what? Assessment of the marshes as the best foraging patches of the Carson Desert remained an untested hypothesis, absent comparative evaluation of alternative environments, that limited theoretical debate focused on Carson Desert palustrine adaptations. While it is tempting to suggest that (accidental) discovery of the Stillwater habitation sites should settle the marsh/upland debate, at least in the Carson Desert, this is scientifically unsatisfactory. In order to say that we truly have learned something about prehistoric hunter-gatherer ecology in the Carson Desert, we must resist mere reformation of explanatory models to accommodate unforeseen discoveries. Rather, our models must be capable of predicting the archaeological record and of explaining unanticipated variability within a consistent theoretical framework.

In these circumstances, our present dilemma is that two different analyses of prehistoric subsistence and settlement patterns in the Carson Desert region are based on the same theoretical framework but arrive at opposing conclusions. Kelly based his earlier study (1985) on an assessment of the environment too coarse to reflect adequately prehistoric foraging landscapes; however, it remains the only regional comparison of upland and lowland resources. On the other hand, the Raven and Elston (1989) study was sufficiently fine-grained to model foraging opportunities available to prehistoric hunter-gatherers local to the marshes of Stillwater, but it was not regional in scope.

The accuracy of the Raven and Elston (1989) model in predicting the distribution and character of archaeological sites at Stillwater indicates that its explanatory power is sufficiently robust to meet requirements of predictability. Clearly, expansion of the model to encompass the diversity of environments available to prehistoric hunter-gatherers of the Carson Desert region is indicated. A regional model will allow archaeologists to compare the resource structure of the entire area and to make testable predictions about settlement systems inside and outside Stillwater Marsh. Tests of the model will facilitate fine tuning the spatial and temporal relationships between marsh settlements and those in other habitats in the greater settlement system.

The need for an expanded model goes beyond the requirements of scientific inquiry to address the administrative concerns of land managers. At a fundamental level, Raven and Elston (1989) have shown that biogeographical techniques and evolutionary theory render it possible to construct a model that can predict the distribution of archaeological sites in the Stillwater Wildlife Management Area, where the Federal mission is to preserve habitat for migratory waterfowl but, at the same time, to look to the preservation and protection of archaeological resources. When site distributions in a wider variety of habitats are similarly predicted, then the expanded model becomes a powerful tool for other land managers of the region faced with conserving archaeological resources.

An expanded model promises to aid assessment of the regional significance of archaeological properties in light of a meaningful regional scale. Each of the numerous Federal, state, and local jurisdictions at work in the modern Carson Desert must manage the prehistoric sites it controls, yet prehistoric hunter-gatherers ranged over the entire Carson Desert without concern for the mandates of latter day land managers. Thus, the astute land manager will be assisted by an understanding of the relationship between his own resource base and the regional environment. A more sophisticated understanding of the distribution and significance of archaeological sites in any particular land management jurisdiction will permit more efficient allocations of time, personnel, and funds, regardless of jurisdictional mission, because virtually every development that occurs on the Federally managed landscape must take into account its effects on significant archaeological sites.

It is in response, then, to both research and management needs that we offer this document. Herein, we expand the scope of the original Stillwater model (Raven and Elston 1989) to include the entire ethnographically known territory of the Toedokado (Cattail Eater) Paiute, and assess the model in jurisdictions of the US Navy as they exist or are proposed.

Theoretical Approach

Archaeologists are confronted with the task of deducing past human behavior from the ephemeral residues left by that behavior. To accomplish this, robust theories of behavior capable of generating testable expectations about behavioral variability must motivate archaeological research strategies. Like our predecessors, we find that optimal foraging theory (Stephens and Krebs 1986) provides the theoretical base for generating expectations about how prehistoric hunter-gatherers should have used the biotic landscape of the Carson Desert.

We rely on evolutionary theory and assume that, all things being equal, organisms that forage efficiently enjoy a selective edge over less efficient competitors; therefore, evolution has selected organisms with the behavioral capability of striving to forage efficiently. Based on this assumption, optimization models serve as useful tools for generating expectations about how foragers can achieve foraging efficiency. Diet breadth models, patch choice models, the marginal value theorem and central place foraging models are useful in this regard. The diet breadth model predicts the set of resources an optimal forager should choose to exploit based on the energetic efficiency and abundance of all alternatives (Schoener 1971). The patch choice model ranks resource patches according to energetic return rates and thereby predicts the order in which foragers should select patches for maximum returns (MacArthur and Pianka 1966), while the marginal value theorem predicts time allocations for foraging within and switching between patches according to diminishing returns (Charnov 1976). Finally, central place foraging models examine the effects of travel and transport costs to and from a central place (Orians and Pearson 1977) on prey selection, on group size, and on optimal central place location (Horn 1966). Although these models test hypotheses about the foraging behavior of living organisms observed on short term time scales, they serve as heuristic devices for generating expectations about how hunter-gatherers should have used resources and patches in the archaeological past over the long term.

Given this theoretical background, we assume that prehistoric hunter-gatherers of the Carson Desert strove for foraging efficiency, which can be modeled in terms of energetic costs and benefits. The motivation to maximize energetic return rates should have determined where in the Carson Desert landscape hunter-gatherers forage; the archaeological record should reflect such locational decisions in the spatial distribution of archaeological sites.

Generating testable hypotheses from these assumptions requires direct linkage between the variables of optimal foraging models and archaeological site distributions, which is achieved in two steps. First, the distribution of archaeological sites must be compared to a model landscape reflecting the distribution of hunter-gatherer resources. We accomplish this by using the potential natural vegetation communities of soil 'range types' to establish a set of mappable habitats (Daubenmire 1968; Dyksterhuis 1949) stratified by vegetation, soil, water, and slope. We use this set of habitats to estimate the landscape of resources that would have been available to hunter-gatherers about the time that European-Americans arrived (circa 1850 AD). This landscape serves as a powerful heuristic tool that is comparable to the ethnographic, archaeological, and paleoenvironmental records.

Second, we must evaluate the foraging potential of the model landscape to generate testable predictions about archaeological site distributions. This is a task that scientists who study foraging behavior share with the foragers; with a caveat that scientists must rely on abstract models of foraging behavior, generalized understandings of resource distributions, and experimental estimates of resource handling costs, while prudent foragers deal with day to day realities in terms of practical experience. Thus, there is a danger that the scientist will generate predictions that are excessively precise or unrealistic given the data at hand and the limitations of foraging models. But, if we can avoid this pitfall, an accurate predictive evaluation of the foraging landscape of Toedokado territory based on optimal foraging theory is feasible.

To evaluate the resource landscape, habitats must be ranked according to their energetic costs and benefits. Such ranking is based on a growing body of experimental literature on the energetic returns of Great Basin resources, accounting for handling (Couture et al. 1986; Simms 1987; Madsen and Kirkman 1988; Raymond and Sobel 1990; Jones and Madsen 1991; Bullock 1994) and transport (Jones and Madsen 1989; Barlow 1990; Rhode 1990; Brannon 1992) costs. From this ranking and modeling of the hunter-gatherer environment of the Carson Desert, we derive our expectations about prehistoric land use and archaeological site distributions in the study area.

Predictive models of archaeological site distributions based on detailed characterizations of environmental variability are not new (see Lafferty et al. 1981 and Grady 1980 for two North American examples), but previous efforts lack linkage with dynamic theories of human behavior. Consequently, predictive failures become intellectual dead-ends which can neither direct future research nor guide resource management. It is in this respect that the present endeavor differs from previous examples; here, we derive a predictive regional model of archaeological site distributions based on a detailed characterization of regional environment and interpreted by a robust theory of hunter-gatherer foraging behavior. This allows us not only to predict the archaeological record, but also to learn from unanticipated variability within a consistent theoretical framework.

Report Organization

The present chapter has introduced the modeling project; Chapter 2 defines the study area, broadly describes the general environment, and discusses the rationale, background, and procedures for identifying habitat types. Habitat characteristics are described in detail in Chapter 3. Chapter 4 discusses the spatial and temporal availability, and energetic return rates, of habitat resources. Chapter 5 ranks habitat types and generates hypotheses about the distribution and character of archaeological sites in each. Chapter 6 stratifies Navy lands within Toedokado Territory by habitat type, and selects a 5% sample for field testing by archaeological survey. Survey results are described in Chapter 7, then analyzed and interpreted in Chapter 8. In Chapter 9, we expand the predictive scope of the model by considering how paleoenvironmental variability affects predictions of the model. Finally, in Chapter 10, we discuss the utility of the model as a research and management tool, presenting recommendations for its future refinement and application.

Constructing the model and assessing its predictive utility is a matter of careful progression from one step to the next. Our intent, in the following discourse, is to lead the reader along our path of logic, but the reader may come to believe himself lured instead into a maze. Hence Figure 2, which charts the course we are about to take and offers reassurance later on.

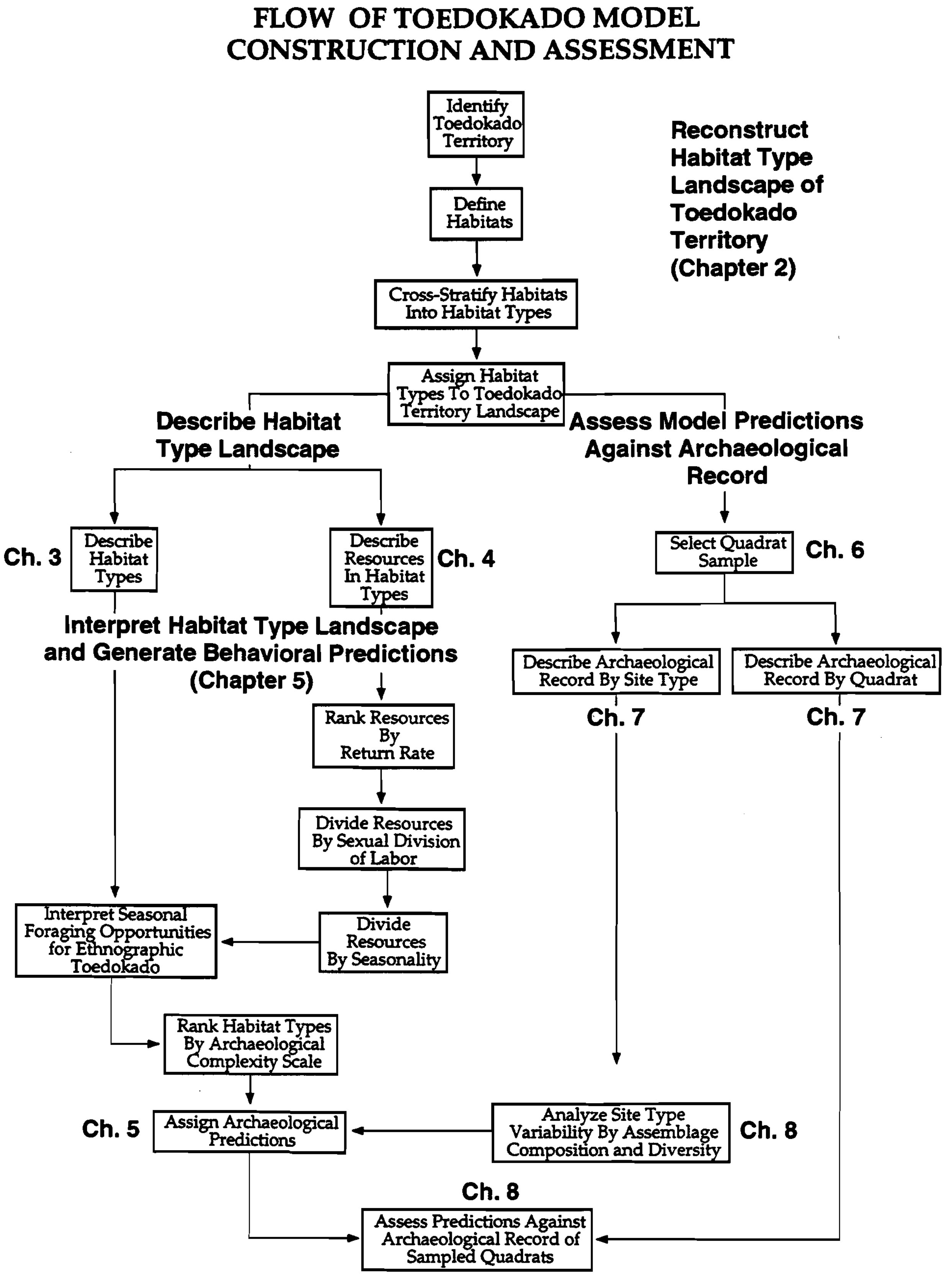

Figure 2. Charted flow of modeling and assessment tasks.

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Chapter 2. MODELING TOEDOKADO TERRITORY

David W. Zeanah, James A. Carter, and Robert G. Elston

Now we set the stage for predicting archaeological site distributions by developing a detailed model of environmental variability within Toedokado territory. We first define the study area and broadly describe its environment. Next, we characterize the environment according to habitat types that are based on soils, vegetation, water, and slope; we do this by considering the advantages and limitations of range and habitat type concepts in a prehistoric plant community modeling application. Then we review the process by which Raven and Elston (1989:49-63) derived plant habitats from range types. These preparatory steps incorporate three soil and range databases into a single typology of potential natural plant communities in Toedokado territory. Finally, we cross-stratify plant communities into habitat types based on presence and absence of perennial water, on potential for inundation, and on slope. This final step provides us with a typology of habitats in Toedokado territory.

A Definition of Toedokado Territory

Our goal is to develop a predictive model of archaeological site locations for the ethnographic territory of the Toedokado, Northern Paiute. However, the study area boundary is misleading to the extent that the Toedokado were not truly territorial people. While some Toedokado families owned rights to particular pinyon stands (Fowler 1992:40-41), territorial boundaries were flexible and ambiguous. Although Toedokado were relatively sedentary compared to numerous other Great Basin groups, mobility remained a critical element of their strategy for exploiting temporally and spatially dispersed resources (Thomas 1985:21-26). Consequently, Toedokado ranged over an immense but not easily bounded area of what is now northwestern Nevada (Fowler 1992:9). For example, Toedokado frequently ventured as far as 55 km northwest to Pyramid Lake and 60 km east to Reese River Valley to fish and hunt; similarly, neighboring bands foraged on lands associated with the Toedokado (Stewart 1939: map 1; Shimkin and Reid 1970:174).

Nevertheless, our goal demands a study area that is representative of the range of environments available to the Toedokado in any given year, that is grounded in the ethnographic literature on the Toedokado, and that is precisely defined. Thus, we review the literature concerned with the annual range of the Toedokado, make an informed (but nevertheless arbitrary) decision about what constitutes Toedokado territory, and place that territory in the Universal Transverse Mercator (UTM) grid.

The Toedokado area first was delineated by Stewart (1939:141), although earlier accounts roughly describe it as associated with the Carson Sink and Stillwater Range (Hodge 1910:772; Lee 1870:111; Loud and Harrington 1929:153; Kelly 1932:72). According to Stewart, the Toedokado ranged from "the mountain range between Humboldt and Carson sinks" on the north to the Desert Mountains on the south (Stewart 1939:141). Stewart maps the boundaries from northwest of Fort Churchill to as far east as Reese River Valley (Stewart 1939:148, map 1).

Shimkin and Reid (1970:175) briefly describe Toedokado territory, giving a map of the area distilled from information provided by Lowie (1924:291) and by Stewart (1939), as well as earlier observations by William Wright (in DeQuille 1963) of the Toedokado "Tule-eaters" Northern Paiute group around Stillwater Marsh and the Stillwater Range in the middle nineteenth century. Shimkin and Reid (1970:173) note "that at the time of white contact the Carson River Basin, the Stillwater Mountains, and some adjoining areas were all occupied by...Toedokado."

Thomas, in his Hidden Cave report, also provides a map of the Toedokado territory or "annual range" (1985:21-22). His map follows that of Shimkin and Reid (1970:175), but estimates the boundaries of the annual range more precisely according to topographic landmarks, placing the western boundary at Churchill Butte and extending it east only into the Clan Alpine Range. However, Thomas notes documentary evidence that Toedokado ranges may have extended as far east as Reese River Valley (after Stewart 1939: map 1; Johnson 1985), and relates accounts of Toedokado Paiute foraging as far east as Edwards Creek Valley (Simpson 1876:109 in Thomas 1985:23) and as far north as Pyramid Lake (Thomas 1985:23, 24).

Fowler (1992:9) describes the area of the Toedokado as one surrounding the Carson Desert, loosely bounded by mountain ranges. She defines the Stillwater Marsh, between the Carson Lake and Carson Sink basins, as the focal point for Cattail-Eater camps and subsistence (Fowler 1992:9). Fowler is more specific in her description of the Toedokado territory than are previous investigators, presumably basing her description on the Shimkin and Reid map (1970:175) rather than on new data. Fowler's narrative puts the north boundary of Toedokado territory at the Western Humboldt Range and the south roughly following the crest of the Desert and Cocoon Mountains; the Clan Alpine Mountains form the eastern border of the territory, with the western border extending as far as the Virginia Range (Fowler 1992:9). In mapping this area, however, Fowler's western boundary extends to the southern toe of the Truckee Range, considerably farther west than previously credited to the Toedokado; too, her map excludes the northeastern portion of Dixie Valley and includes the southern end of the Cocoon Mountains (Fowler 1992:10).

For purposes of the present exercise we take Toedokado territorial boundaries, with two minor exceptions,* to be as described by Fowler in text (1992:9), as illustrated by Shimkin and Reid (1970:175), and as delimited on the topographic landscape by Thomas (1985:22). Using Thomas's map as a reference, we have plotted a boundary on U.S. Geological Survey 30' by 60' quadrangles according to topographic landmarks. This area is illustrated in Figure 3; UTM grid coordinates of angle points in the boundary as mapped are given in Appendix A. The demarcated area encloses 9,430 square kilometers, and precisely delimits our interpretation of Toedokado territory in a manner replicatable by land managers. The model developed herein is applied exclusively to areas within these boundaries.

Physiography of the Study Area

The Toedokado territorial boundary we use follows the crest of the Clan Alpine Range southwestward, crossing Fairview Valley just west of Middlegate. It then follows the crest of Fairview Peak and Slate Mountain, turning westward and northward along the crest of the Sand Springs Range. The boundary turns westward again, taking a line along the north slope of the Desert Mountains. It then turns northeast, with the westernmost boundary point on Churchill Butte. The boundary generally follows the crest of the Hot Springs Mountains and the West Humboldt Range. It then turns eastward, going north of the Carson Sink. The boundary crosses the Stillwater Range to trend southeastward across Dixie Valley to complete the circuit at the north end of the Clan Alpine Range.

This area encompasses more than 940,000 hectares (2,330,000 acres). It includes the entire Carson River watershed east of Churchill Butte, including Carson Lake, Stillwater Marsh, and Carson Sink, as well as basins in southern Dixie Valley and Fairview Valley, and Salt Wells Basin. Highlands additional to those mentioned as boundary features include the southern Stillwater Range, Cocoon Mountains, and Dead Camel Mountains.

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*For administrative reasons (see Chapter 6), the southern boundary of the territory takes in two small areas, totalling 93 acres, not considered Toedokado territory by any researcher.

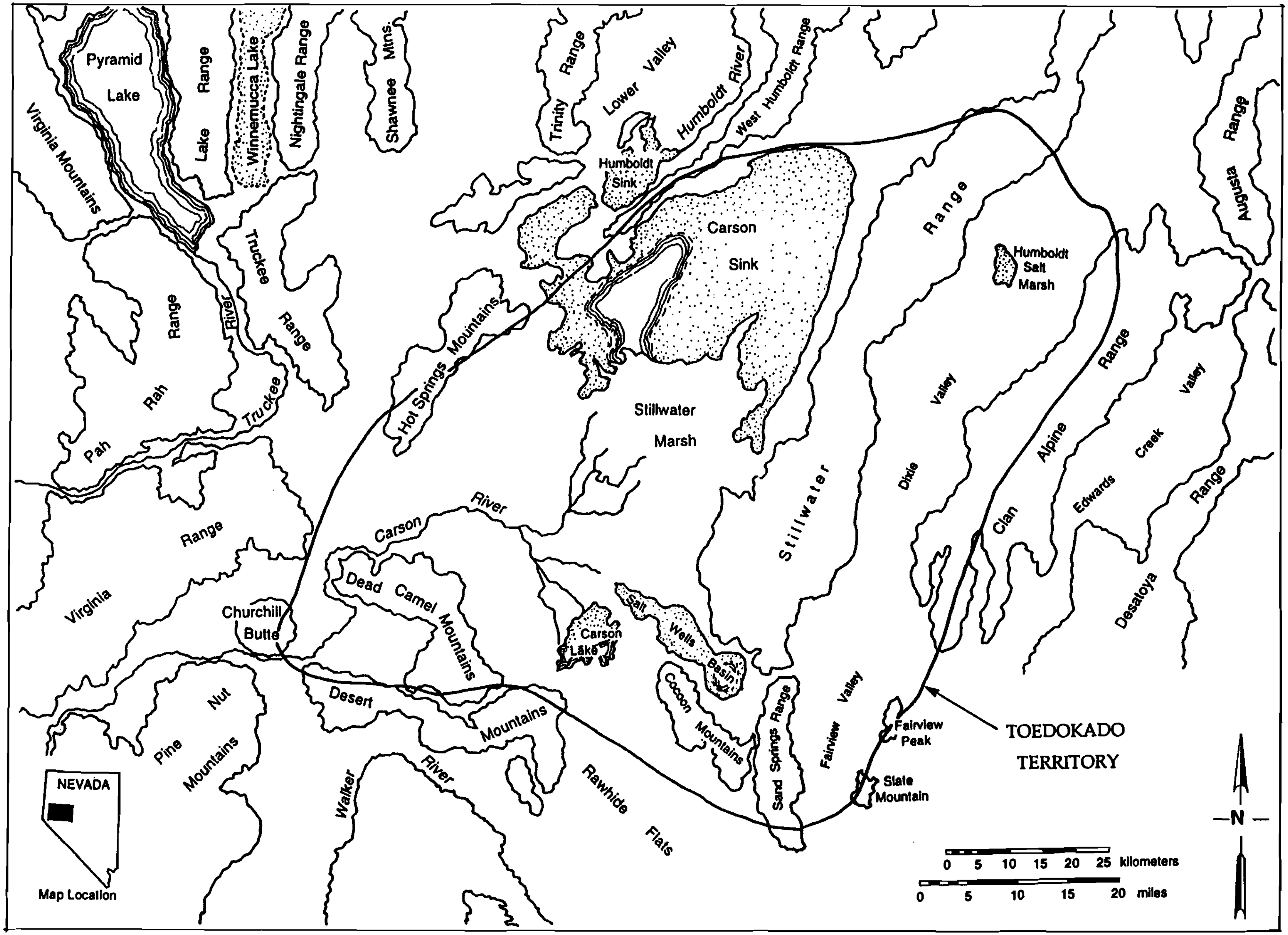

Figure 3. Map of Toedokado territory relative to physiographic landmarks of the Carson Desert (after Thomas 1985, Shimkin and Reid 1970).

The study area includes two of the lowest areas of the northern Great Basin, with a base of 1178 m (3860 ft amsl) in the Carson Sink and 1025 m (3360 ft amsl) in Dixie Valley. The highest point in the study area is at Mount Augusta in the Clan Alpine Range at 3038 m (9964 ft amsl), while the highest point of the Stillwater Range is 2678 m (8783 ft amsl) at Job Peak. Most of the region receives between 100 and 250 mm of rainfall per year, but higher elevations may receive as much as 450 mm. Average annual temperatures range from 7 to 13 degrees Celsius and the average frost free season is between 60 and 150 days, depending on elevation (USDA Soil Conservation Service 1981:21).

The study area incorporates portions of the Lahontan Basin and Tonopah floristic sections, which differ primarily by the presence of pinyon in the Tonopah section (Cronquist et al. 1986:89-92). Marshes in the study area support cattail, bulrush, sedge, and rush. The greasewood-saltbush association is the most common vegetation community in the study area. Saltbushes that are widespread below 1500 m (4920 ft amsl) intermix with black greasewood at lower elevations and with Bailey's greasewood at higher elevations. Indian ricegrass is a dominant grass of the greasewood/saltbush association, generally preferring sandier soils. Big sagebrush and black sagebrush are dominant shrubs at higher elevations, while stands of singleleaf pinyon and Utah juniper occupy areas between 1800 and 2400 m (5906 and 7872 ft amsl) in the Stillwater and Clan Alpine ranges (USDA Soil Conservation Service 1981:21). Low lying saline basins are abiotic. The plants and associated animals in all their variety are discussed fully in Chapter 4.

Conceptualizing Range Type and Habitat Type

In order to model hunter-gatherer ecology in the study area, we must estimate the spatial distribution and abundance of critical resources as they existed before the middle nineteenth century. Surveys of modern vegetation and wildlife are inadequate to the task because grazing, fire suppression, range management policy, irrigation, and urban development have altered extensively the biota of the Lahontan Basin (cf. Young et al 1976). Therefore, we must find another method of estimating the distribution and abundance of resources available to ethnographic Toedokado, one free of distortion induced by modern development. To accomplish this task, Raven and Elston (1989) borrowed the range type concept from range management and soil science, to identify 'habitats' representing plant communities potentially important to hunter-gatherers. Habitats were subdivided further into 'habitat types' based on water and drainage.

We, too, employ range type and habitat type concepts. However, using these devices as tools for interpreting archaeological site distributions demands careful consideration of their definitions and derivations. Habitat types and range types are similar constructs, independently derived, that link vegetation community with physiographic landscape (Daubenmire 1968, 1985; Dyksterhuis 1949, 1958, 1983); both can serve as hierarchical systems for classifying potential natural vegetation (Society of Range Management 1983, Hironaka 1984). As used here, potential natural vegetation is the climax community or set of associated climax communities that would become established on any particular piece of land, under current climatic conditions (Society of Range Management 1983). We consider habitat type the set of soils, landforms, and hydrological conditions that will support a specific climax vegetation community (Daubenmire 1968; Passey et al. 1982). Each set of distinctive geological, topographic, climatic, and hydrological conditions within a climax vegetation community represents a separate range type (Dyksterhuis 1949, 1958). Therefore, a habitat type (a potential natural vegetation community) may include multiple range types (geographic locations capable of supporting that community) [Hironaka 1984].

Range types correlate strongly with soil types, because both vary according to the same geological, topographic, climatic, and hydrological conditions (Dyksterhuis 1958, Aandahl and Heerwagen 1964).

Consequently, the Soil Conservation Service uses range types to link soil mapping data to potential natural vegetation communities. They rely on aerial photographs to estimate distributions of both range types and soil types. In addition, the distribution of range types can be inferred from soil mapping units.

Range and soil scientists classify range types by analyzing the productivity and composition of relict sites, which are stands of vegetation that maintain climax plant communities because undisturbed or protected long enough for a climax community to reestablish (Passey et al. 1982:6). Range scientists sample relict sites by selecting plots within the stand and clipping all herbaceous growth therein to ground level. They usually sample in mid-summer, before seeds of most common grasses are sufficiently dry to shatter. The collected herbage is air dried and weighed by species. Estimates of the total annual production and percentage species composition of the relict stand in kilograms per hectare are generated from these field measurements. Such estimates are particularly detailed for perennial grasses and grass-like plants, perennial forbs, and shrubs (Passey et al. 1982:6).

Significant differences in species composition, species proportion, and total plant production of relict stands distinguish different potential natural vegetation communities (Passey et al. 1982). These communities are correlated with the soil, topographic, hydrological, and climatic conditions of the relict stands to identify range types. This correlation between potential natural vegetation and physiographic location allows range scientists to extrapolate the spatial distribution of the vegetation community into other areas where the same physiographic conditions occur.

Range types can serve as a basis by which the archaeologist can estimate prehistoric plant distributions because they describe relict stands that correlate with soil types. The identification of potential natural vegetation communities from relict stands allows vegetation composition and productivity to be modeled by soil types, notwithstanding modern disruption to vegetation communities. Detailed descriptions of the composition, abundance, and productivity of perennial grasses, forbs, and shrubs permit detailed analysis of the raw abundance of their species. Too, the link between range type and mapped soil units permits estimation of the spatial distribution of resources in potential natural plant communities. Raven (1984) and Eckerle (1989) have expressed the potential uses of range types to prehistoric archaeology; other examples of the application of range types to archaeological data analysis and interpretation are given by Eckerle (1988a, 1988b); Frison et al. (1988); Leach (1988); Zeanah (1992); Raven (1990); and Raven and Elston (1989).

The use of range types to model prehistoric plant communities warrants caution in four areas, however, because of limitations in the way range types are defined, identified, and described. Limitations in two areas are purely methodological, concerning bias in the quantitative description of potential natural communities. The second two caveats speak directly to basic assumptions of range and habitat concepts.

Methodologically, since range scientists usually clip relict sites in mid-summer, when most forbs no longer maintain flowers, they cannot identify many perennial forbs to species. Instead, they usually record unidentified forbs as 'other' perennial forbs (Passey et al. 1982:8). Too, annual forbs and grasses are underrepresented in relict sites because they thrive in successional rather than climax communities of the Great Basin (Young et al. 1976:198; Raven and Elston 1989:106-107). Forbs and annual grasses that rarely appear in range site descriptions include several potentially important human foods such as goosefoot, tansy mustard, white-stemmed blazing star, sunflower, and bitterroot. Because of this bias, the potential natural vegetation communities quantified in range types cannot represent a complete set of plant food resources that may have attracted prehistoric hunter-gatherers. The distributions of these resources can be only loosely inferred from range type data and supplemental sources.

The second methodological issue is that herbaceous growth weight forms the basis of productivity estimates for range types. Although weight is a consistent intraspecies measure, obviously it cannot constitute an accurate measure of comparative productivity among species, *if we define production as yield of edible plant parts*. For example, when sampling relict plots soil scientists completely clip grasses and forbs to ground level for measurement, but clip only the current season's growth of leaves, twigs, inflorescences, and fruit of trees and shrubs. Thus, in this collection mode, ten kilograms of Indian ricegrass cannot be calorically equivalent to ten kilograms of pinyon. Too, measures of above ground biomass cannot reflect the food value to hunter-gatherers of subsurface plant parts. Therefore, dry weight estimates of growth for any species can be used as a quantitative measurement of the relative abundance and distribution of that species but never of the relative values of different species as food resources. Instead, we rely on experimental and ethnographic data on the energetic efficiency of resource utilization to assess the relative value of various resources (cf. Chapters 4 and 5).

There are two limitations inherent in basic assumptions of the range and habitat concepts: first, an environmental model based on range types is a model of climax vegetation, yet it is not only climax vegetation that occupied the prehistoric Carson Desert. Indeed, fire, flood, and grazing by native fauna frequently disrupted the climax of many areas (Young et al 1976:188-191), encouraging successional plant communities and inducing short-term fluctuation in the resource structure of the prehistoric Carson Desert. Successional regions would have fostered economically important forbs and annual grasses, presumably attracting prehistoric foragers. Therefore, a model of past plant communities based on range types fails to predict the spatial and temporal variability of successional habitats. Second, and more important, range types estimate productivity and composition of potential natural plant communities under modern conditions; such communities are not living fossils of extinct plant associations. For example, modern livestock grazing has fostered expansion of sagebrush and invasion of annual forbs at the expense of native perennial grasses in rangelands of the Lahontan Basin (Young et al 1976; Young and Tipton 1990). Modern irrigation has altered the salinity and lowered the water budget of lowland marshes, thereby altering their potential natural vegetation communities (Fowler 1992:45). Thus, range type descriptions derived from modern relict stands reflect the modern equilibrium as affected by modern alterations (cf. Young et al. 1976).

Too, paleoenvironmental data derived from pollen cores and packrat middens indicate several major changes in the composition of Lahontan Basin plant communities during the Holocene, including contraction of sagebrush communities in favor of greasewood/saltbush (Wigand and Mehringer 1985), expansion of marsh communities and woodland at the expense of greasewood/saltbush, and a shift from juniper to pinyon-dominated woodlands (Wigand 1990). Modern potential natural communities do not represent the plant communities that existed before these shifts occurred; indeed, some plant associations of the past have no modern analogs (Tausch et al. 1993). Some range scientists advocate revision of habitat and range type concepts in light of the paleoenvironmental record (Tausch et al. 1993), pointing out that modern plant "communities" are the result of dynamic responses of individual species to long term climatic change through adaptation, migration, and hybridization. Consequently, the composition of vegetation communities maintained by range sites has varied significantly over time. Environmental changes alter the composition of natural communities and thereby change the habitat type. Such temporal variability suggests that the assumption that a single equilibrium plant community with a specific species composition occurs exclusively on each range type may be erroneous. Instead, these range scientists argue that multiple equilibrium communities may be possible in equivalent environments. The community that occurs in any particular environmental location is a consequence of the unique climatic and disturbance history of that location. In other words, plant communities classified as successional in terms of habitat type should be considered alternative potential natural plant communities.

The foregoing observations compel acknowledgment of the temporal and spatial dynamics of the biotic landscape of the Carson Desert, but, as long as these limitations and criticisms are controlled, habitat types serve as useful analytical tools in consideration of prehistoric site distributions. Range types and their associated vegetation communities represent a consistent qualitative description of modern plant community composition and productivity, which can be used to extrapolate the climax resource landscape that existed in the study area before modern times.

While the model landscape becomes progressively less accurate the farther back in time it is applied, it provides a baseline by which prehistoric resource distributions can be estimated, because plant communities are modeled according to soil type. Since soils and vegetation vary according to the same geological, topographic, hydrological, and climatic conditions, and since the formation of soils reflects the interaction between vegetation and environment over long periods of time (Eckerle 1989), soil types should reflect, grossly but reliably, the vegetation communities that typically grew on them in the past.

Although specific compositions of present habitat types may differ from their prehistoric predecessors, they should be fundamentally similar in productivity, structure, and function (Tausch et al 1993:445). Range types that are highly productive in total biomass today should have been so in the past, despite differences in particular species composition or stage of succession. Range types that currently favor particular perennial plant species should have been favorable for those or similar species in the past (although the precise percentage contribution of the species to the community may have been different). Using the paleoenvironmental record as a guide, we should be able to estimate how the distribution of critical resources may have varied in the past. For example, we should be able to estimate effects of an expansion of pinyon-juniper woodland or a constriction of greasewood/saltbush based on an understanding of the modern structure of potential natural plant communities.

Thus, we accept range and habitat types as useful heuristic tools for modeling prehistoric resource distributions. A model of Carson Desert habitat types should represent a valid characterization of the climax resource structure that existed before the intrusion of European-Americans. As such, it serves as a model landscape into which can be integrated data on ethnographic Toedokado subsistence and settlement strategies. This, in turn, constitutes a predictive baseline to compare with archaeological site distributions. Too, the paleoenvironmental record serves as a guide to how the ethnographic resource landscape may have differed from that of prehistory.

Construction of the Previous Stillwater Model

Formulation of the Stillwater model (Raven and Elston 1989) from soil and range type data was straightforward. The basic analytical units of the model were one kilometer square quadrats tied into the Universal Transverse Mercator (UTM) grid; unit size was selected to accommodate observations of subtle distinctions in the landscape of soil and range types without imposing spurious precision onto available soil and range data (Raven and Elston 1989:50). Moreover, square kilometer quadrats locked into the UTM grid were convenient for archaeological sampling and survey (Raven 1990).

The Stillwater Wildlife Management Area, which constituted the sampling universe, lies entirely within the boundaries of the Fallon-Fernley soil survey (Dollarhide 1975); soil maps from the survey were used to identify the predominant soil mapping unit falling within each square kilometer cell of the study area. In all, 33 discrete soil mapping units were identified in the Stillwater Wildlife Management Area (Raven and Elston 1989:51). Publication of the Fallon-Fernley soil survey preceded compilation of present range type descriptions (USDA Soil Conservation Service 1992), however, so that numerous soil types identified in the Stillwater Wildlife Management Area lacked associations with up-to-date range type categories. Fortunately for us, SCS personnel in Fallon identified 13 range types that occurred in 13 combinations on the 33 Fallon-Fernley soil types.

Each of the range type combinations was designated a habitat; thus, "habitat" refers to a potential natural plant community, or association of communities, that is defined by a specific set of co-occurring range types. Raven and Elston (1989) also identified two additional ecological settings as habitats, marshes and playas, to yield a total of 15 habitats. They calculated the productivity and composition of the potential natural plant communities by averaging the annual air dry production and species composition of each constituent range type in each community.

The final stage of the process cross-stratified the 15 communities according to presence or absence of perennial water and tendency to flood. Raven and Elston (1989) assumed that these two variables impose critical constraints on biotic productivity and that hunter-gatherers react to the combined distributions of biotic resources, perennial water, and irregular inundation. Therefore, habitats were subdivided into habitat types according to the perennial water regime and to potential for irregular flooding, yielding now 34 habitat types. Thus, a habitat type is a specific variant of a habitat, as determined by significant variation in physiographic or hydrological conditions.

Each square kilometer cell in the Stillwater Wildlife Management Area was assigned a habitat, each designated by a two-digit number. This delineation represented the final subdivision of environmental variables in the Stillwater study area, and served as the basis for all subsequent evaluations of the biogeographical landscape and predictions of the archaeological record (Raven and Elston 1989).

Construction of a Habitat Model for Toedokado Territory

Construction of the Stillwater model was relatively simple because the exercise relied on a single, consistent soil and range database. Turning now to all of Toedokado territory, we find that available soil and range type data are neither uniform nor consistent; indeed, three different soil and range type databases encompass overlapping portions of the study area. Even with the three sources, however, 674 square kilometers (7%) of the northern and western extremities of the study area remain unaddressed by any database. With the three databases collectively covering 93% of the study area, the problem becomes how to transform three disparate data sets into one internally consistent database suitable for expanding the Stillwater model to encompass all of Toedokado territory.

Available Soil and Range Databases

The three available databases include two soil surveys and one vegetation type inventory, each of which records different kinds of data at different levels of intensity. For example, one soil survey provides detailed soil maps but does not associate mapping units with range types. The other soil survey is associated with range types but soil maps are not at hand. Finally, the vegetation type survey maps range types in detail but without cross-reference to soil types. Each database is described separately below.

The Fallon-Fernley Soil Survey

This is the soil survey (Dollarhide 1975) that produced the original Stillwater model. As can be seen in Figure 4, the Fallon-Fernley soil survey extends southwest and north of the Stillwater Wildlife Management Area to cover much of the western half of Toedokado territory. For this area we simply expand the Stillwater model to the boundaries of the soil survey, using the same set of procedures developed for the Stillwater model. However, range associations of soil mapping units, not previously confronted in the Stillwater model area, must be established.

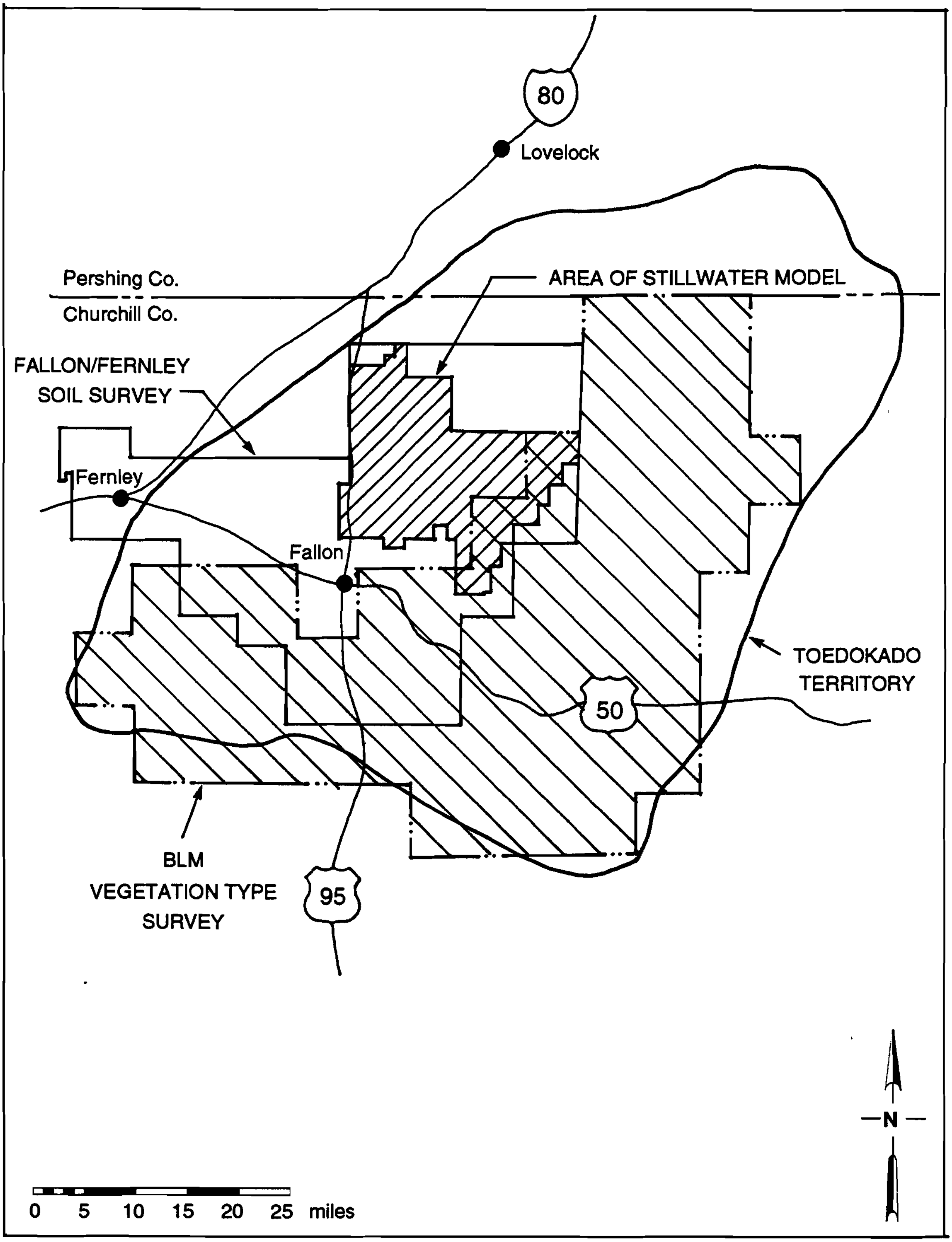

Figure 4. The Fallon-Ferley Soil Survey (Dollarhide 1975) and the Bureau of Land Management Vegetation Type Survey relative to Toedokado territory.

Bureau of Land Management Vegetation Type Inventory

The Bureau of Land Management (BLM) conducted an inventory of vegetation types on BLM lands in Churchill County during the early 1980s (Andrea Minor, personal communication, April 1994). Vegetation types are defined as communities and associations of plants located on definable plots of land (Society of Range Management 1983). The survey area extends over much of southern and eastern Toedokado territory, slightly overlapping the Fallon-Fernley soil survey. Survey coverage, however, excluded lands within the boundaries appearing in Figure 4 that are not administered by BLM.

BLM identified vegetation types from aerial photos and field examinations. Each vegetation type was plotted as a polygon on 7.5′ orthophotoquads, and was labeled to indicate plant composition and range condition of the mapped unit. Soil data are not recorded because BLM did not conduct a soil survey in conjunction with the vegetation survey. However, the survey did report range types, estimating the percentage composition by range type for each mapped vegetation type on the orthophotoquad. Consequently, the BLM vegetation survey provides range type data considerably more precise and detailed than can be inferred from soil type. However, the range of variability recorded on these maps defies translation into general habitat types comparable to those of the Stillwater model and, while the mapped vegetation types appear to correspond closely to mapped soil units, they are not cross-referenced to soil types.

Churchill County Soil Survey

The Soil Conservation Service currently is preparing a soil survey for parts of Churchill County not included in the Fallon-Fernley soil survey. Maps and documentation for the survey are in preliminary stages of preparation and are not easily available for reference. However, SCS personnel in Fallon provided us a draft copy of soil map unit descriptions for their survey areas falling within our study area (USDA Soil Conservation Service nd). Similarly, the BLM Carson City District Office has provided access to draft soil maps and NAS Fallon has provided soil maps of Navy parcels in Toedokado territory, which are based on soil mapping units of the Churchill County Soil Survey (USDA Extension Service 1991).

The Churchill County Soil Survey is more suited to our purposes than is the Fallon-Fernley Soil Survey because each soil mapping unit is identified with a set of range types. However, the preliminary status and limited availability of the soil maps limits their usefulness in the present exercise. Precise boundary definitions of the survey are unavailable at this writing, so the area of coverage is not demarcated on Figure 4, but we understand the completed soil survey is to cover all of Churchill County east and south of the Fallon-Fernley soil survey.

Identification of Habitats of the Carson Desert

Incorporation of the three data sets into a single habitat model comparable to that of Stillwater demands a reversal of the sequence by which the Stillwater model was constructed. Instead of translating soil types into range types into habitats, we first identified a set of habitats and then worked our way back to the specific soil and vegetation survey map data, as described below.

Plant Habitats of the Stillwater Wildlife Management Area

The set of habitats (before cross-stratification by water or flooding) identified by Raven and Elston (1989:61) were taken as a baseline. Because these habitats formed the basis of the Stillwater model, we made as few modifications to these plant habitats as possible. Of course, we have revised the numbering sequence employed previously to accommodate more habitat types. Table 1 indicates the nomenclature, composition, and characterization of the original Stillwater plant habitats as well as the current habitat designator.

Table 1. Revised Concordance of Potential Plant Communities, Range Types and Habitat Types of the Stillwater Model.

Present Habitat Designator	Stillwater Habitat Type Designator	Constituent Range Types	Habitat Name
01	11, 12, 13	1, 25	Marsh, marsh w/islands
02	21, 22, 23	-	Playa
03	31, 32	25	Sodic Flat, 4"-8" p. z.
04	41, 42	5/25	Wet sodic bottom/sodic flat
05	43, 44	2/5/25	Moist floodplain/wet sodic bottom/ sodic flat
06	45, 46	2/5	Moist floodplain/wet sodic bottom
07	51, 52	25/24-9/12/41	Sodic flat/sodic terrace-sandy fans and sheets/sodic sands/deep sodic sands
09	53, 54, 55, 56, 57	9/12-25/36	Sandy fans and sheets/sodic sands-sodic flat 4"-8"/sodic flat 3"-6"
10	61, 62, 65, 66	18	Gravelly loam, 4"-8" p.z.
11	63, 64	9/18	Sandy fans and sheets/Gravelly loam, 4"-6" p.z.
13	71, 72	25/18	Sodic Flat, 4"-8" p.z./Gravelly loam, 4"-6" p.z.
14	81, 82	24	Sodic terrace
15	91, 92, 93	23/16	Dunes and sodic dunes

key: p.z. = precipitation zone

We made a few minor changes to the Stillwater habitats in the interest of consistency and incorporation of current range type data. For example, the present configuration of the marsh habitat (01 in the present numbering system) includes Range Type 1, or wetland, of which a description was not available to the Stillwater model. Another change to the set of Stillwater model habitats concerns Habitat 9, which was two separate communities in the Stillwater model, with Habitat Types 53 and 54 comprising one, and 55, 56, 57 comprising the other. However, since identical sets of range types characterize both communities, we have collapsed them into one habitat. Similarly, we have combined Stillwater Habitat Types 61 and 62 with Habitat Types 65 and 66 into the present Habitat 10. This is warranted because the draft range type descriptions (USDA Soil Conservation Service 1989) referenced by Raven and Elston (1989) employed separate range type numbers for gravelly loams 4" - 6" (Range Type 18) and gravelly loams 6" - 8" (Range Type 30), but the range type descriptions used here (USDA Soil Conservation Service 1992) combine the two into a single range type: gravelly loams 4" - 8" (Range Type 18). Since this was the sole distinction between the two Stillwater habitats, we have combined them into one habitat for the Toedokado model.

Plant Habitats of the Carson Desert

The present study area is many times larger and contains a greater variety of topographic, hydrological, geological, soil, and vegetation variability than the area of the Stillwater model. Consequently, the set of habitats identified for Stillwater cannot account for the diversity of Toedokado territory. To identify an expanded set of habitats, we turned to the Churchill County Soil Survey (USDA Soil Conservation Service nd). As mentioned earlier, these soil descriptions list from one to three of the most common range types within each soil unit, as well as contrasting range types that occur in minor proportions (< 5%). We reviewed these soil descriptions systematically to identify range types recurrently associated with soil mapping units of the Churchill County Soil Survey, either individually or in sets of two to four. We assume that these sets of co-occurring range types are equivalent to the habitats of the Stillwater model.

Not surprisingly, most of the original 13 Stillwater habitats were also present in the Churchill County soil descriptions. However, we identified a set of 24 possible range site combinations and one ecological setting (badlands) which were not identified in the previous Stillwater exercise; each of these is a new habitat. The habitats and ecological setting derived from the Churchill County Soil Survey are indicated in Table 2. The sequence of present habitat designators is arbitrary except that it reflects the order in which habitats were identified.

Table 2. Habitats Derived from Churchill County Soil Survey.

Present Habitat Designator	Constituent Range Types	Habitat Name
16	9	Sandy 5"-8" p.z.
18	27	Barren Gravelly Slope 4"-8" p.z.
19	50	Coarse Gravelly Loam 5"-8" p.z.
20	9 / 18/ 23	Sandy 5"-8" p.z./Gravelly Loam 4"-8" p.z./Dunes 4"-8" p.z.
21	18/22	Gravelly Loam 4"-8" p.z./Valley Wash 4"-8" p.z.
26	18/ 27	Gravelly Loam 4"-8" p.z./Barren Gravelly Slope 4"-8" p.z.
27	14 /18/ 45	Coarse Silty 4"-8"/Gravelly Loam 4"-8" p.z./Sandy 8"-10" p.z.
28	5/ 6	Saline Meadow/Saline Bottom
29	25/ 41	Sodic Flat/Deep Sodic Fan
31	8	Droughty Loam 8"-10"
34	80/ 81/ 82	Pinyon-Juniper Woodland
35	7/ 32	Loamy Slope 8"-10" p.z./Shallow Calcareous Loam 8"-10"
36	13	Loamy 4"-8" p.z.
37	7	Loamy Slope 8"-10" p.z.
38	16/ 25	Sodic Dunes/Sodic Flat
40	19	Stony Slope 4"-8" p.z.
42	15	Stony Loam 4"-8" p.z.
44	20	Shallow Claypan 8"-10"
46	37	Loamy Slope 5"-8" p.z.
47	46/ 54	Cobbly Claypan 12-14"/Loamy Slope 10"-12"
48	7/ 47	Loamy Slope 8"-10" p.z./Eroded Granitic Slope
49	18/ 19	Gravelly Loam 4"-8" p.z./Stony Slope 4"-8" p.z
52	7/ 51	Loamy Slope 8"=10" p.z./South Slope 8"-10" p.z.
54	-	Badland
56	7/ 18/ 19/ 27	Loamy Slope 8"-10" p.z./Gravelly Loam 4"-8" p.z./Stony Slope 4"-8" p.z./ Barren Gravelly Slope 4"-8" p.z.

Key: p.z. = precipitation zone

Transformation of Mapped Soil and Vegetation Types into Habitats

Armed with a set of potential habitats expanded by 25, we returned to the three soil and range databases to transform each mapped soil and vegetation type into a habitat. As did Raven and Elston (1989), we used square kilometer quadrats of the UTM grid as our basic analytical unit.

Our attention turned first to the BLM vegetation type survey maps because they present the most precise range type data among the three sources. The dominant vegetation mapping unit of each square kilometer of the UTM grid was recorded. Each vegetation type then was classified as the most appropriate plant habitat according to the range type concordances tabulated in Appendix B. This was a straightforward process in most cases where the range types recorded for a vegetation mapping unit corresponded exactly to the set of range types typical of a habitat. However, a minority of cases contained unexpected range type configurations, where some range types designated on the vegetation maps were obsolete classes deleted from the current range type handbook. These cases demanded translation of obsolete range type designators into appropriate current designators. In most cases, this allowed classification of the vegetation type as a habitat. Finally, a minority of vegetation types contained a few range types that did not conform to habitat configuration. In these cases, the vegetation type was classified to the most appropriate habitat based on the dominant one or two range types.

We then turned to the maps of the Fallon-Fernley Soil Survey (Dollarhide 1975) to record soil data for each square kilometer quadrat not included in the Stillwater model or in the BLM Vegetation Type Survey. We superimposed the UTM grid over the soil maps and recorded the dominant soil mapping unit within each UTM Cell. These soil types were designated as habitats based on the soil map unit/range type/habitat concordances tabulated in Appendix C, identical, in many cases, to concordances given by Raven and Elston (1989:56). We determined range type equivalencies of the remaining soil mapping units by identifying equivalent map units in the Churchill County Soil Survey (USDA Soil Conservation Service nd), referring to representative soil taxa listed in range type descriptions (USDA Soil Conservation Service 1992) or extrapolating from similar or closely related soils in the Fallon-Fernley Soil Survey (Dollarhide 1975:7-48) identified by Raven and Elston (1989:56).

The next stage referred to BLM's draft Churchill County soil maps to assign habitats to areas outside the boundaries of both the Fallon-Fernley Soil Survey and the BLM Vegetation Type Survey. These were recorded in a manner identical to the Fallon-Fernley Soil Survey. The most extensive mapped soil unit within each square kilometer was recorded and assigned to the appropriate habitat. Concordances between Churchill County soil mapping units, range types, and habitats were determined by reference to draft soil descriptions (USDA Soil Conservation Service nd) and are tabulated in Appendix C.

Having done all this, we accomplished assignment of a habitat to each of 8758 square kilometer cells for which soil or range type data were available. The remaining 674 cells in Toedokado territory for which no data were available depended on extrapolation of soil classifications and range types apparent on air photos and adjacent soil and range type maps. Through extrapolation we were able to classify all but 29 cells. As we know, composition and areal distribution of plant communities is linked closely to soil type. Soil type in the study area is influenced especially by the nature and distribution of deposits laid down in ancient Lake Lahontan, and in the deltas and floodplains of its major tributaries (here, the Humboldt and Carson Rivers). These deposits have been modified by considerable eolian erosion. Old lacustrine sediments have been exposed on the basin floor and in places around its margins, while extensive subaerial deposits (silt lunettes, sand dunes, and sand sheets) are found on the basin margins, on surrounding mountain slopes, and in Dixie Valley.

In places where the "bathtub ring" effect of ancient lake stands is pronounced (e.g., the western and northern margins of the Carson Sink), shoreline terraces decrease in age downslope, and the relative age of fans and subaerial deposits can be distinguished by whether they overlie or are cut by Pleistocene shore features. In such places, the same sets of landscape features are repeated in the same order. For example, fans and shoreline features intermediate to the maximum Pleistocene highstand of Lake Lahontan (1333 m) and the Late Pleistocene shoreline of Russell (1203 m) tend to be classified as Range Types 18 and 26. It is a simple matter to extend these range types into adjacent areas between the same elevations when air photos suggest similar slopes and rock types. Similarly, vegetated sand dunes at the margins of the basin are Range Types 16 and 25; one is reasonably certain that similar dunes in the same position are the same range types.

Soil maps covered several areas where adjacent range type maps were unavailable. In most cases, the soil maps provide estimates of pristine vegetation present, although not in proportions of dominant species as given by range types. In areas under cultivation (vicinity of Fallon, Stillwater, and Fernley), soil mapping is exceedingly detailed, with each former river floodplain, terrace, levee, channel, and slough mapped as a slightly different variant of a relatively few soil series. These soils, however, tended to support similar pristine vegetation, and usually were collapsed into a category called "riverine" for our purposes. In some places, it was possible to extrapolate soils into areas not covered by soil maps, using the same kinds of clues employed for extending range types.

Whether using range type or soil maps, however, the farther we project in this fashion from known points, the less confidence we have in our classifications. Working with air photos very far from known points, one can merely distinguish the general types of geomorphs (i.e., fans, inset fans, steep rocky mountain slopes, smooth mountain slopes, dunes, etc.) without estimating any soils or range types. This is still useful, however, because it limits the resource possibilities for each identified geomorphic feature.

Table 3 presents the number of cells, including those of the Stillwater model, assigned each habitat. In all, 9403 of the 9430 square kilometer cells of the study area were habitat-assignable.

Table 3. Number of Cells per Habitat.

Habitat Designator	Name	No. Cells
01	Marsh, marsh w/ islands	225
02	Playa	1327
03	Sodic Flat, 4"-8" p.z.	637
04	Wet sodic bottom/sodic flat	103
05	Moist floodplain/wet sodic bottom/sodic flat	118
06	Moist floodplain/wet sodic bottom	192
07	Sodic flat/ sodic terrace-sandy fans and sheets/sodic sands/deep sodic sands	166
09	Sandy fans and sheets/sodic sands-sodic flat 4"-8"/sodic flat 3"-6"	346
10	Gravelly loam, 4"-8" p.z.	1229
11	Sandy fans and sheets/Gravelly loam, 4"-6" p.z.	641
13	Sodic Flat, 4"-8" p.z./Gravelly loam, 4"-6" p.z.	248
14	Sodic terrace	36
15	Dunes and sodic dunes	58
16	Sandy 5"-8" p.z.	280
18	Barren Gravelly Slope 4"-8" p.z.	232
19	Coarse Gravelly Loam 5"-8" p.z.	61
20	Sandy 5"-8" p.z./Gravelly Loam 4"-8" p.z./Dunes 4"-8" p.z.	207
21	Gravelly Loam 4"-8" p.z./Valley Wash 4"-8" p.z.	184
26	Gravelly Loam 4"-8" p.z./Barren Gravelly Slope 4"-8" p.z.	439
27	Coarse Silty 4"-8"/Gravelly Loam 4"-8" p.z./Sandy 8"-10" p.z.	51
28	Saline Meadow/Saline Bottom	128
29	Sodic Flat/ Deep Sodic Fan	190
31	Droughty Loam 8"-10"	76
34	Pinyon-Juniper Woodland	475
35	Loamy Slope 8"-10" p.z./Shallow Calcareous Loam 8"-10"	72
36	Loamy 4"-8" p.z.	34
37	Loamy Slope 8"-10" p.z.	490
38	Sodic Dunes/ Sodic Flat	198
40	Stony Slope 4"-8" p.z.	171
42	Stony Loam 4"-8" p.z.	101
44	Shallow Claypan 8"-10"	101
46	Loamy Slope 5"-8" p.z.	96
47	Cobbly Claypan 12-14"/Loamy Slope 10"-12"	193
48	Loamy Slope 8"-10" p.z./Eroded Granitic Slope	36
49	Gravelly Loam 4"-8" p.z./Stony Slope 4"-8" p.z	40
52	Loamy Slope 8"=10" p.z./South Slope 8"-10" p.z.	13
54	Badland	34
56	Loamy Slope 8"-10" p.z./Gravelly Loam 4"-8" p.z./Stony Slope 4"-8" p.z./ Barren Gravelly Slope 4"-8" p.z.	175
Key: p.z. = precipitation zone		9403

Cross-Stratification of Habitats into Habitat Types by Water, Inundation, and Slope

Classification of the environment of Toedokado territory requires yet another step to achieve a model comparable to that of Stillwater. Raven and Elston (1989:59) assumed that prehistoric hunter-gatherers evaluated foraging patches in light of a combination of biotic and abiotic variables. We account for biotic variables by determining habitats associated with plant communities and transforming them into mapped range and soil data. Two abiotic variables likely to have been important determinants of hunter-gatherer foraging decisions, availability of perennial water and potential for irregular (non-annual) inundation (Raven and Elston 1989), were used to cross-stratify Stillwater habitats into habitat types: we repeat the exercise here, cross-stratifying the Carson Desert habitats. In addition, we identify a third important abiotic variable not relevant to the vast flat expanses of the Stillwater marsh and Carson Sink, yet necessary to cross-stratification of habitats into habitat types for much of Toedokado territory: slope.

Cross-Stratification by Water Source

In arid and alkaline environments, the distribution of perennial water sources constrains feasible camp locations and foraging areas of hunter-gatherers (Birdsell 1953; Taylor 1964; Lee 1968; Steward 1970:120-121). For these reasons, Raven and Elston (1989:59) identified perennial water as an important variable in their construction of habitat types. We, too, recognize the importance of this variable and have recorded the presence (and type) or absence of perennial water sources for each of the 9430 cells in the study area. Six categories of water source are recognized: upland spring, lowland spring, marsh, lake, river, and slough or delta. The distribution of quadrats associated with each water type is illustrated in Figure 5.

Springs were recorded by simply reviewing all USGS 7.5 min. and 30 min. x 60 min. quadrangles encompassing the study area and noting every cell that contained a marked spring. In addition, we identified salt springs on the northwest edge of Eightmile Flat based on field observation. Springs were divided arbitrarily into upland and lowland categories at the 1450 m (4757 ft amsl) elevation. If more than one spring was present within a cell, the number of springs was noted. If a quadrat contained a spring in association with another type of water source, the spring was given preference and the quadrat recorded as spring-associated.

As a cautionary note, we observe that tectonic activity affects springs and seeps, particularly in Dixie and Fairview Valleys where modern earthquakes have created and sealed springs (Zones 1957). Available data are insufficient to distinguish systematically either springs created by earthquakes in recent times or extinct ancient springs that would have been available to ethnographic and prehistoric populations.

Identification of marshes, rivers, sloughs, deltas, and lakes as they would have been available to prehistoric hunter-gatherers also is problematic. Our goal was to identify the maximum extent of perennial sources as they could have existed under hydrological conditions representative of the middle Nineteenth century. Short term fluctuations in water budgets make it tricky to assign definite boundaries to such sources. Too, irrigation development associated with the Newlands Project has altered considerably the water budget of the Carson Desert, making modern conditions unreflective of those of the middle nineteenth century (Kelly and Hattori 1985:40; Raven and Elston 1989:34-44; Fowler 1990:11, 44-45). Consistent identification of nineteenth century water sources requires careful reference to the relevant historic literature.

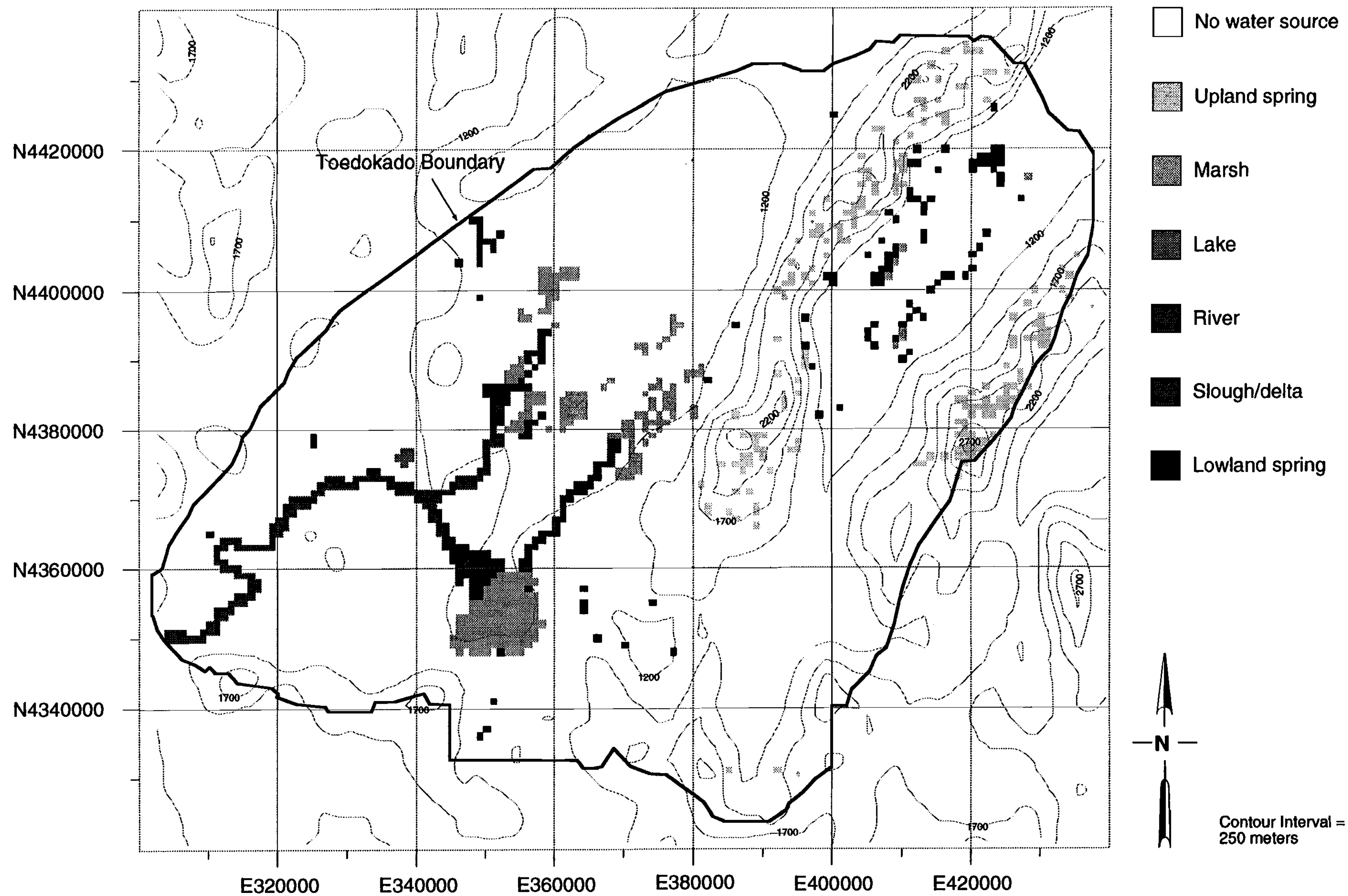

Figure 5. Distribution of water types in Toedokado territory.

Most quadrats with marshlands fall in the Stillwater Wildlife Management Area (Raven and Elston 1989: Table 10; Raven 1990:133). All of Carson Lake below the 1192 meter (3911 ft amsl) contour was identified as a marshland, estimated from accounts of its average historical size of 27,000 acres (Kerley et. al 1993:10-11), as well as Russell's estimation of the size of Carson Lake in 1882 at 26,000 acres (Russell 1885:68-69). Marshes identified in Dixie Valley are small, associated with flowing wells and springs at or near Dixie Hot Springs.

We consider channels of the Old Carson River, South Carson River, and Stillwater Slough permanent bodies of riverine, delta, or slough fresh water. The locations of the historical courses of these bodies are taken from Morrison (1964: Plate 11; see also Russell 1885: Plate VII) and include a great deal of the "Tule Swamp" on the South Carson River appearing on an 1867 plat map (Monroe's map, Raven and Elston 1989: cf. Figure 10). We have classified quadrats which possess both riverine and other non-spring water sources as simply riverine.

We used the Raven and Elston (1989:59-63) estimate of the extent of Stillwater Slough for parts of the slough within the Stillwater Wildlife Management Area; those portions of the slough southwest of the Management Area were identified from Morrisons' map (1964: Plate 11) and extrapolated from Raven and Elston (1989:4). Humboldt Slough occasionally dries completely and is highly alkaline when it does contain water. However, Morrison (1964:104) considered the Humboldt River an occasional source of water flowing into the Carson Sink, which would have transformed Humboldt Slough into a perennial source of fresh water. Based on this consideration, Raven and Elston (1989:67) classified Humboldt Slough an historically "permanent" water source and we retain this classification.

While historical photographs demonstrate that both Large and Small Soda Lakes stands have fluctuated in the historical period (Berger 1984:146-150), such fluctuation has been relatively slight. Russell (1895:16) estimated that the largest lake covered 298.5 acres and was 147 feet deep at the end of the nineteenth century, which corresponds well with modern plots of the lake on USGS 7.5' quadrangles. Therefore, we took the lake boundaries as mapped by the USGS to represent their historical average.

Table 4 cross-tabulates water sources by plant habitat for all quadrats in Toedokado territory. As can be seen, 187 quadrats in the study area contain upland springs and 93 contain lowland springs. Marshes occur in 253 quadrats of the study area, river sloughs and delta occupied 122 quadrats, rivers crossed 137 quadrats, while deep water lakes lie in only six.

Cross-tabulation of water sources with habitats reveals potentially important bias in the way we assigned habitats to quadrats. Note, for example, that only 71 of 253 noted marshes fall within quadrats assigned to the marsh (Habitat 01). Riparian habitats (4, 5, 6, and 28) show a slightly better correlation with 82 of 137 river quadrats and 57 of 122 slough and delta quadrats assigned to riparian habitats. Finally, despite the widespread dispersion of springs, none of the identified habitats account for the discrete patches of wetland vegetation that typically grow around springs. These discrepancies reflect primarily the different criteria by which we assigned habitats and water sources to square kilometer quadrats; habitats reflect only the soil or vegetation type comprising the largest portion of a square kilometer cell. In many cases, riparian and marsh associated vegetation and soil types were present in a quadrat but were not recorded as the habitat type when they comprised a minor portion of that quadrat. However, the mere presence of a marsh or river in a quadrat was sufficient to warrant its recordation as a water source. This recording bias logically would have its greatest effect on springs that usually are associated with palustrine patches only a few acres in extent and therefore lost in a square kilometer quadrat.

Table 4. Distribution of Water Sources by Habitat.

Habitat Designator	Name	Upland Spring	Lowland Spring	Marsh	Lake	River	Slough/ Delta
No Data		0	0	0	1	0	0
01	Marsh	0	4	71	0	0	0
02	Playa	0	3	16	0	0	13
03	Sodic Flat, 4"-8" p.z.	0	6	57	0	0	24
04	Wet sodic bottom/sodic flat	0	0	6	0	1	29
05	Moist floodplain/wet sodic bottom/ sodic flat	0	0	2	0	30	19
06	Moist floodplain/wet sodic bottom	0	0	40	0	51	9
07	Sodic flat/sodic terrace-sandy fans and sheets/sodic sands/deep sodic sands	0	0	13	1	11	7
09	Sandy fans and sheets/sodic sands-sodic flat 4"-8"/sodic flat 3"-6"	0	0	38	0	3	19
10	Gravelly loam, 4"-8" p.z.	1	3	2	0	7	0
11	Sandy fans and sheets/Gravelly loam, 4"-6" p.z.	0	2	0	0	16	1
13	Sodic Flat, 4"-8" p.z./Gravelly loam, 4"-6" p.z.	1	0	1	4	1	0
14	Sodic terrace	0	0	0	0	0	0
15	Dunes and sodic dunes	0	0	0	0	2	1
16	Sandy 5"-8" p.z.	0	1	0	0	1	0
18	Barren Gravelly Slope 4"-8" p.z.	4	14	0	0	0	0
19	Coarse Gravelly Loam 5"-8" p.z.	0	0	0	0	0	0
20	Sandy 5"-8" p.z./Gravelly Loam 4"-8" p.z./ Dunes 4"-8" p.z.	0	1	0	0	1	0
21	Gravelly Loam 4"-8" p.z./Valley Wash 4"-8" p.z.	0	4	0	0	0	0
26	Gravelly Loam 4"-8" p.z./Barren Gravelly Slope 4"-8" p.z.	0	2	1	0	4	0
27	Coarse Silty 4"-8"/Gravelly Loam 4"-8" p.z./Sandy 8"-10" p.z.	0	0	0	0	0	0
28	Saline Meadow/Saline Bottom	0	22	3	0	0	0
29	Sodic Flat/Deep Sodic Fan	0	16	2	0	0	0
31	Droughty Loam 8"-10"	4	0	0	0	0	0
34	Pinyon-Juniper Woodland	77	1	0	0	0	0
35	Loamy Slope 8"-10" p.z./Shallow Calcareous Loam 8"-10"	0	0	0	0	0	0
36	Loamy 4"-8" p.z.	0	0	0	0	0	0
37	Loamy Slope 8"-10" p.z.	21	3	0	0	0	0
38	Sodic Dunes/Sodic Flat	0	9	1	0	5	0
40	Stony Slope 4"-8" p.z.	3	0	0	0	2	0
42	Stony Loam 4"-8" p.z.	0	0	0	0	2	0
44	Shallow Claypan 8"-10"	11	0	0	0	0	0
46	Loamy Slope 5"-8" p.z.	3	0	0	0	0	0
47	Cobbly Claypan 12-14"/Loamy Slope 10"-12"	58	0	0	0	0	0
48	Loamy Slope 8"-10" p.z./Eroded Granitic Slope	1	0	0	0	0	0
49	Gravelly Loam 4"-8" p.z./Stony Slope 4"-8" p.z	0	0	0	0	0	0
52	Loamy Slope 8"=10" p.z./South Slope 8"-10" p.z.	0	0	0	0	0	0
54	Badland	0	1	0	0	0	0
56	Loamy Slope 8"-10" p.z./Gravelly Loam 4"-8" p.z./Stony Slope 4"-8" p.z./ Barren Gravelly Slope 4"-8" p.z.	3	1	0	0	0	0
Total		187	93	253	6	137	122

Key: p.z. = precipitation zone

These biases are potentially critical because wetland habitats maintain higher densities of biomass than do those of dry land. Therefore, in any particular cell, a wetland community may out-produce a dryland community even though the dryland habitats occupy most of the area of the cell. This demands that our cross-stratification of habitats by water must serve not only to note the presence of water, as it did in the original Stillwater model, but also to calibrate our expectations about the vegetation composition of quadrats containing water sources. For riparian habitats this is simple; we assume that any quadrat assigned a non-riparian habitat, but having a riparian water source, will be assigned a minor coverage (25%) by Habitat 06, moist floodplain/ wet sodic bottom.

We can make similar assessments for quadrats assigned to non-wetland habitats, but nevertheless containing marshes or springs. However, these assessments require that we make three additions to our habitat inventory, as listed in Table 5.

Table 5. Wetland Habitats Accounting for Water Sources in Non-Wetland Quadrats.

Present Habitat Designator	Stillwater Habitat Type Designator	Range Type Configurations	Habitat Name
51	NA	3/4	Loamy Bottom 8-12" p.z./Wet Meadow 8-12" p.z.
53	13	1/25	Marsh w/islands and edge of Carson/Stillwater complex
55	NA	69	Wet Meadow 4-8" p.z.

Key: p.z. = precipitation zone

Raven and Elston (1989:64-68) identified our Habitat 53 as their marsh Habitat Type 13, which represents marsh plant communities and exposed islands. We extrapolate this community to apply also to marshlands bordered by adjacent dry lands. Any quadrat not recorded as marshland, but containing a marsh water source, is considered herein to contain 75% dryland and 25% marsh vegetation. Habitats 51 and 55 refer to plant communities associated with springs. Both were derived from identification of suitable range types from the current range site handbook (USDA Soil Conservation Service 1992). Habitat 51 refers specifically to springs and associated riparian zones above 1450 m (4757 ft amsl) in elevation; in contrast, Habitat 55 describes spring-associated communities below that elevation. Quadrats containing springs are considered separate habitat types bearing minor occurrences (25%) of spring-fed vegetation communities as well as the plant community associated with the dominant dryland habitat.

Cross-Stratification by Inundation Potential

Many settings of Toedokado territory are prone to periodic but irregular inundation, which affects the biotic productivity of those areas. Numerous irregularly inundated playas and greasewood/ saltbush habitats, in particular, will develop marshes when flooded. Raven and Elston (1989) identified irregularly inundated landscapes within the Stillwater Wildlife Management Area with the aid of orthophotoquads prepared by the National Wetlands Inventory (Cowardin et al. 1979; USDI Fish and Wildlife Service 1980). In most cases, we have abided by their determinations; however, the National Wetlands Inventory does not extend far beyond the boundaries of the Stillwater Wildlife Management Area. To develop comparable designations of irregularly inundated lands elsewhere in Toedokado territory, we are compelled to estimate such areas from extant literature.

For example, in the Carson Sink outside the Stillwater Wildlife Management Area, we define areas below the 1180 meter (3872 ft amsl) contour as irregularly inundated. This does not achieve the century flood levels observed at 1182.6 to 1185.7 meters (3880 to 3890 ft amsl) in the 1860s (Morrison 1964:82), and at 1181.4 meters (3876 ft amsl) in the 1980s (Kerley et al. 1993:13), but probably is more representative of the area frequently exposed to non-annual flooding. This assignment required that 45 quadrats in the Stillwater Wildlife Management Area classified by Raven and Elston (1989:62) as playa be reclassified here as irregularly inundated playa.

Eleven thousand acres of Carson Lake between its 1192 meter (3911 ft amsl) elevation and the 1194.5 meter (5919 ft amsl) elevation of its outlet into Stillwater Slough (Kerley et al. 1993:10) were designated as irregularly inundated. Also included were abandoned river channels of Fallon 4 age or younger, mapped by Morrison (1964: Plate 11) in the Carson River delta. The latter are all channels between the Old River, Stillwater Slough, and the South Carson River, and include the New River and New River Slough courses.

Mahala and Massie Sloughs also were designated as irregularly inundated. These areas currently are marshy termini of irrigation waste water drains (Morrison 1964:7). Prior to irrigation, they probably flooded only irregularly in the past. Massie Slough is at a low base level (1207 meters [3960 ft amsl]) adjacent the Hot Springs Mountains and could have acted as a natural drain in regimes of higher moisture. Mahala Slough (1219 meters [4000 ft amsl]) lies at the base of the Swingle Bench scarp, again a likely natural drain in a dune-levee basin. Smaller interdunal and deflated basins, including Mustang Pond and Mud Lake, along with interdunal and deflation basins north and west of the Soda Lakes and the Indian Lakes were not classified as irregularly inundated areas because they likely are too small to contain enough water to create marshy habitat.

According to Nials (1994:24), Labou Flat contained a pluvial lake in Late Pleistocene times, and probably held smaller lakes during the Holocene; standing water was observed there in early May 1994. On the basis of this evidence, we consider the Flat irregularly inundated below the current playa basin at 1264.5 m (4149 ft amsl) elevation. Nials (1994:24) believes that Rawhide Flat never has maintained standing water, even though a high water table keeps the basin somewhat moist. Therefore, we defined no areas of irregular inundation there.

Little is known about inundation in Dixie Valley. Davis (1982) cites evidence for standing water near Dixie Hot Springs at 6900 B.P. and suggests water stood in the Humboldt Salt Marsh in historic times. Based on the modern definition and mapping of Humboldt Salt Marsh, we define areas below 1028 meters (3373 ft amsl) in Dixie Valley as irregularly inundated.

Finally, we have identified areas of Four Mile Flat below 1897 meters (6224 ft amsl) as irregularly inundated. This determination is based on field observations and mapped water on the 7.5' USGS quadrangles.

All totalled, we encoded 896 quadrats in 17 habitats and ecological settings as irregularly inundated, their distribution is illustrated in Figure 6. The number of cells by habitat is indicated in Table 6. Most (64%) cells are classified as playa (Community 2). All irregularly inundated cells fit their corresponding plant habitat well, as all 17 plant communities and ecological settings are of types characteristic of low elevation and level terrain. As was the case with water sources, all cells identified as irregularly inundated are considered potentially separate habitat types from non-inundated cells assigned to the same habitat.

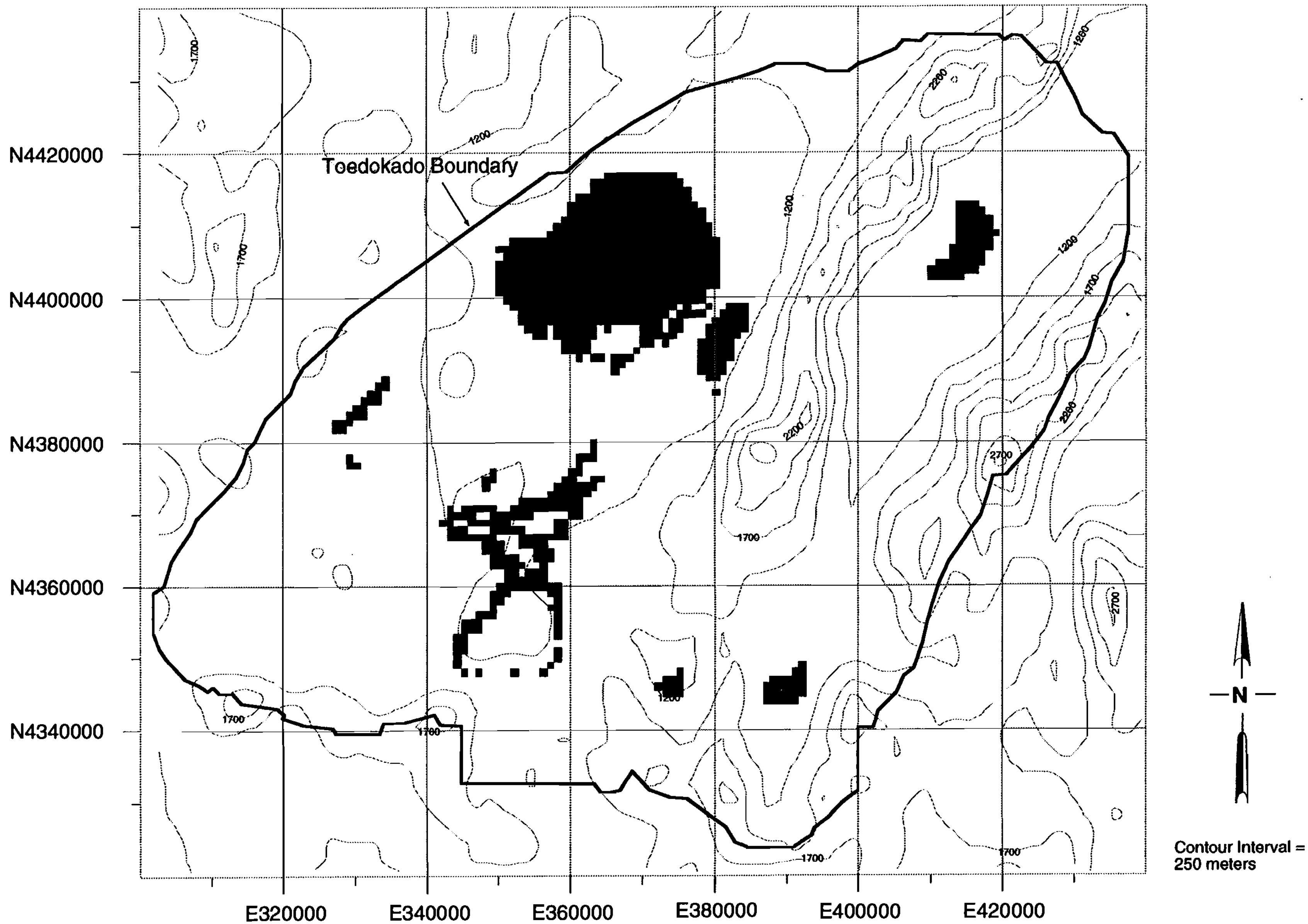

Figure 6. Distribution of irregularly inundated quadrats in Toedokado territory.

Table 6. Irregularly Inundated Quadrats by Potential Plant Community.

Habitat Designator	Name	Count
1	Marsh	69
2	Playa	596
3	Sodic Flat, 4"-8" p.z.	54
4	Wet sodic bottom/sodic flat	22
5	Moist floodplain/wet sodic bottom/sodic flat	42
6	Moist floodplain/wet sodic bottom	39
7	Sodic flat/sodic terrace-sandy fans and sheets/sodic sands/deep sodic sands	19
9	Sandy fans and sheets/sodic sands- sodic flat 4"-8"/sodic flat 3"-6"	21
10	Gravelly loam, 4"-8" p.z.	11
11	Sandy fans and sheets/Gravelly loam, 4"-6" p.z.	10
16	Sandy 5"-8" p.z.	1
19	Coarse Gravelly Loam 5"-8" p.z.	1
20	Sandy 5"-8" p.z./Gravelly Loam 4"-8" p.z./Dunes 4"-8" p.z.	1
26	Gravelly Loam 4"-8" p.z./Barren Gravelly Slope 4"-8" p.z.	1
28	Saline Meadow/Saline Bottom	3
29	Sodic Flat/Deep Sodic Fan	2
54	Badland	4
Total	896	

Key: p.z. = precipitation zone

Cross-Stratification by Slope

Prehistoric hunter-gatherers surely considered slope an important factor in their foraging and settlement decisions in the mountainous uplands of Toedokado territory because the degree of relief in a resource patch should significantly affect foraging procurement costs as well as comfort. To characterize slope in the 9430 square kilometer study area, we had to find an expedient, accurate way to measure slope in each kilometer quadrat. For this we used repackaged USGS 1:250,000 Digital Elevational Model (DEM) data for the study area. These data are derived from Defense Mapping Agency 1:250,000 topographic sheets, and have a nominal 30 m accuracy for elevation. A UTM grid matrix was superimposed over the data base and elevations of four points within each square kilometer cell were recorded digitally. These data were processed to interpolate elevations for each square kilometer quadrat. A proprietary computer program calculated slope values for each cell. For every quadrat, the program determines the maximum elevation difference between each pair of cross-wise and diagonally adjacent cells to calculate a percentage slope value for the intermediate quadrat; resulting data were read into a database file for evaluation.

Figure 7 illustrates the cumulative distribution of slope values in the project area. As can be seen, more than 51% of quadrats have slope values of less than 3% and the number of quadrats diminishes rapidly thereafter with increasing slope. We arbitrarily subdivide the distribution trend where three very minor breaks occur: at 3%, 9%, and 18% slope. These allow the distribution to be grouped in four ordinal intervals: < 3%, 3%- 9%, 10%- 18%, and > 18%. Figure 8 illustrates the spatial distribution of quadrats assigned by slope category in the Toedokado territory. As can be seen, the distribution of slopes corresponds well with the topography of the study area. Slopes in excess of 18% are confined to higher altitudes of the Stillwater, Clan Alpine, and Fairview Ranges. Slope values between 10% and 18% occur generally at lower elevations in these same ranges, as well as along the crests of the Sand Springs, Cocoon, Desert, and Dead Camel Ranges. Quadrats with slope values of 3-9% occur peripherally to 10-18% slope quadrats and at lower elevation. Finally quadrats with less than 3% slope occur extensively in areas of the Carson Sink, Carson Desert, Salt Wells Basin, Fairview Valley, and Dixie Valley.

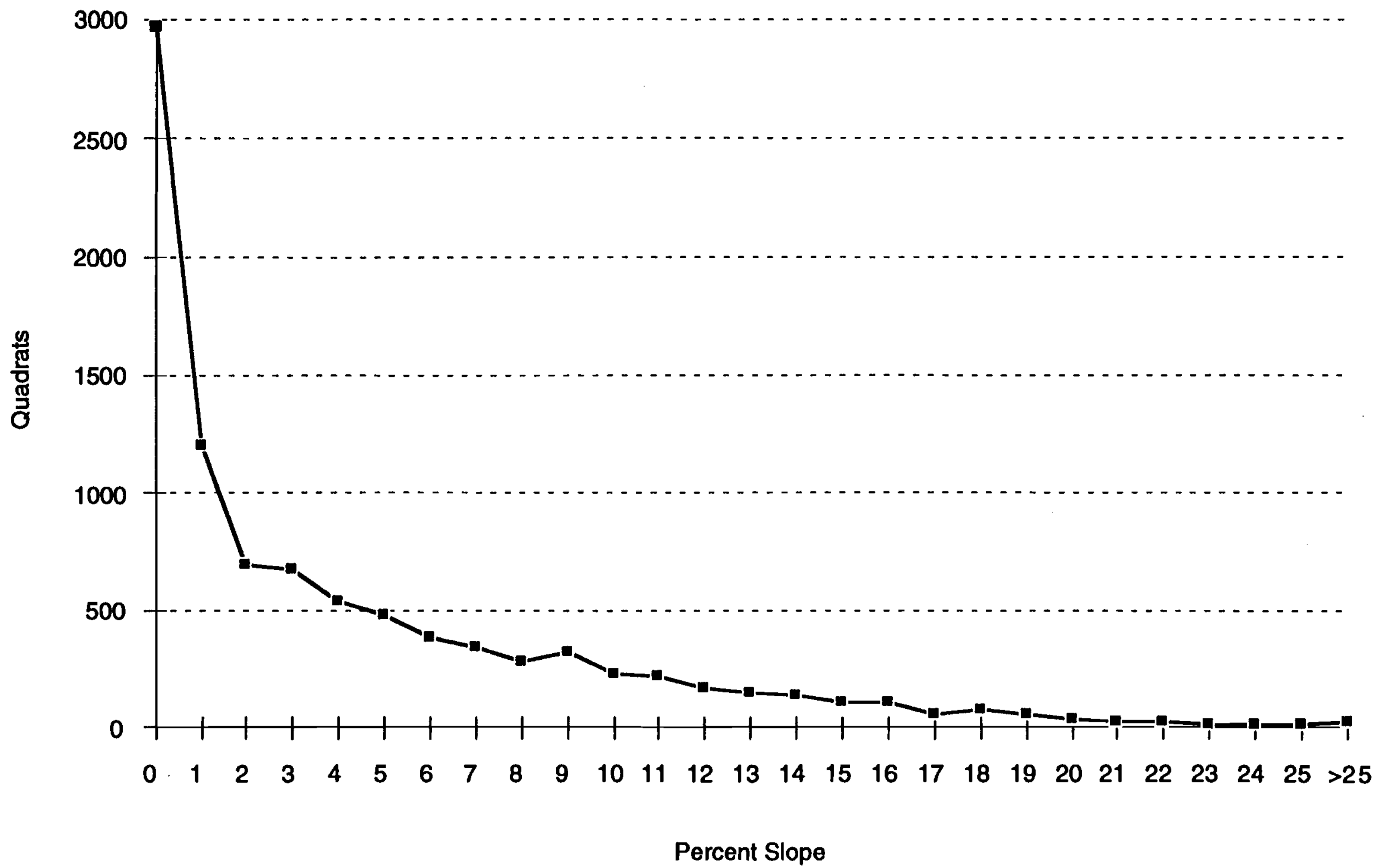

Figure 7. Distribution of quadrats by percent slope in Toedokado territory.

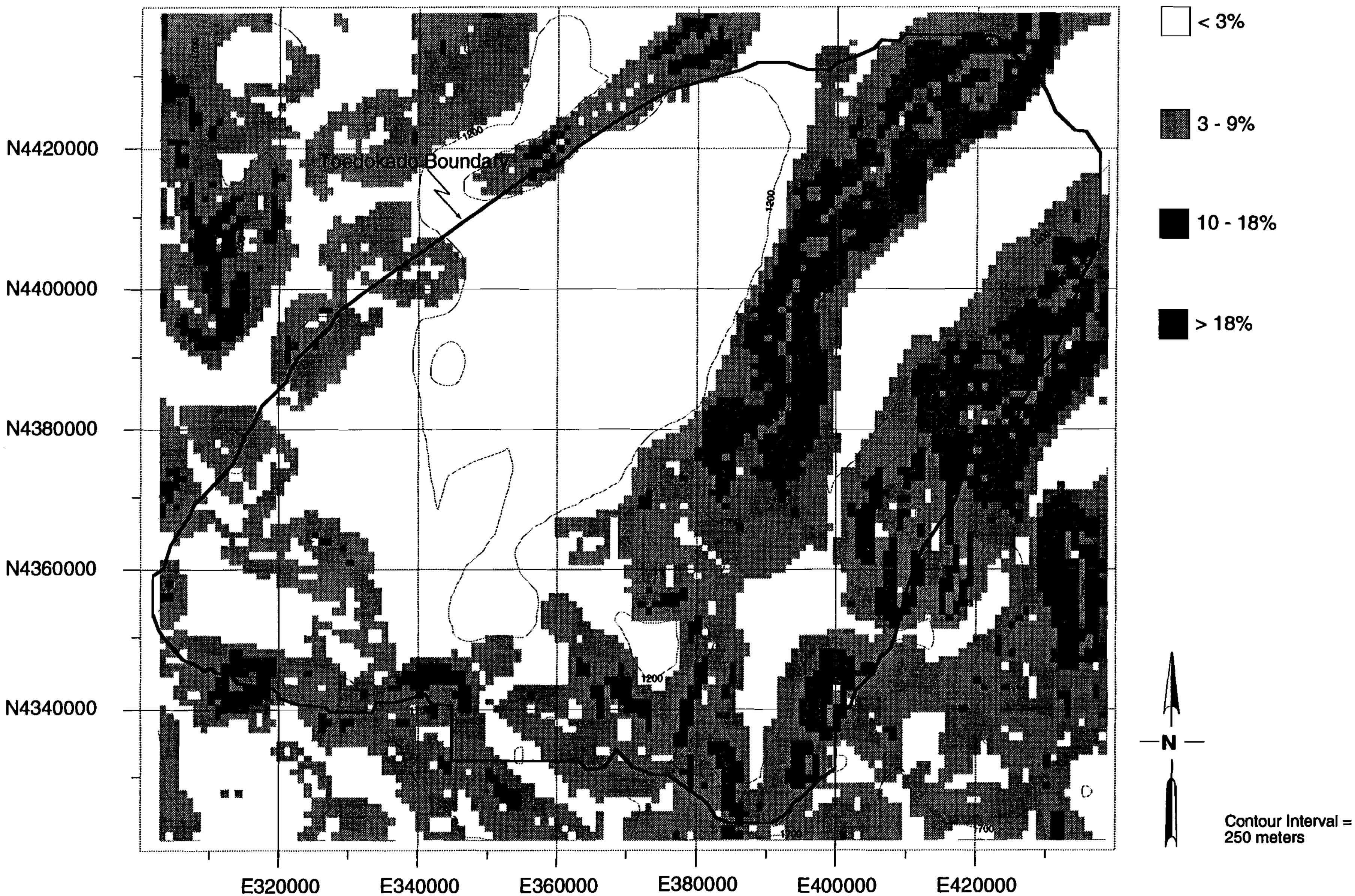

Figure 8. Distribution of quadrats by percent slope interval in Toedokado territory.

Table 7 indicates the distribution of these slope intervals by habitat in Toedokado territory; in addition, the expected slope range for each habitat, derived from range site descriptions (USDA Soil Conservation Service 1992) is presented. Generally, the digital estimates of slope correspond well to the range expected for each habitat. For example, the largest block of <3% slope (n=1307) is associated with playa (Habitat 02). In contrast, the largest block of slopes between 9% and 18% (n=277), and slopes greater than 18%, are associated with pinyon-juniper woodlands that are restricted to mountainous uplands of the Stillwater and Clan Alpine Ranges.

Table 7. Slope Interval Quadrats by Habitat.

Habitat Designator	Name	Expected Slope	<3%	3-9%	9-18%	>18%
No Data		NA	8	21	0	0
01	Marsh	<1%	224	1		
02	Playa	<1%	1307	20		
03	Sodic Flat, 4"-8" p.z.	<2%	573	45	18	1
04	Wet sodic bottom/sodic flat	<2%	99	3	1	
05	Moist floodplain/wet sodic bottom/sodic flat	<4%	118			
06	Moist floodplain/wet sodic bottom	<4%	176	16		
07	Sodic flat/ sodic terrace- sandy fans and sheets/ sodic sands/deep sodic sands	2-8%	164	2		
09	Sandy fans and sheets/sodic sands- sodic flat 4"-8"/sodic flat 3"-6"	2-4%	328	18		
10	Gravelly loam, 4"-8" p.z.	2-15%	348	679	200	2
11	Sandy fans and sheets/Gravelly loam, 4"-6" p.z.	2-15%	388	233	20	
13	Sodic Flat, 4"-8" p.z./Gravelly loam, 4"-6" p.z.	<2%	102	98	31	17
14	Sodic terrace	<4%	34	2		
15	Dunes and sodic dunes	2-30%	25	30	3	
16	Sandy 5"-8" p.z.	2-8%	162	107	10	1
18	Barren Gravelly Slope 4"-8" p.z.	30-50%	12	87	98	35
19	Coarse Gravelly Loam 5"-8" p.z.	2-15%	28	26	7	0
20	Sandy 5"-8" p.z./Gravelly Loam 4"-8" p.z./ Dunes 4"-8" p.z.	2-30%	51	140	16	
21	Gravelly Loam 4"-8" p.z./Valley Wash 4"-8" p.z.	2-15%	78	79	26	1
26	Gravelly Loam 4"-8" p.z./Barren Gravelly Slope 4"-8" p.z.	2-50%	83	289	58	9
27	Coarse Silty 4"-8"/Gravelly Loam 4"-8" p.z./ Sandy 8"-10" p.z.	0-15%	12	39		
28	Saline Meadow/Saline Bottom	<2%	128			
29	Sodic Flat/ Deep Sodic Fan	<4%	186	4		
31	Droughty Loam 8"-10"	2-15%	2	27	47	
34	Pinyon-Juniper Woodland	30-50%	1	86	277	111
35	Loamy Slope 8"-10" p.z./Shallow Calcareous Loam 8"-10"	8-75%	3	27	34	8
36	Loamy 4"-8" p.z.	2-8%	20	14		
37	Loamy Slope 8"-10" p.z.	15-75%	18	179	247	46
38	Sodic Dunes/ Sodic Flat	<15%	133	53	9	3
40	Stony Slope 4"-8" p.z.	15-50%	22	89	56	4
42	Stony Loam 4"-8" p.z.	8-30%	8	68	25	
44	Shallow Claypan 8"-10"	15-50%		45	50	6
46	Loamy Slope 5"-8" p.z.	30-50%	1	31	58	6
47	Cobbly Claypan 12-14"/Loamy Slope 10"-12"	30-75%	11	55	98	29
48	Loamy Slope 8"-10" p.z./Eroded Granitic Slope	15-75%		13	23	0
49	Gravelly Loam 4"-8" p.z./Stony Slope 4"-8" p.z	2-15%	7	31	2	
52	Loamy Slope 8"-10" p.z./South Slope 8"-10" p.z.	15-75%	0	0	13	0
54	Badland	<2%	28	6		
56	Loamy Slope 8"-10" p.z./Gravelly Loam 4"-8" p.z./Stony Slope 4"-8" p.z./Barren Gravelly Slope 4"-8" p.z.	2-15%	5	87	78	5
Total			4893	2750	1505	284

Key: p.z. = precipitation zone

However, a few discrepancies in the data base are apparent. Note, for example, the twenty examples of playa with slope between 3% and 9%. Such erroneous classifications are a consequence of scale; recall that slope was determined by calculating the maximum difference in average elevation over a distance of three kilometers. Thus, examples of steep playa merely reflect playa margins within three kilometers of rise into the uplands.

This requires caution when cross-stratifying to derive habitat types. Since the goal of slope stratification is to distinguish quadrats with potential for relatively level terrain in mountainous areas, we have elected to cross-stratify by slope only those habitats whose ranges extend above 1525 m (5003 ft amsl) in elevation. In other words, only Habitats 18, 27, 34, 35, 37, 42, 44, 46, 47, 48, and 56, are divided into separate habitat types according to slope.

Derivation of Habitat Types

From soil and range data, we have identified 41 potential habitats within Toedokado territory, and we have cross-stratified them according to presence or absence of perennial water, potential for inundation, and slope. The final task is to distill these biotic and abiotic variables into a set of habitat types that represent "distinctive constellations of ecological factors ... that interact to produce a characteristic biotic community or set of communities" (Raven and Elston 1989:50).

We have synthesized data previously reported. For sampling purposes, we have avoided identifying any habitat type with fewer than 10 cells in the Toedokado study area. This has required that we ignore some of the variability presented in previous tables while emphasizing those that occur with sufficient ubiquity to identify a population large enough to sample. This exercise has led us to the 77 habitat types presented in Table 8 below. Each habitat type is designated by a two digit number indicating the habitat represented; when a sufficient number of cases allow designation of a separate habitat type based on water, inundation, or slope, we have added a letter suffix to the habitat designator. All habitat types with inundation potential are designated with an "a," habitat types containing perennial water are identified with a "b", and habitat types with slopes over 9% are identified with a "c". In addition, the associated wetland or riparian community that contributes to its biotic composition is indicated for habitat types with water.

Table 8. Habitat Types by Habitat and Cross-Stratification Variables.

Type	Name	Variant	No. of Quadrats	Associated Wetland Habitats
1	Marsh		156	
1a		inundated	69	
2	Playa		704	
2a		inundated	591	
2b		water source	32	53/55
3	Sodic Flat, 4"-8"p.z.		509	
3a		inundated	41	
3b		water source	87	53/55
4	Wet sodic bottom/sodic flat		53	
4a		inundated	14	
4b		water source	36	53/06
5	Moist floodplain/wet sodic bottom/ sodic flat		29	
5a		inundated	38	
5b		water source	51	53/06
6	Moist floodplain/wet sodic bottom		55	
6a		inundated	37	
6b		water source	100	53/06

Table 8, continued.

Type	Name	Variant	No. of Quadrats	Associated Wetland Habitats
7	Sodic flat/sodic terrace- sandy fans and sheets/sodic sands/deep sodic sands		116	
7a		inundated	18	
7b		water source	32	53/06
9	Sandy fans and sheets/sodic sands- sodic flat 4"-8"/sodic flat 3"-6"		265	
9a		inundated	21	
9b		water source	60	53/06
10	Gravelly loam, 4"-8" p.z.		1205	
10a		inundated	11	
10b		water source	13	53/06/51/55
11	Sandy fans and sheets/Gravelly loam, 4"-6" p.z.		612	
11a		inundated	10	
11b		water source	19	06/53
13	Sodic Flat, 4"-8" p.z./Gravelly loam, 4"-6" p.z.		248	
14	Sodic terrace		36	
15	Dunes and sodic dunes		58	
16	Sandy 5"-8" p.z.		280	
18	Barren Gravelly Slope 4"-8" p.z.		95	
18c		steep	119	
18b		water source	18	51/55
19	Coarse Gravelly Loam 5"-8" p.z.		61	
20	Sandy 5"-8" p.z./Gravelly Loam 4"-8" p.z./Dunes 4"-8" p.z		207	
21	Gravelly Loam 4"-8" p.z./Valley Wash 4"-8" p.z.		184	
26	Gravelly Loam 4"-8" p.z./Barren Gravelly Slope 4"-8" p.z.		439	
27	Coarse Silty 4"-8"/Gravelly Loam 4"-8" p.z./Sandy 8"-10" p.z.		51	
28	Saline Meadow/Saline Bottom		103	
28b		water source	25	53/55
29	Sodic Flat/Deep Sodic Fan		172	
29b		water source	18	53/55
31	Droughty Loam 8"-10"		76	
34	Pinyon-Juniper Woodland		77	
34c		steep	320	
34b		water source	78	51
35	Loamy Slope 8"-10" p.z./Shallow Calcareous Loam 8"-10"		30	
35c		steep	42	
36	Loamy 4"-8" p.z.		34	
37	Loamy Slope 8"-10" p.z.		195	
37c		steep	271	
37b		water source	24	51/55
38	Sodic Dunes/Sodic Flat		183	
38b		water source	15	55/06/53
40	Stony Slope 4"-8" p.z.		171	
42	Stony Loam 4"-8" p.z."		76	
42c		steep	25	
44	Shallow Claypan 8"-10" p.z.		37	
44c		steep	53	
44b		water source	11	51
46	Loamy Slope 5"-8" p.z.		32	
46c		steep	64	
47	Cobbly Claypan 12-14"/Loamy Slope 10"-12"		44	
47c		steep	91	
47b		water source	58	51
48	Loamy Slope 8"-10" p.z./Eroded Granitic Slope		13	
48c		steep	23	
49	Gravelly Loam 4"-8" p.z./Stony Slope 4"-8" p.z"		40	
51	Loamy Bottom 8-12" p.z./Wet Meadow 8-12" p.z.		0*	
52	Loamy Slope 8"=10" p.z./South Slope 8"-10" p.z.		13	
53	Marsh w/islands and edge of Carson/Stillwater complex		0*	
54	Badland		34	
55	Wet Meadow 4-8" p.z.		0*	
56	Loamy Slope 8"-10" p.z./Gravelly Loam 4"-8" p.z./ Stony Slope 4"-8" p.z./Barren Gravelly Slope 4"-8" p.z.		92	
56c		steep	83	

Key: p.z. = precipitation zone
* These habitats are subsumed in habitat types containing perennial water

The set of habitat types appearing in Table 8 constitutes our characterization of Toedokado territory; habitat types of all analytical cells in the study area are represented in Figure 9. As will be seen in following chapters, this habitat typology allows us to generate predictions about the behavioral responses of prehistoric hunter-gatherers to the environment of the Carson Desert.

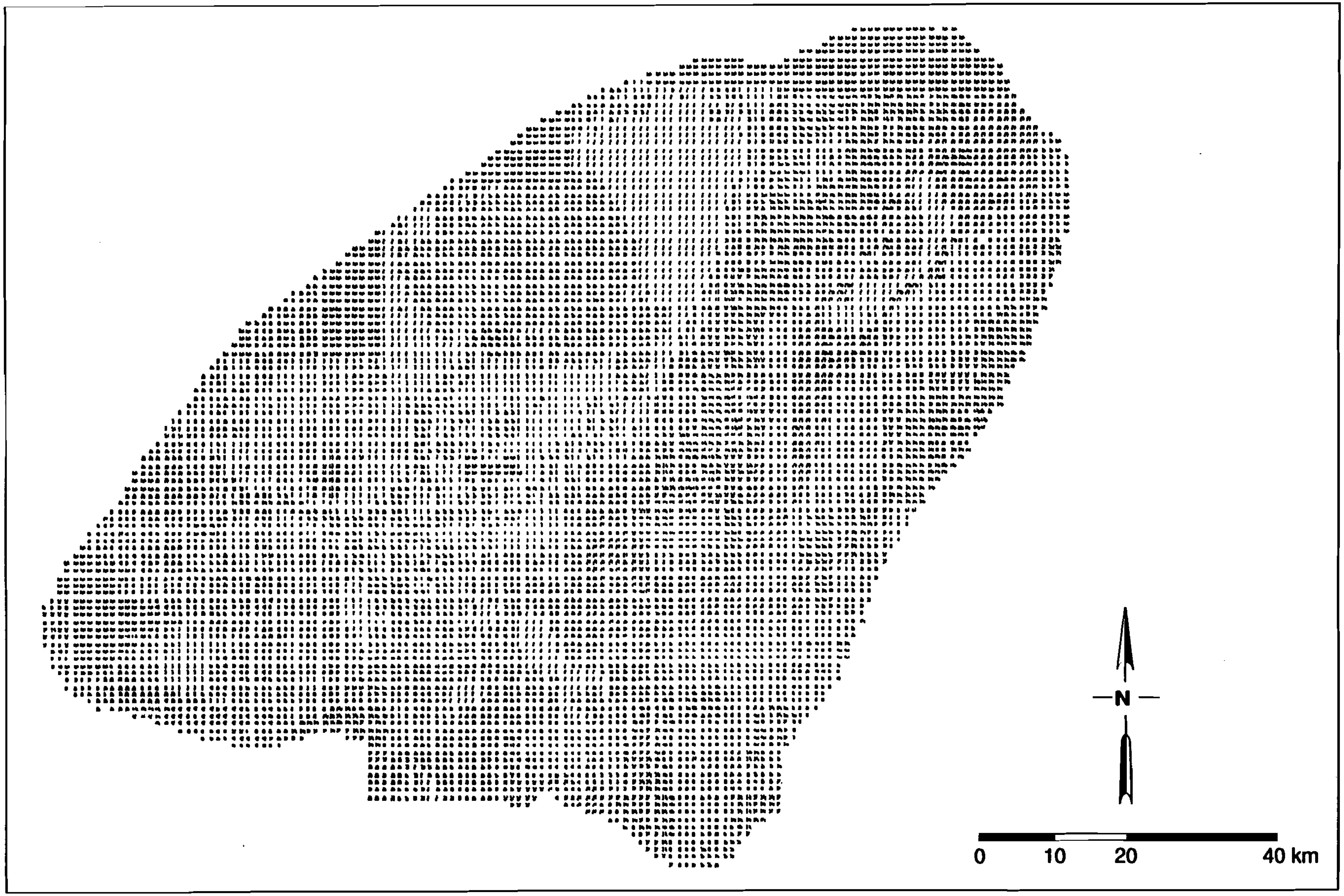

Figure 9. Habitat Types of all ananlytical cells in Toedokado territory. Note: A large sized (1:250,000 scale) version of this map, depicting grid coordinates and easily readable habitat type designators, is on file with NAS Fallon.

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Chapter 3. HABITAT DESCRIPTIONS

David W. Zeanah and Julia E. Hammett

The preceding chapter identified 41 habitats representing sets of range types that commonly co-occur on one kilometer square quadrats in Toedokado territory, and stratified the habitats into 77 habitat types based on water, inundation, and slope. Each habitat type represents a set of biotic and abiotic characteristics that constrain prehistoric hunter-gatherers seeking to make prudent foraging and settlement decisions.

This chapter describes in detail the vegetation composition and physical characteristics of each habitat. These discussions are distilled from descriptions of constituent range types, as presented in the Range Site Description Handbook for Land Resource Area 27 (USDA Soil Conservation Service 1992) supported by relevant additional sources. Each range type is a distinctive climax vegetation community that thrives in a particular set of physiographic conditions. Potential natural vegetation communities are described quantitatively by calculating the total annual air-dry production of herbage and estimating the percentage composition of each identified species. We have profiled the composition and productivity of associated potential natural vegetation communities of each habitat, averaging the productivity and composition values of constituent range types.

Please note that common plant names are used in text throughout this report. A concordance of common and Latin plant names appears in Appendix G.

Habitat Descriptions

For purposes of discussion and description, we recognize five communities of habitat, according to physiographic and vegetation associations: abiotic, wetland, greasewood/saltbush, sagebrush, and montane. Such categories suit our purpose because the habitats are unequivocally assignable to one or another community, and because they commonly are employed as gross classifications of plant communities in the biogeographical literature of the Carson Desert (cf. Billings 1945; Young et al. 1976; Cronquist et al. 1986). Table 9, presents habitats according to community, and summarizes pertinent descriptive details of each.

Total Habitat Productivity

To further organize habitat description, we discuss each habitat within each community in order of its total annual air-dry production, most productive habitat first. Note that habitat productivity is used merely as an organizing principle: we do not infer the value of habitats as food patches on the basis of biomass. Figure 10 illustrates the total average annual air-dry production in kilograms per hectare of each habitat for normal years. Figure 11 shows the spatial distribution of annual productivity in Toedokado territory as extrapolated from the values in Figure 10. Annual productivity values range from none at all in abiotic habitats to more than 3000 kilograms per hectare in Habitat 1 (marsh). Wetland habitats are the most productive by far for yearly growth; the least productive wetland habitat yields twice the plant biomass per year of any habitat in greasewood-saltbush, sagebrush, or montane communities. The productivity of wetlands creates high densities of annual growth in Stillwater Marsh, Indian Lakes, Carson Lake, Carson River lowlands, and lowlands of Dixie Valley.

Table 9. Summary Characteristics of Habitats in Toedokado Territory.

Community & Habitat	Description	Normal Year Productivity (kg/ha)	Expected Slope	Elevation Range (meters asl)	Percent Composition (Grasses-Forbs-Shrubs)	Dominant Shrub	Dominant Grass & Grasslike plants
Abiotic							
2	playa	0	<1%	1000-1370	NA	NA	NA
54	badland	0	<2%	1065-1525	NA	NA	NA
Wetland							
1	marsh	3138	<1%	1065-1525	90-10-0	willow	cattail
55	lowland spring	2800	<2%	1035-1370	85-15-0	black greasewood	alkali bluegrass
6		2634	<4%	1065-1525	82-10-8	willow	creeping wildrye
28		2073	<2%	1065-1525	80-10-10	black greasewood	Great Basin wildrye
51	upland spring	1961	<2%	1675-2290	80-10-10	Basin big sagebrush	Great Basin wildrye
5		1886	<4%	1065-1220	80-9-11	black greasewood	creeping wildrye
53	marsh islands	1765	<2%	1065-1220	80-10-10	black greasewood	cattail
4		1429	<2%	1065-1220	75-10-15	black greasewood	alkali sacaton
Greasewood/ Shadscale							
29		756	<4%	1065-1370	35-5-60	Torrey quailbush	Great Basin wildrye
7		541	2-8%	1065-1370	45-5-50	black greasewood	Indian ricegrass
16		504	2-8%	1065-1370	75-5-20	fourwing saltbush	Indian ricegrass
36		504	2-8%	1220-1525	35-5-60	shadscale	Indian ricegrass
15	dunes	448	2-30%	1035-1525	35-5-60	black greasewood	Indian ricegrass
20	dunes	448	2-30%	1035-1370	50-5-45	fourwing saltbush	Indian ricegrass
3		392	<2%	1000-1220	15-5-80	black greasewood	inland saltgrass
11		392	2-15%	1065-1370	60-5-35	Bailey's greasewood	Indian ricegrass
14		392	<4%	1000-1370	25-5-70	shadscale	Indian ricegrass
19		392	2-15%	1065-1525	50-5-45	Bailey's greasewood	Indian ricegrass
42		392	8-30%	1280-1675	45-5-50	Bailey's greasewood	Indian ricegrass
9		364	2-4%	1065-1220	58-6-36	black greasewood	Indian ricegrass
38	dunes	364	<15%	1035-1220	30-5-65	black greasewood	Indian ricegrass
13		336	<2%	1035-1220	20-5-75	black greasewood	Indian ricegrass
46		336	30-50%	1370-1830	40-5-55	shadscale	Indian ricegrass
56		303	2-15%	1280-1765	43-5-52	shadscale	Indian ricegrass
10		280	2-15%	1035-1525	30-5-65	Bailey's greasewood	Indian ricegrass
21		252	2-15%	1035-1525	25-8-67	Bailey's greasewood	Indian ricegrass
49		238	2-15%	1035-1525	28-5-67	Bailey's greasewood	Indian ricegrass
26		196	2-50%	1220-1525	40-5-55	shadscale	Indian ricegrass
40		196	15-50%	1035-1525	25-5-70	shadscale	Indian ricegrass
18		112	30-50%	1220-1675	40-5-55	shadscale	Indian ricegrass
Sagebrush							
31		560	2-15%	1370-1525	40-5-55	Wyoming big sagebrush	Indian ricegrass
37		560	15-75%	1675-1980	50-5-45	Wyoming big sagebrush	Indian ricegrass
27		504	0-15%	1220-1675	53-5-42	big sagebrush	Indian ricegrass
48		476	15-75%	1525-1675	50-5-45	Wyoming big sagebrush	desert needlegrass
52		476	15-75%	1675-1980	48-5-47	Wyoming big sagebrush	Thurber needlegrass
35		448	8-75%	1675-1980	50-7-43	Wyoming big sagebrush	Thurber needlegrass
44		336	15-50%	1370-1830	50-5-45	sagebrush	desert needlegrass
Montane							
47	mountain brush	616	30-75%	1830-2895	52-10-38	big sagebrush	Thurber needlegrass
34	pinyon/juniper	355	30-50%	1830-2895	50-10-40	mountain big sagebrush	Thurber needlegrass

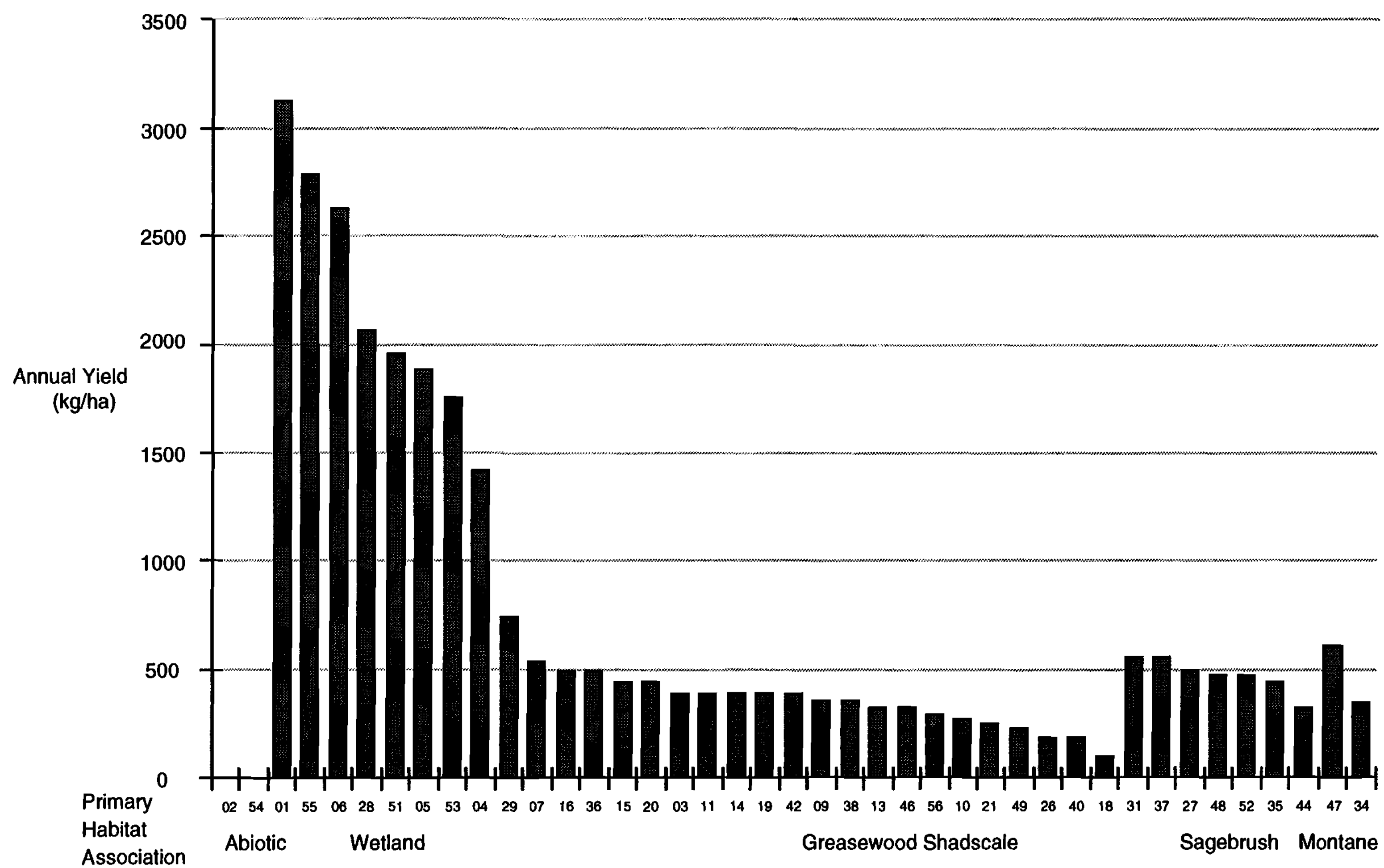

Figure 10. Total average annual yield of herbaceous growth (kg/ha) in Toedokado habitats arranged by primary plant association.

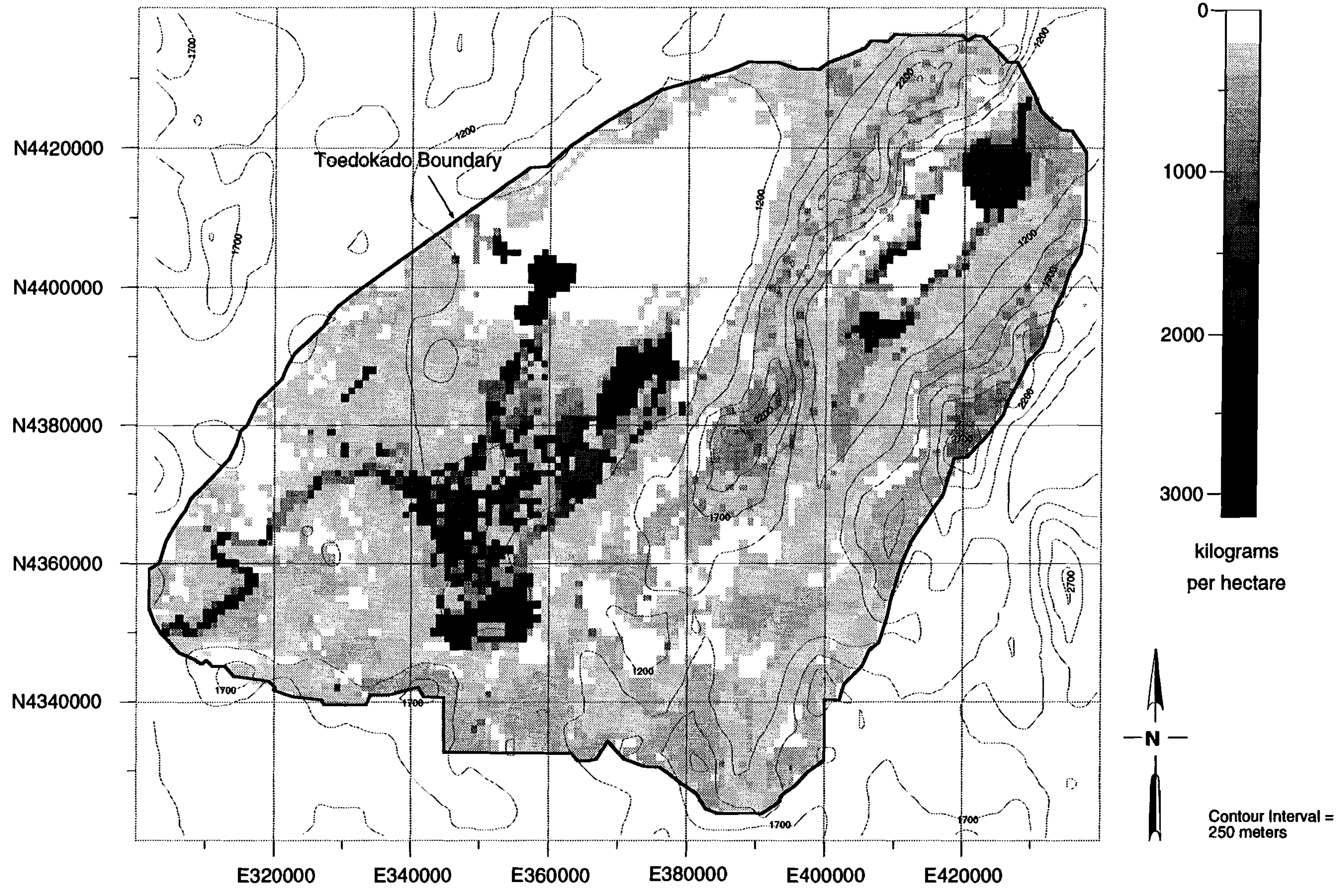

Figure 11. Normal year annual air-dry production (kg/ha) by square kilometer quadrat in Toedokado territory.

Abiotic Associations

Habitat types classified as abiotic comprise ecological settings that normally cannot support vegetation; consequently, the Soil Conservation Service does not assign range types to them. Only two habitat types in Toedokado territory are abiotic: playa and badlands.

Habitat Types 02, 02a, 02b. Playa.

Alkaline playas comprise the most common habitat type in the study area. They are flat, arid, shallow basins that lack external drainage. As such, they serve as catchments for regional streamflow and runoff. Because slopes are so slight, vast but shallow seasonal lakes sometimes form on playas. The ratio of surface area to volume is extraordinarily high causing rapid evaporation and accumulation of salts in playa sediments.

Because playas are flooded periodically, their biotic potential is variable. Usually abiotic, lacking plants, animals, and insects, they sometimes host large, transient pools which support brine shrimp populations which, in turn, attract waterfowl. Very occasionally, water may stand on playas for a few years in succession, allowing full wetland habitats to become established (Weller 1986). Frequently, barren playas are proximate standing perennial water that supports marshes with stands of cattail, creeping spikerush, or alkali bulrush (see Habitat 1).

Figure 12 illustrates the distribution of playas in Toedokado territory. The most extensive cluster of playa habitats occurs in the Carson Sink. Large clusters also can be found in Dixie Valley, Labou Flat, Salt Wells Basin, and on the margins of Carson Lake.

Habitat Type 54. Badlands.

Badlands are Pleistocene lake shorelines that are severely eroded by runoff from surrounding alluvial fans and mountain slopes. Their soils are strongly saline lacustrine sediments supporting no vegetation (Dollarhide 1975:14). Only 34 quadrats in Toedokado territory are badlands. These are widely dispersed in the Carson Desert, with the largest tracts west of Carson Lake and Indian Lakes (Figure 13).

Wetland Associations

Habitats of the wetland community are structured by a perennial water source. Indeed, they mark the distribution of water, the critical resource for fauna and for hunter-gatherers in arid landscapes. The vegetation composition of these most productive habitats is presented in Table 10 in kilograms per hectare.

Table 10. Species Composition of Wetland Habitat Types, by Weight (kg/ha).

Common Name	Genus/species	1	55	6	28	51	5	53	4
Grasses and Grass-like Plants									
alkali bluegrass	*Poa juncifolia*	0	1120	105	62	0	75	0	43
alkali bulrush	*Scirpus robustus*	0	0	0	0	0	0	194	0
alkali sacaton	*Sporobolus airoides*	0	56	527	518	39	358	6	472
alkaligrass	*Puccinellia*	0	0	0	21	0	0	0	0
alpine timothy	*Phleum alpinum*	0	0	0	0	20	0	0	0
arrowgrass	*Triglochin*	0	0	37	41	0	25	0	43

Table 10, continued.

Common Name	Genus/species	1	55	6	28	51	5	53	4
Grasses and Grass-like Plants, continued.									
Baltic rush	*Juncus balticus*	0	0	163	110	0	109	0	0
bottlebrush squirreltail	*Sitanion hystrix*	0	0	0	21	0	4	6	6
bulrush	*Scirpus*	94	0	0	0	0	0	53	0
cattail	*Typha*	879	0	0	0	0	0	424	0
common alkali grass	*Puccinellia lemmonii*	0	56	0	0	0	0	0	0
common reed	*Phragmites australis*	0	0	37	41	0	25	0	43
creeping spikerush	*Eleocharis palustris*	628	0	0	0	0	0	318	0
creeping wildrye	*Elymus triticoides*	0	0	711	62	118	472	0	0
Great Basin wildrye	*Elymus cinereus*	0	0	263	498	804	170	6	43
Indian ricegrass	*Oryzopsis hymenoides*	0	0	0	0	0	4	6	6
inland saltgrass	*Distichlis spicata stricta*	0	224	211	207	0	151	11	171
mat muhly	*Muhlenbergia richardsonis*	0	0	79	0	0	38	0	0
meadow barley	*Hordeum brachyantherum*	0	0	0	0	20	0	0	92
Nevada bluegrass	*Poa nevadensis*	94	0	79	0	196	38	53	0
rabbitfootgrass	*Polypogon monspeliensis*	0	0	69	0	0	47	0	0
rush	*Juncus*	251	840	0	0	180	4	124	6
sedge	*Carex*	251	336	105	41	255	75	124	43
slender wheatgrass	*Agropyron trachycaulum*	0	0	0	0	20	0	0	0
sloughgrass	*Beckmannia*	0	0	69	0	0	47	0	0
spikerush	*Eleocharis*	0	0	0	0	20	0	0	0
tufted hairgrass	*Deschampsia cespitosa*	0	0	0	0	20	0	0	0
western wheatgrass	*Agropyron smithii*	0	0	263	62	137	170	0	43
Forbs									
cinquefoil	*Potentilla*	0	0	43	0	0	28	0	0
clover	*Trifolium*	0	0	43	0	0	28	0	0
coneflower	*Rudbeckia*	94	0	0	0	0	0	53	0
glasswort	*Salicornia*	0	98	0	0	0	0	0	0
groundsel	*Senecio*	0	0	43	0	0	28	0	0
lupine	*Lupinus*	0	0	0	0	20	0	0	0
nodding waternymph	*Najas*	94	0	0	0	0	0	53	0
penstemon	*Penstemon*	0	0	0	0	20	0	0	0
prince's plume	*Stanleya pinnata*	0	0	0	0	0	2	6	4
sago pondweed	*Potamogeton*	94	0	0	0	0	0	53	0
thelypod	*Thelypodium*	0	0	0	21	0	2	4	4
wapato, arrowhead	*Sagittaria latifolia*	94	0	0	0	0	0	53	0
water plantain	*Alisma plantago-aquatica*	94	0	0	0	0	0	53	0
western dock	*Rumex occidentalis*	0	0	26	41	0	19	0	43
wild iris	*Iris missouriensis*	94	0	43	0	20	28	47	0
yarrow	*Achillea*	0	0	0	0	20	0	0	0
Shrubs									
Anderson peachbrush	*Prunus andersonii*	0	0	0	0	20	0	0	0
Bailey's greasewood	*S. vermiculatus baileyi*	0	0	0	0	0	4	6	6
Basin big sagebrush	*A. tridentata tridentata*	0	0	26	0	118	19	0	0
black greasewood	*Sarcobatus vermiculatus*	0	28	53	109	0	120	141	143
bud sagebrush	*Artemisia spinescens*	0	0	0	0	0	4	6	6
four-winged saltbush	*Atriplex canescens*	0	0	0	0	0	4	6	6
horsebrush	*Tetradymia*	0	0	0	0	0	4	6	6
pickleweed/iodine bush	*Allenrolfea occidentalis*	0	0	0	0	0	4	6	6
rubber rabbitbrush	*Chrysothamnus nauseosus*	0	28	53	62	20	38	6	29
seepweed, wada	*Suaeda*	0	0	26	41	0	19	10	29
shadscale	*Atriplex confertifolia*	0	0	0	21	0	8	18	14
silver buffaloberry	*Shepherdia argentea*	0	0	53	21	0	38	0	29
silver sagebrush	*Artemisia cana*	0	0	26	0	0	19	0	0
Torrey quailbush	*Atriplex torreyi*	0	0	26	41	0	19	6	29
wild rose	*Rosa*	31	0	0	0	39	0	18	0
Woods rose	*Rosa woodsii*	0	0	26	0	0	19	0	0
Trees									
Fremont cottonwood	*Populus fremontii*	0	0	26	0	0	19	0	0
willow	*Salix*	31	0	79	0	17	38	18	0

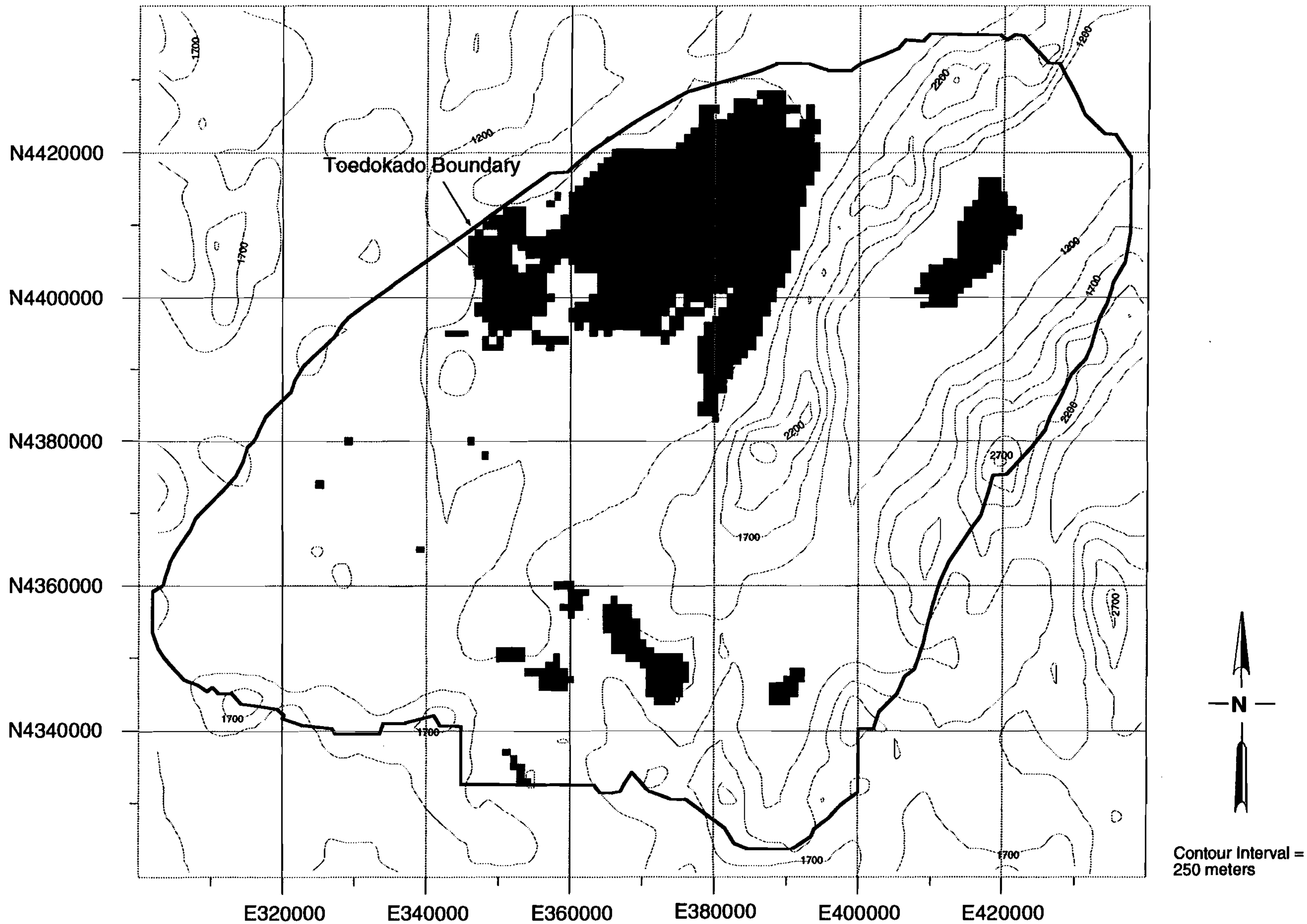

Figure 12. Distribution of playas (Habitat Types 02, 02a, 02b) by square kilometer quadrat in Toedokado territory.

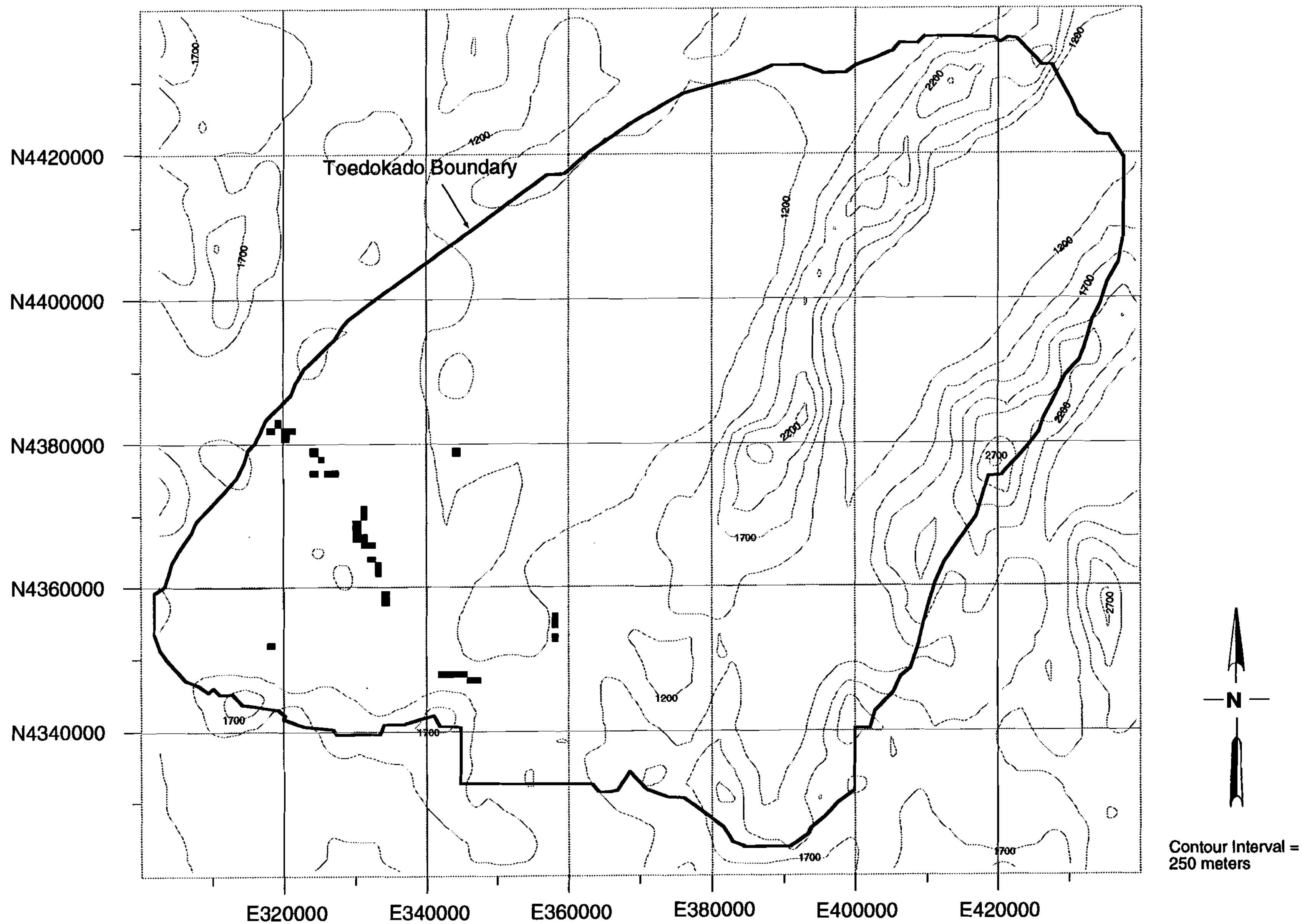

Figure 13. Distribution of badlands (Habitat Type 54) by square kilometer quadrat in Toedokado territory.

Habitat Types 01, 01a. Marsh.

The distribution of marsh habitat types in Toedokado territory is described in the previous chapter. Marshes occur in axial stream floodplains, margins of floodplain playas, and adjacent sloughs, springs, seeps, and ponds. Marshes typically are flat, constituted of deep, poorly drained silty loams that remain saturated throughout the growing season; depth to 50 cm is common.

The marshes of the Carson Desert respond dynamically to seasonal and yearly fluctuations in hydrological regime. Spring runoff from adjacent mountain ranges, as well as water transported from more distant areas drained by the Carson River, cause marshes to expand in spring. Marshlands contract in summer in response to evaporation and transpiration. The extent of expansion and contraction depends on yearly variability in precipitation. However, exceptionally dry years constrict marshlands, leaving vast alkaline flats to mark former marsh perimeters (Hamilton and Auble 1993:2). Exceptionally wet years can diminish the extent of marshlands by drowning emergent vegetation in lakes deeper than 50 cm (Elston 1990).

The total vegetation production for marshes ranges from a high of 4500 kilograms per hectare in favorable years, to a low in unfavorable years of 2200 kilograms per hectare. Normal production is more than 3100 kilograms per hectare, nearly 20 percent more than the next most productive habitat in the study area. Marsh vegetation is principally (90 percent) grass-like plants with most of the remainder hydrophilic forbs. Shrub plants including wild rose, willow, and greasewood occur only in trace amounts (<3 percent); generally, cattail, creeping spikerush, and alkali bulrush dominate with cattail constituting more than one-fourth the total plant biomass, as calculated by the USDA Soil Conservation Service (1992).

The particular plant composition of any location within marsh habitat reflects water depth and salinity, however. For example, vegetation in shallow (< 5 cm), low-salinity, standing water is primarily rush and sedge, while emergent plants such as hardstem bulrush and cattail proliferate at water depths between 5 and 50 cm. Submergent and floating plants such as sago pondweed dominate in deeper waters. Emergent alkali bulrush and deepwater chara become more common as salinity increases (Hamilton and Auble 1993:10-15). Frequently, each of three dominant plant species will grow in vast pure stands. This led Billings (1945:17) to identify three separate plant associations within marsh habitat: bulrush, cattail, and spikerush.

Marsh wetlands, compared with other habitats, support a more concentrated and diverse fauna due to a reliable water supply for all animals, and a steady source of food and shelter for a host of water fowl including ducks, geese, grebes and swans. Four native fishes are available in the shallow waters of the lower Carson River basin: tui chub, Tahoe sucker, redside shiner, and speckled dace. Muskrats are an important fur-bearing mammal (Fowler 1992:70-71), found in shallow water marshes.

Habitat Type 55. Wet Meadow 4-8 in. precipitation zone

Habitat Type 55 refers to wet meadows occurring on alluvial flats and lake plains adjacent seeps and springs, at elevations below 1450 meters (4757 ft amsl) elevation. The distribution of this habitat in Toedokado territory corresponds to the distribution of lowland springs described previously (see Chapter 2); the range type example defining this habitat occurs at Dixie Hot Springs (USDA Soil Conservation Service 1992). Typically, Habitat 55 is flat (i.e., no more than 2 percent slope) and soils are deep and poorly drained. Surface soils are alkaline, decreasing in salinity and alkalinity with depth. Usually the water table stabilizes between 50 and 100 cm below surface in summer months. Runoff is slow resulting in brief flooding of low depressions. Erosion is slight.

Potential vegetation composition is about 85 percent grasses and 15 percent forbs with only a trace of shrubs. Dominant plant taxa include alkali bluegrass and rush, with notable inclusions of sedge, inland saltgrass, and other perennial forbs and grasses. Alkali bluegrass constitutes approximately 40 percent of vegetation production. Stands of glasswort and alkaligrass frequently occur along pond margins and channel edges. Billings (1945:16) identified these stands as individual plant associations in the Carson Desert. Habitat 55 also includes examples of the saltgrass association discussed by Billings (1945:16). Overall, vegetation production is approximately 2800 kilograms per hectare in normal years.

Habitat Types 06, 06a, 06b. Moist Floodplain, Wet Sodic Bottom

These habitat types occur in axial stream floodplains and adjacent alluvial flats and lake plains. Soils are deep and poorly drained, and generally are alkaline on lake plains but slightly saline in axial stream floodplains. High water tables and frequent winter and spring flooding are characteristic (Raven and Elston [1989:75] provide additional description of this riparian habitat). Figure 14 illustrates the distribution of quadrats assigned to Habitat 6 in the study area. As can be seen, they are most common south of Carson Lake and along the lower Carson River.

Normal year herbaceous growth in this habitat achieves more than 2600 kilograms per hectare. The potential vegetation is 82 percent grasses, 10 percent forbs, and 8 percent shrubs and trees. Alkali sacaton, inland saltgrass, and Baltic rush dominate alluvial flats while floodplains support creeping wild rye, wheatgrass, and Great Basin wildrye; stands of Fremont cottonwood trees and of willow frequently grow adjacent watercourses. Cottonwood groves in the study area usually are no more than a hundred meters wide, but sometimes can be as much as a mile in diameter (Billings 1945:18). Mature cottonwood groves can achieve an overstory canopy cover of 40 to 65 percent. The understory composition of these groves differs slightly from unforested examples of Habitat Type 6, having substantial stands of western wheatgrass and minor quantities of horsetail and yarrow. Cottonwood groves are important habitat for a variety of fauna (USDA Soil Conservation Service 1992).

Cottonwood groves form the Cottonwood Association in Billings's (1945:16, 18) classification of Carson Desert plant communities and the Soil Conservation Service identifies a specific range type for them (USDA Soil Conservation Service 1992). However, current soil and range data map no locations for this range type even though its type site is in Lahontan State Park along the Carson River. Since cottonwood groves usually are no more than a few acres in extent and since we presently are unable to pinpoint their locations, we have elected to note that this tree community is present within Habitat Type 6 rather than distinguish it as a separate habitat.

Habitat Types 28, 28b. Saline Meadow, Bottom.

The physiography of these riparian habitat types includes alluvial flats, lake plains, and axial stream floodplains. Slopes are negligible at less than 2 percent gradient. Soils are deep, poorly drained, medium to fine textured, and alkaline. The distribution of Habitat 28 in Toedokado territory is illustrated in Figure 15. Quadrats assigned to Habitat 28 occur in two large clusters, north and south of Humboldt Salt Marsh and at Dixie Valley Playa, and in an isolated patch near Dixie Valley Hot Springs.

Native vegetation is 80 percent grasses, 10 percent forbs, and 10 percent shrubs. Alkali sacaton, Great Basin wildrye, and inland saltgrass dominate the habitat although notable quantities of black greasewood co-occur. Vegetation production averages 2100 kilograms per hectare for a normal year, the fourth highest value for a habitat set within the study area. Nearly a quarter of this yield is Great

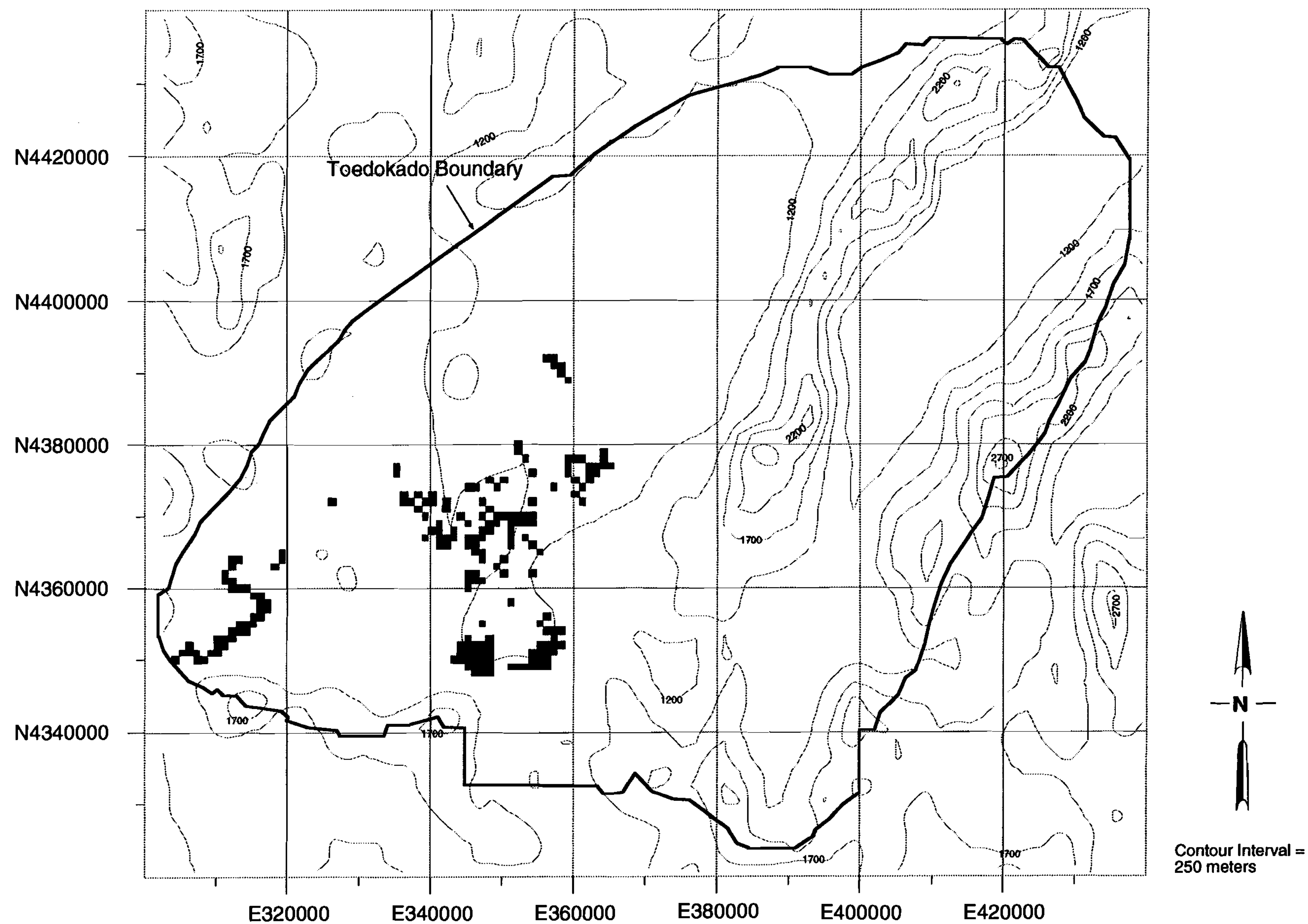

Figure 14. Distribution of moist floodplain, wet sodic bottom habitats (Habitat Types 06, 06a, 06b) by square kilometer quadrat in Toedokado territory.

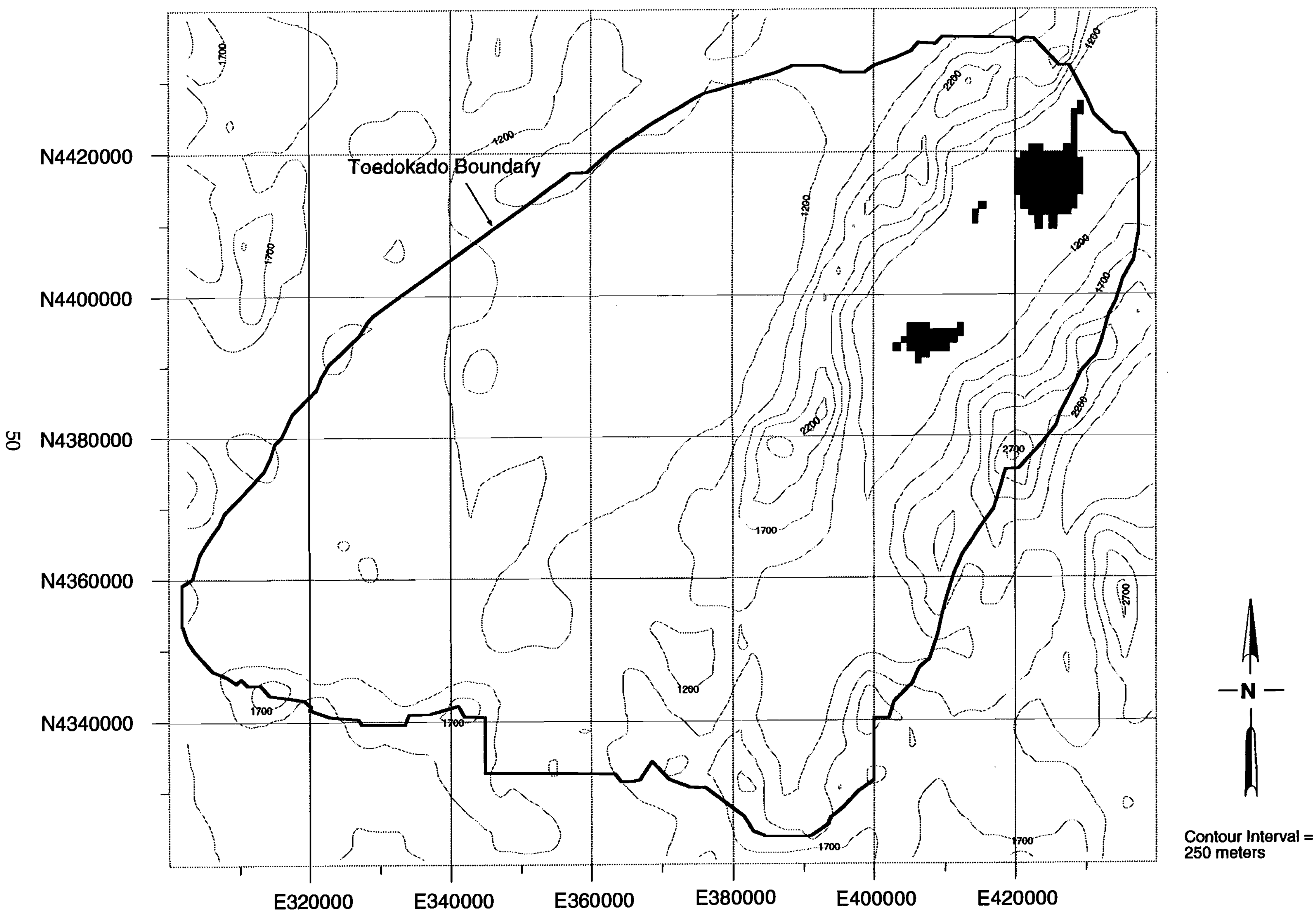

Figure 15. Distribution of saline meadow and saline bottm habitats (Habitat Types 28, 28b) by square kilometer quadrat in Toedokado territory.

Basin wildrye and another quarter alkali sacaton. Frequently, this habitat occurs near standing perennial water in axial stream floodplains, floodplain playas and adjacent sloughs, springs, seeps, and ponds (see Habitats 1, 6, and 55). Billings's (1945:16) Saltgrass Association of the Carson Desert includes this habitat.

Habitat Type 51. Loamy Bottom, Wet Meadow 8-12 in. precipitation zone

Habitat 51 lies on inset fans, axial stream floodplains, and terrace remnants, and around seeps and springs above 1450 m (4757 ft amsl) elevation. Slopes are less than 4 percent. Soils are deep, poorly drained, and fertile, with a high water table. Proximity to water assures this habitat of seasonal flooding. The distribution of Habitat Type 51 in Toedokado territory is identical to that of upland springs, as discussed in Chapter 2.

Plant communities of Habitat 51 are wet meadow grasslands. Great Basin wildrye dominates the potential assemblage of native vegetation. Sedge, rush, western wheatgrass, and Basin big sagebrush all comprise strong components of this plant community. Overall, this habitat is 80 percent grasses, and 10 percent each of forbs and shrubs; Great Basin wildrye constitutes more than 40 percent of the total cover. Plant production averages 2000 kilograms per hectare in normal years, a high value for the study area. The abundance of grasses and forbs in this habitat render it highly attractive to a variety of wildlife. Some observers of the Clan Alpine Range have noted that limited pockets of aspen, willow, and cottonwood trees occur in riparian drainage bottoms of this habitat (USDI Bureau of Land Management 1991), but these are not identified in current range type descriptions (USDA Soil Conservation Service 1992).

Habitat Types 05, 05a, 05b. Moist floodplain, Wet Sodic Bottom, Sodic Flat

Described previously by Raven and Elston (1989:64-75), this riparian habitat occurs on the deep, poorly drained and alkaline soils of alluvial flats, lake plains, and axial stream floodplains. The water table typically lies close to the surface, increasing the likelihood of winter and spring flooding. Figure 16 indicates the distribution of quadrats assigned to Habitat 5 in Toedokado territory. These quadrats are dispersed throughout the Carson River lowlands.

Potential natural vegetation is 80 percent grasses and grass-like plants, 11 percent shrubs, and 9 percent forbs. Alluvial flats and lake plains support alkali sacaton, inland saltgrass, and Baltic rush while stands of black greasewood and shadscale occur on coppice mounds. Creeping wild rye dominates stream floodplains but western wheatgrass and Great Basin wildrye are common. Stands of Fremont cottonwood and willow occur adjacent stream courses. The estimated annual production of herbage exceeds 1890 kilograms per hectare in normal years. This habitat frequently occurs adjacent perennial sloughs and ponds (see Habitat 1).

Habitat Type 53. Wetland, Sodic Flat.

This habitat type is distinct from Habitat Type 1 because it contains juxtaposed marsh habitats and small islands and adjacent shorelines of the Carson-Stillwater soil complex. Its distribution is restricted to quadrats bearing marshes as water sources but without dominant marsh vegetation as discussed and described in Chapter 2. Soils of these islands and shorelines are deep, well-drained, strongly alkaline mixed alluvium. Water capacity is moderate, while permeability varies greatly. Surface runoff is slow, and inundation may occur in winter and early spring.

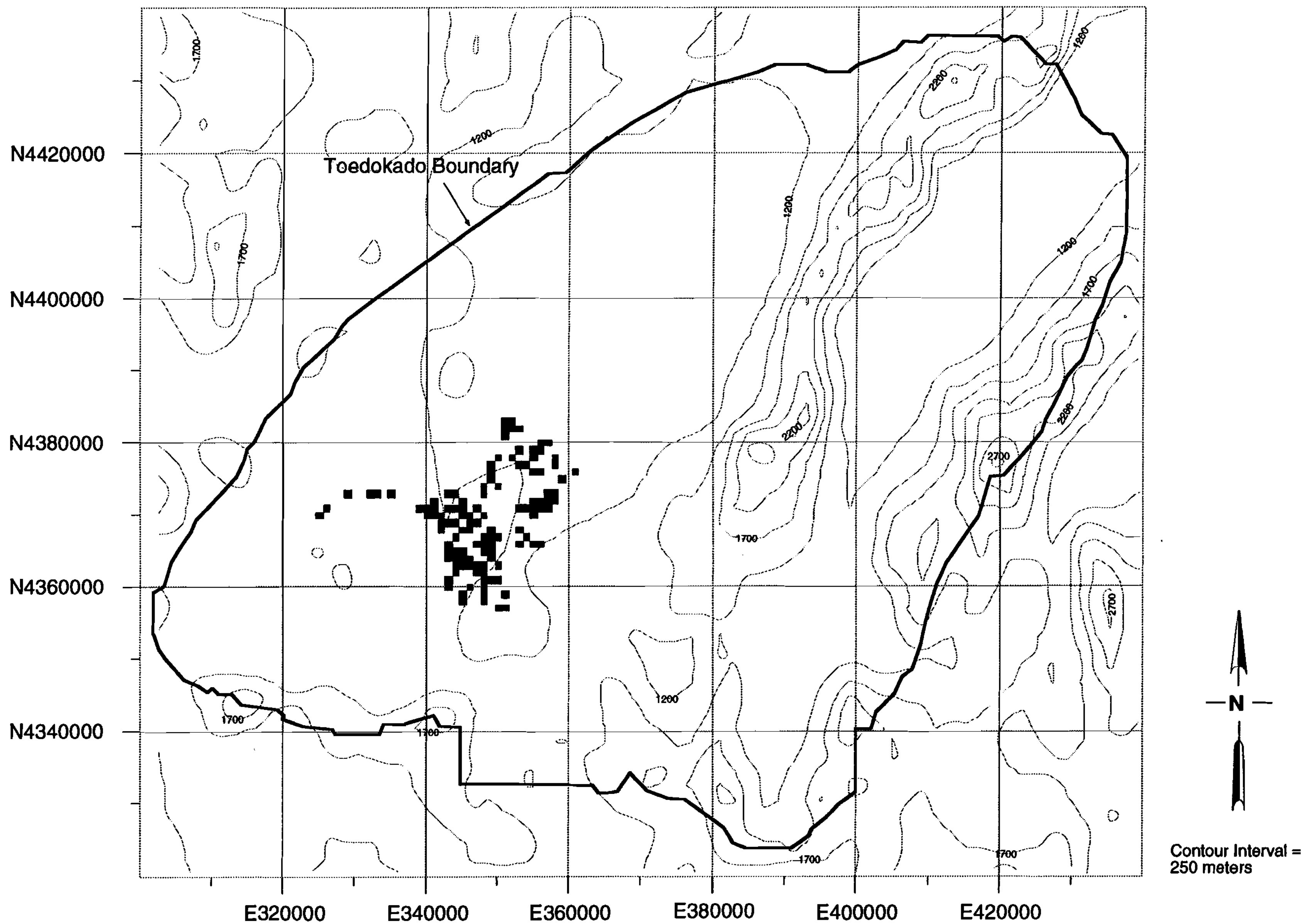

Figure 16. Distribution of moist floodplain, wet sodic bottom habitats (Habitat Types 05, 05a, 05b) by square kilometer quadrat in Toedokado territory.

Dominant native plants in the wetland aspect of this habitat are cattail, creeping spikerush, and alkali bulrush. Black greasewood, shadscale, and inland saltgrass are on islands and shorelines. The dry land aspect is relatively low in plant production, normally 400 kilograms per hectare, with 65 percent composed of black greasewood. However, it does host inland saltgrass and minor inclusions of Indian ricegrass, bottlebrush squirreltail, needlegrass, and seepweed. Although the Soil Conservation Service reports only minor percentages of iodine bush in this habitat, US Fish and Wildlife Service observations suggest that iodine bush is common on alkaline mud flats adjacent marshlands (Hamilton and Auble 1993:10-11). Perhaps the most important aspect of this habitat to hunter-gatherers is that it affords relatively dry land from which to launch forays into marsh wetlands.

Habitat Types 04, 04a, 04b. Wet Sodic Bottom, Sodic Flat

These riparian habitat types described by Raven and Elston (1989:64-69) occupy alluvial flats, lake plains, and axial stream floodplains between 1070 m (3511 ft amsl) and 1220 m (4002 ft amsl) elevation. Slopes are gentle (<2 percent) and soils are deep, poorly drained, and alkaline. Floodplains commonly are inundated. Figure 17 illustrates the distribution of quadrats assigned to Habitat Type 4 in the study area. These are most extensive south of Stillwater Marsh but are dispersed through the lowlands of Carson River and Carson Lake as well.

Potential natural vegetation in these habitats produces 1430 kilograms per hectare in normal years, typically 75 percent grasses, 10 percent forbs, and 15 percent shrubs; alluvial flats and lake plains in this habitat frequently contain black greasewood, shadscale, and saltgrass. Axial stream floodplains contain greater quantities of alkali sacaton, inland saltgrass, and Baltic rush. Minor quantities of creeping wild rye, wheatgrass, Indian ricegrass, and bluegrass are present here.

Greasewood/Saltbush Associations

Habitats belong in this category if they are unassociated with a water source and their dominant shrub is shadscale, four-wing saltbush, black greasewood, or Bailey's greasewood (Table 11). Indian ricegrass usually is the most common grass. These communities occur below 1675 m (5496 ft amsl) elevation, occupying alluvial and lacustrine plains as well as lower alluvial fans.

Habitat Types 29, 29b. Sodic Flat, Deep Sodic Fan.

These habitat types occur on alluvial flats, fan skirts, lake plains, and playa margins. They are fairly flat, achieving no more than 4 percent grade. Soils are alkaline, fine textured mixed alluvium. Available water capacity is moderate and permeability varies. Surface runoff is slow, with ponding in winter and early spring. All quadrats assigned to Habitat Types 29 and 29b occur in the lowlands of Dixie Valley (Figure 18).

Vegetation is 60 percent shrubs, 35 percent grasses, and 5 percent forbs; dominant taxa include Torrey quailbush, black (or big) greasewood, and Great Basin wildrye. This habitat has the largest quantity of Torrey quailbush (230 kg/ha) of any habitat in the study area. The co-occurrence of Torrey quailbush and black greasewood indicate that Habitat 29 represents a variant of the Big Greasewood Association originally defined by Billings (1945:12) for the Carson Desert. Annual herbaceous production is moderate at 800 kilograms per hectare in normal years. However, this habitat occasionally occurs near wet axial stream floodplains, floodplain playas, and adjacent sloughs, springs, seeps, and ponds (see Habitats 1, 28, 53, 55).

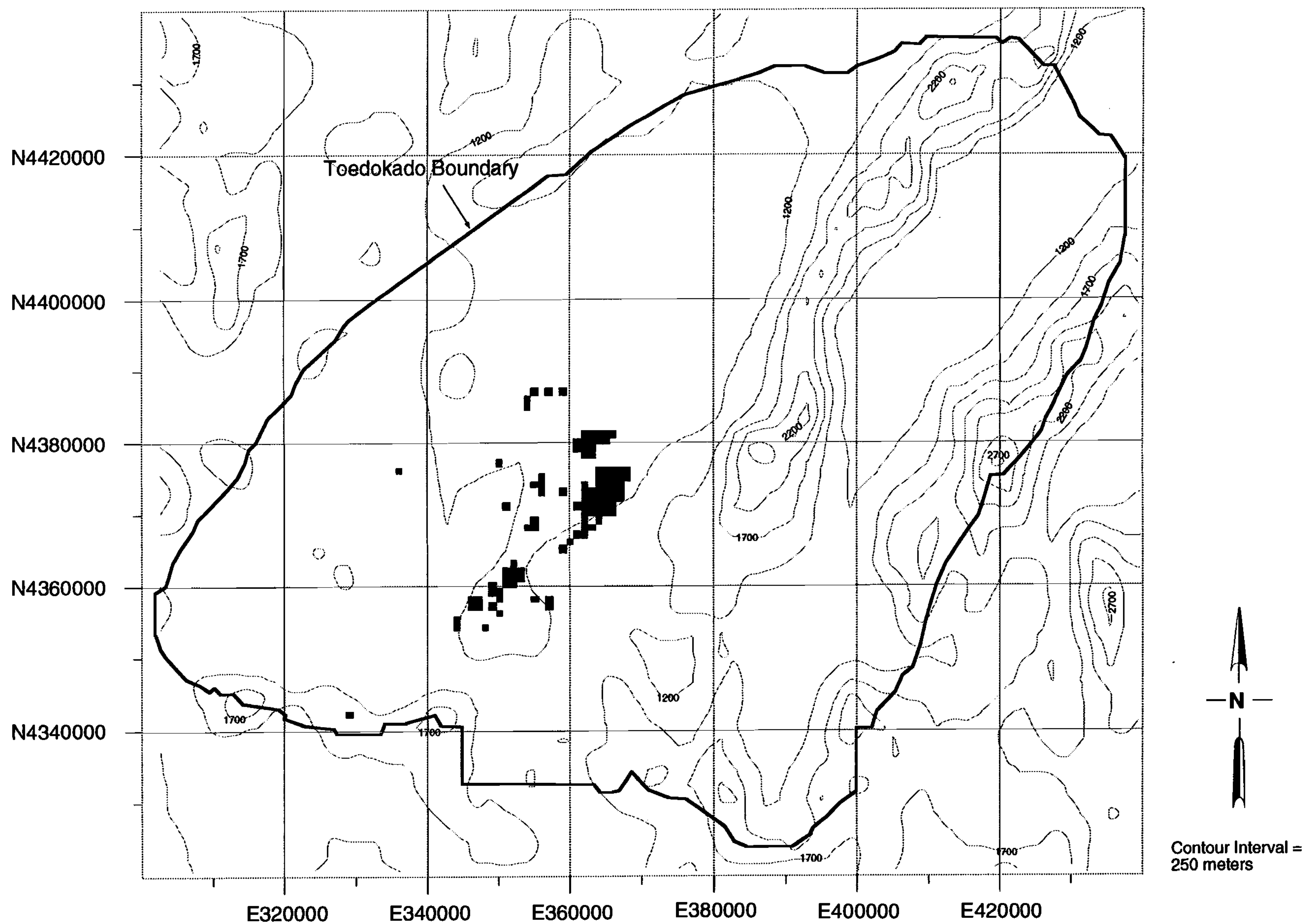

Figure 17. Distribution of wet sodic bottom, sodic flat habitats (Habitat Types 04, 04a, 04b) by square kilometer quadrat in Toedokado territory.

Table 11. Species Composition of Greasewood/Saltbush Habitat Types, by Weight (kg/ha).

Habitat Type Common Name	Genus/Species	29	7	16	36	15	20	3	11	14	19	9	38	13	42	46	56	10	21	49	26	40	18
Grasses																							
alkali sacaton	*Sporobolus airoides*	38	16	0	0	4	0	12	0	0	0	4	7	7	0	0	0	0	0	0	0	0	0
bottlebrush squirreltail	*Sitanion hystrix*	23	22	10	25	4	9	12	12	27	12	7	7	13	12	10	9	14	15	10	10	6	3
creeping wildrye	*Elymus triticoides*	0	0	0	0	4	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
desert needlegrass	*Stipa speciosa*	0	0	0	10	0	4	0	2	0	16	0	0	3	13	25	55	6	9	7	6	10	7
galleta	*Hilaria jamesii*	0	0	0	10	0	4	0	2	0	0	0	0	3	34	7	3	6	9	6	4	6	3
Great Basin wildrye	*Elymus cinereus*	219	76	0	0	9	4	12	0	8	0	7	7	7	0	0	3	0	5	0	0	0	0
Indian ricegrass	*Oryzopsis hymenoides*	8	97	307	113	112	161	12	174	51	137	131	47	27	118	101	36	42	30	31	33	20	22
inland saltgrass	*Distichlis spicata stricta*	30	15	0	0	4	0	24	0	12	0	7	18	10	0	0	0	0	0	0	0	0	0
King desertgrass	*Blepharidachne kingii*	0	0	0	0	0	4	0	2	0	0	0	0	3	0	0	3	6	2	2	4	0	3
needleandthread	*Stipa comata*	0	22	50	0	31	36	0	25	0	0	29	4	0	12	0	6	0	6	0	0	0	0
rush	*Juncus*	6	5	0	0	0	0	12	0	0	0	4	7	6	0	0	0	0	0	0	0	0	0
sand dropseed	*Sporobolus cryptandrus*	4	5	10	10	9	9	0	4	8	12	4	3	0	12	7	1	1	0	2	0	6	0
Sandberg bluegrass	*Poa secunda*	0	0	0	43	0	9	0	12	0	0	0	0	10	0	10	15	22	10	14	10	6	0
thickspike wheatgrass	*Agropyron dasystachyum*	0	5	10	0	0	4	0	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0
Forbs																							
annual forb		0	5	20	0	9	9	0	8	0	8	7	4	0	4	0	0	0	0	0	0	0	0
buckwheat	*Eriogonum*	0	0	0	0	0	4	0	2	0	12	0	0	3	0	0	4	6	2	2	4	0	3
deserttrumpet	*Eriogonum inflatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
evening primrose	*Oenothera*	0	2	10	0	4	9	0	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0
globemallow	*Sphaeralcea*	0	5	10	10	4	4	0	8	8	12	4	4	3	8	7	0	6	7	5	4	4	3
penstemon	*Penstemon*	0	2	10	0	4	9	0	4	0	0	4	0	0	0	0	6	0	0	0	0	0	0
prince's plume	*Stanleya pinnata*	8	5	0	0	4	4	12	4	8	12	4	7	7	0	0	3	6	8	5	2	4	0
skeletonweed	*Lygodesmia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
thelypod	*Thelypodium*	4	5	0	0	0	0	8	0	8	0	4	4	3	0	0	0	0	0	0	0	0	0
Shrubs																							
Anderson wolfberry	*Lycium andersonii*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	6	0
Bailey's greasewood	*S. vermiculatus baileyi*	8	4	15	15	4	28	12	43	12	98	7	11	41	118	10	0	69	38	57	37	44	3
Basin big sagebrush	*A. tridentata tridentata*	30	11	0	0	9	4	0	0	0	0	0	0	0	0	0	55	0	0	0	0	0	0
black greasewood	*Sarcobatus vermiculatus*	161	111	15	0	76	6	256	8	99	0	92	195	128	0	0	29	0	3	0	0	0	0
bud sagebrush	*Artemisia spinescens*	17	15	15	101	0	15	12	21	13	39	4	6	15	12	50	0	28	13	19	17	10	7
burrobrush	*Hymenoclea*	0	0	0	0	9	4	0	0	0	0	0	0	0	0	0	1	10	9	0	2	0	3
Cooper wolfberry	*Lycium cooperi*	0	5	0	0	4	4	0	4	12	0	4	4	3	0	0	1	8	5	3	4	0	0
Douglas rabbitbrush	*Chrysothamnus vicidiflorus*	0	0	0	15	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	2	0	3
four-winged saltbush	*Atriplex canescens*	23	27	76	0	63	63	12	39	12	20	4	11	7	0	0	1	0	10	0	2	0	3
gray molly kochia	*Kochia americana vestita*	0	0	0	15	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0
green molly kochia	*Kochia americana*	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0
hairy horsebrush	*Tetradymia comosa*	0	0	0	0	84	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hopsage	*Grayia spinosa*	11	11	18	15	13	15	0	12	0	12	7	4	3	12	10	11	9	21	7	6	6	3
horsebrush	*Tetradymia sp.*	8	8	0	0	4	0	12	0	12	0	7	11	7	12	0	7	0	0	0	0	0	0
littleleaf horsbrush	*Tetradymia glabrata*	0	2	15	0	9	15	0	12	0	12	4	0	3	0	0	0	9	21	5	6	0	3
Nevada dalea	*Psorothamnus polydenis*	0	5	12	0	19	13	0	7	0	0	7	4	0	0	0	0	0	0	0	0	0	0
Nevada ephedra	*Ephedra nevadensis*	0	2	15	15	0	9	0	12	0	12	4	0	3	12	10	9	8	13	7	6	6	4
pickleweed/iodine bush	*Allenrolfea occidentalis*	8	5	0	0	4	0	12	0	0	0	4	11	7	0	0	0	0	0	0	0	0	0
rabbitbrush	*Chrysothamnus* sp.	0	0	0	0	4	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
rubber rabbitbrush	*Chrysothamnus nauseosus*	17	10	0	0	0	0	12	0	12	0	4	7	7	0	0	3	0	17	0	0	0	0
seepweed	*Suaeda torreyana*	8	5	0	0	0	0	20	0	12	0	7	11	10	0	0	0	0	0	0	0	0	0
shadscale	*Atriplex confertifolia*	23	38	0	141	4	22	24	31	106	39	15	18	44	78	101	42	62	35	57	51	49	39
spiny horsebrush	*Tetradymia spinosa*	0	0	0	0	9	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torrey quailbush	*Atriplex torreyi*	227	0	0	0	0	0	12	0	0	0	4	7	7	0	0	0	0	0	0	0	0	0
winterfat	*Eurotia lanata*	0	11	25	38	9	17	0	17	0	20	15	0	4	12	10	3	8	5	7	6	6	6
wolfberry	*Lycium*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	2	0	3

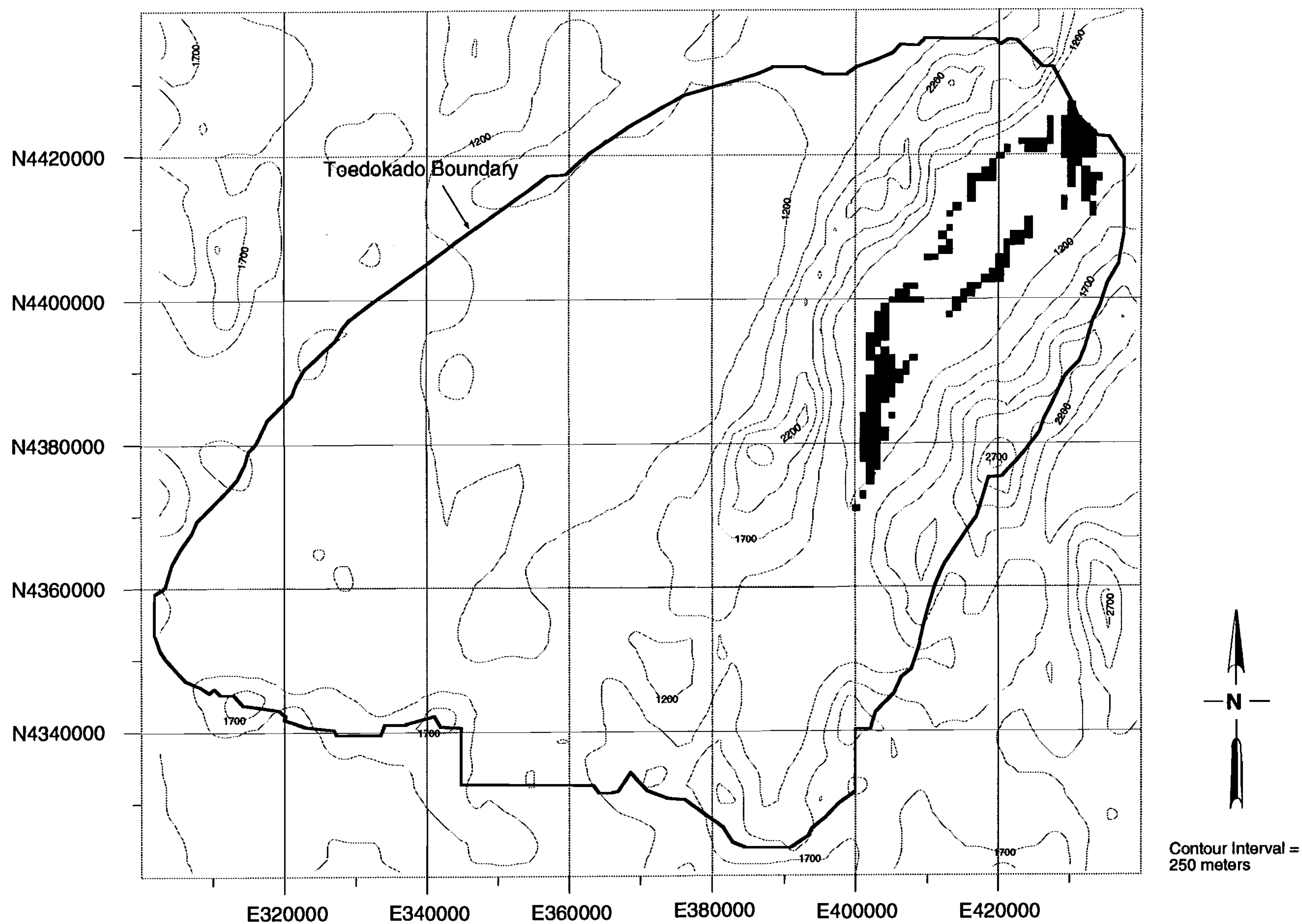

Figure 18. Distribution of sodic flat, deep sodic fan habitats (Habitat Types 29, 29b) by square kilometer quadrat in Toedokado territory.

Habitat Types 07, 07a, 07b. Sodic Flat, Sodic Terrace-Sandy Fans and Sheets, Sodic Sands, Deep Sodic Sands

These habitat types occupy lake plains and beach terraces, alluvial flats, and the lower skirts of alluvial fans; Raven and Elston (1989:75-79) provide additional discussion. Soils, typically derived from alluvial or lacustrine sources, are deep, well-drained, and alkaline, capped with eolian sediments. Quadrats assigned to these habitat types most commonly occur in the Carson River lowlands, but isolated clusters are to be found in the northern Carson Desert (Figure 19) as well.

Associated potential plant communities are 45 percent grasses, 5 percent forbs, and 50 percent shrubs. Total annual air-dry herbaceous production is 540 kilograms per hectare in normal years, including shadscale, black greasewood, Indian ricegrass, and inland saltgrass; Great Basin wildrye is also present in notable quantities. This habitat frequently occurs near standing perennial water in wet axial stream floodplains, floodplain playas, and adjacent sloughs, springs, seeps, and ponds (see Habitats 1, 6, and 55).

Habitat Type 16. Sandy 5-8 in. precipitation zone

Sandy sheets on lower piedmont slopes and alluvial plains constitute Habitat Type 16. Slopes vary from two to eight percent. Soils are well-drained, deep lacustrine sands of various bedrock sources that may be overlain by alluvial or eolian sands. Examples of this habitat are most common in Fairview Valley, Salt Wells Basin, and the foothills of the Dead Camel and Desert Mountains (Figure 20).

Indian ricegrass and four-wing saltbush, with notable inclusions of needleandthread grass and winterfat dominate potential native vegetation. The habitat type is 75 percent grass-like plants, 20 percent shrubs, and 5 percent weedy forbs. Although total production for this habitat is merely 500 kilograms per hectare in a normal year, more than half the yield is Indian ricegrass, at 300 kg/ha; a higher yield than in any other habitat of the study area. Young and his colleagues observed an average density of 2.8 ricegrass plants per square meter at an example of this range type north of Labou Flat (Young et al. 1983:83). The habitat type is also notable because it bears the most annual forbs (18 kg/ha) of any habitat in the study area.

Habitat Type 36. Loamy 4-8 in. precipitation zone

This habitat type occurs on piedmont slopes, alluvial plains, and relict alluvial fans. Slope varies from two to eight percent gradient. Soils are shallow, moderately coarse textured, and slightly to strongly alkaline; desert pavement is a common attribute. Examples of this habitat type are most extensive in northern Dixie Valley, with only a handful more elsewhere (Figure 21).

The flora of Habitat Type 36 is a good example of what Billings (1945:6-7) classified as the Little Greasewood-Shadscale Association of the Carson Desert. Potential native vegetation is 60 percent shrubs, 35 percent grasses, and 5 percent forbs. Dominant plants include shadscale, Indian ricegrass, bud sagebrush, Sandberg's bluegrass, and winterfat. Plant production approximates 500 kilograms per hectare in normal years. The habitat type is particularly notable because it maintains higher densities of shadscale (139 kg/ha) and winterfat (38 kg/ha) than any other habitat in the study area.

Habitat Types 15. Dunes, Sodic Dunes

Soils form in deep, well-drained eolian sediments of stabilized and partially stabilized sand dunes in this habitat which Raven and Elston (1989:89) have described in detail. Clusters of quadrats

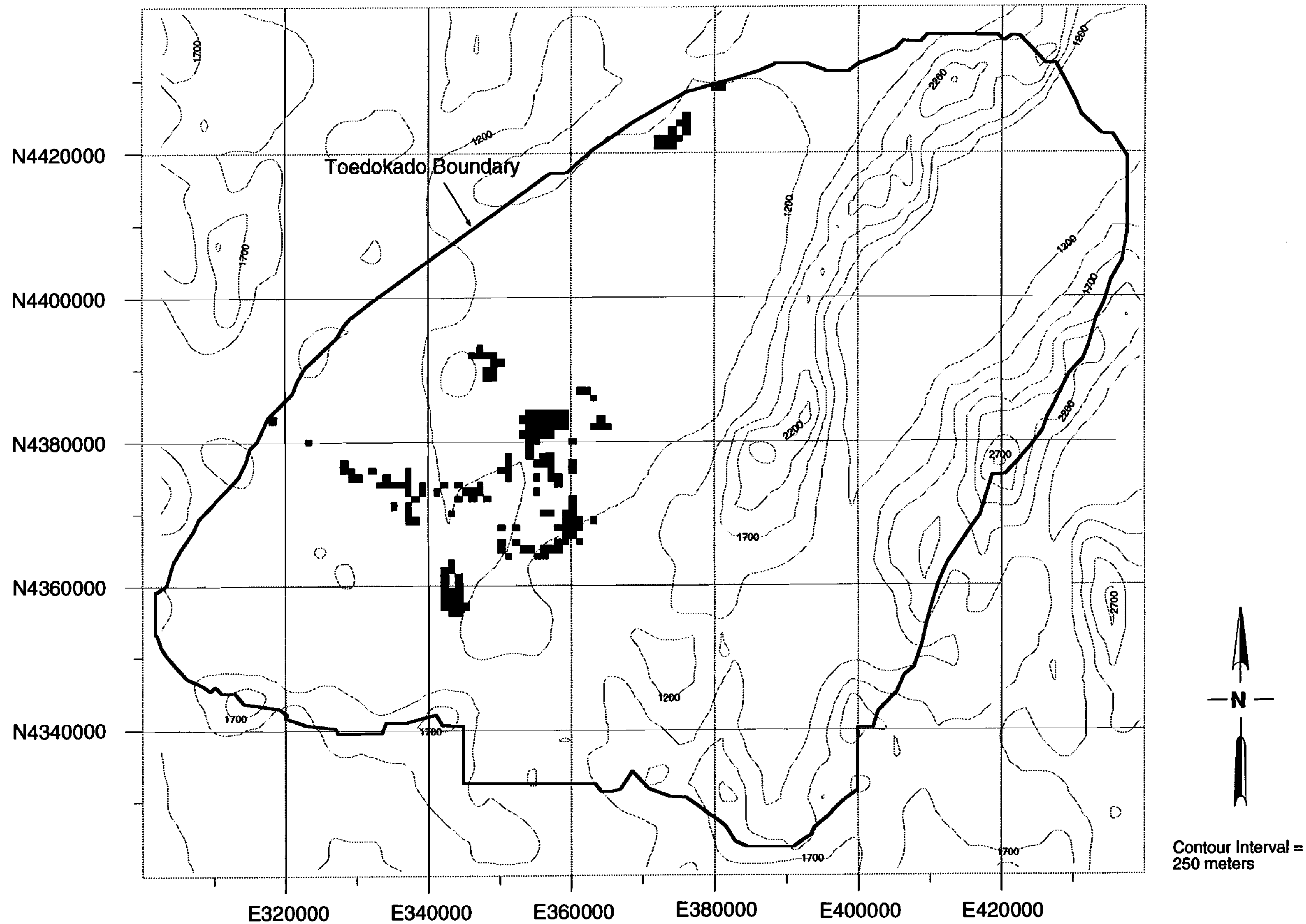

Figure 19. Distribution of sodic flat, sodic terrace-sandy fans and sheets, sodic sands, deep sodic sands habitats (Habitat Types 07, 07a, 07b) by square kilometer quadrat in Toedokado territory.

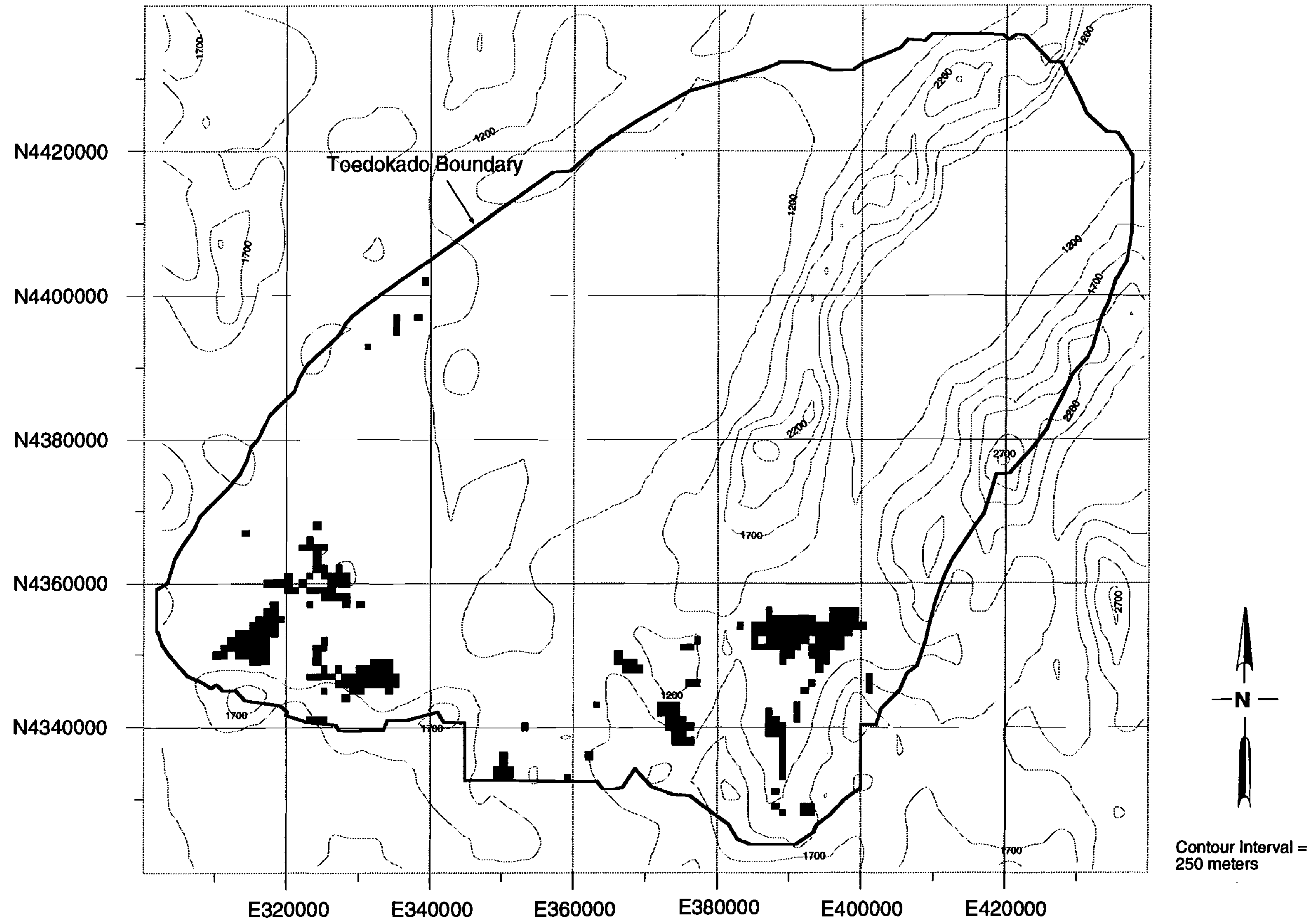

Figure 20. Distribution of sandy 5-8 in. precipitation zone habitat (Habitat Type 16) by square kilometer quadrat in Toedokado territory.

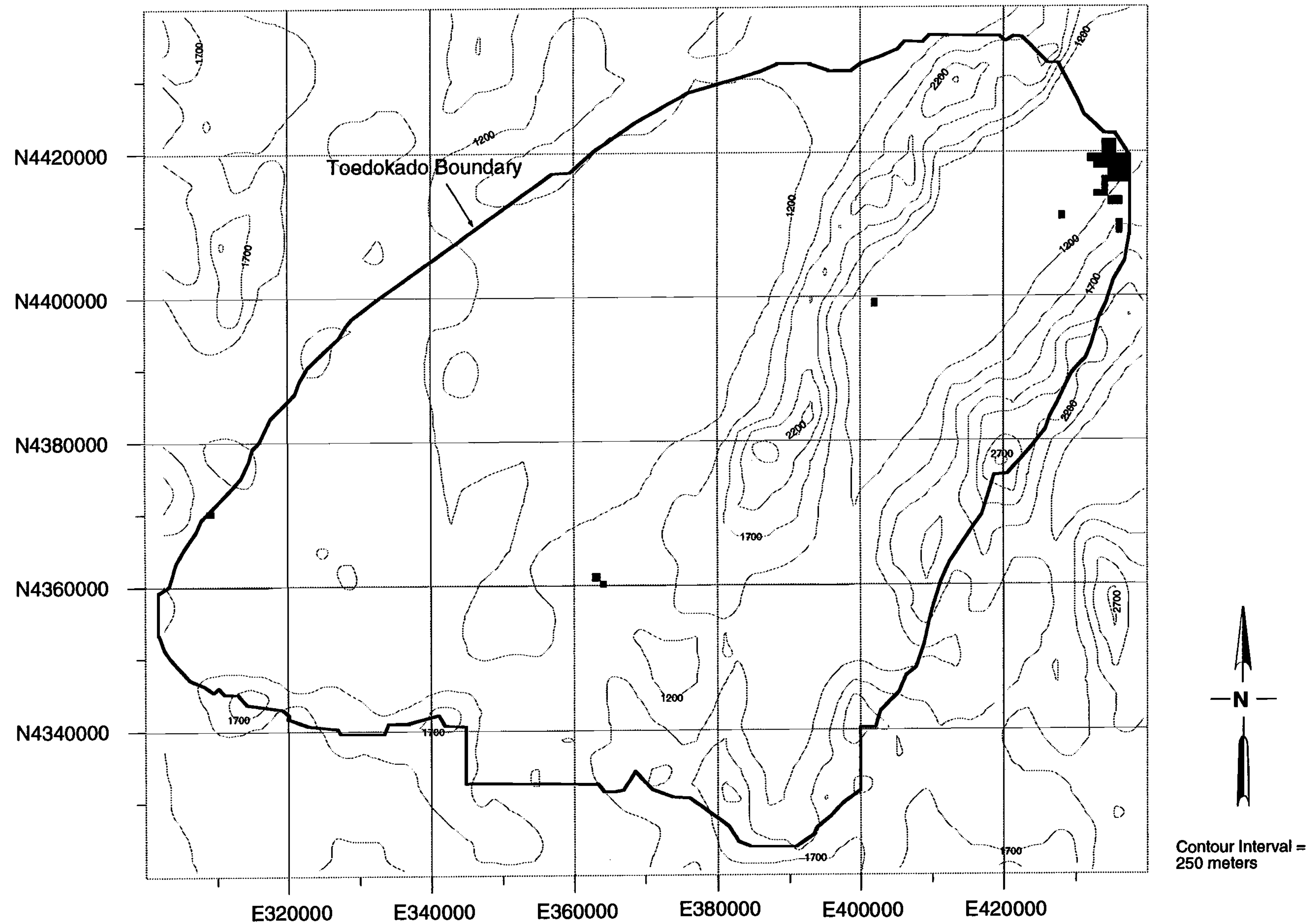

Figure 21. Distribution of loamy 4-8 in. precipitation zone habitat (Habitat Type 36) by square kilometer quadrat in Toedokado territory.

assigned to Habitat 15 occur in the lowlands between the Desert and Cocoon Mountains, in northern Eightmile Flat, and along the southwest margins of Carson Sink (Figure 22).

Total annual herbaceous production may reach 450 kilograms per hectare in normal years. Vegetation is 35 percent grasses, 5 percent forbs, and 60 percent shrubs. Black greasewood, four-wing saltbrush, Indian ricegrass, and needleandthread are characteristic. Annual forbs are *relatively* abundant (8 kg/ha). Habitat Type 15 maintains higher densities of Nevada dalea (Smokebush- 19 kg/ha) and hairy horsebrush (84 kg/ha) than any other habitat in the study area; both are examples of what Billings (1945:9-11) has classified as the Dalea Association of the Carson Desert. Indeed, Billings describes the area between the Desert Mountains and Eightmile Flat as a type example of the association, commenting that the Dalea Association vegetation supports large populations of heteromyid rodents.

Habitat Type 20. Sandy 5-8 in. precipitation zone; Gravelly Loam 4-8 in. precipitation zone; Dunes 4-8 in. precipitation zone

Habitat Type 20 occurs on stabilized sand dunes, sand sheets of lower piedmont slopes, lake plains and terraces, and alluvial plains. Typically, these are well-drained soils formed in deep sands derived from various rock sources, sometimes overlain with alluvial or eolian sands or rock fragments. Slopes vary from 2 to 30 percent. Figure 23 depicts the locations of quadrats assigned to Habitat Type 20; most occur between the Desert and Cocoon Mountains and north of Eightmile Flat.

Native vegetation is predominantly Indian ricegrass with notable inclusions of four-wing saltbush, needleandthread grass, and Bailey's greasewood. This habitat type is half grasses, 45 percent shrubs, and the remainder forbs. The ground cover produces approximately 400 kilograms per hectare in a normal year, of which more than a third is ricegrass. The habitat type is also notable for the relative abundance of annual forbs (8 kg/ha), as well as Nevada Dalea (13 kg/ha) and hairy horsebrush (56 kg/ha). The composition and distribution of Habitat Type 20 indicate that it includes examples of the Dalea Association described by Billings (1945:9-10).

Habitat Types 03, 03a, 03b. Sodic Flat 4-8 in. precipitation zone

These habitat types, identified and described by Raven and Elston (1989:71), occur on deep, well-drained alluvium of alluvial flats and lake plains, frequently on playa margins. Soils are strongly alkaline. Drainage is poor, sometimes resulting in inundation in winter or spring. Coppice mounds, a common geomorphic feature, are highly saline, vegetated dunes composed of organic matter, eolian sand, and lacustrine sediments. They frequently occur in bands separating playas from upland communities, possibly reflecting the extent of former shorelines. Within these bands, coppice dunes can occupy approximately 30 percent of total area, with the remaining area barren playa surfaces. Although coppice mounds typically are only a few meters in diameter, several mounds can coalesce to form larger mound complexes. Their cyclic formation and destruction are caused by vegetation; they form around established shrubs encouraging further vegetative growth in early stages of formation. However, vegetation absorbs salts from the surrounding playa, accumulating in the mound, and ultimately increasing the salinity of the mounds to the point that seeds no longer can germinate. After established plants die, the unprotected mounds are susceptible to wind erosion (Blank et al. 1992:196; Nials 1994:4).

The potential native vegetation is 15 percent grasses and grass-like plants, 5 percent forbs, and 80 percent shrubs. Total annual air-dry production is only 390 kilograms per hectare in normal years. Black

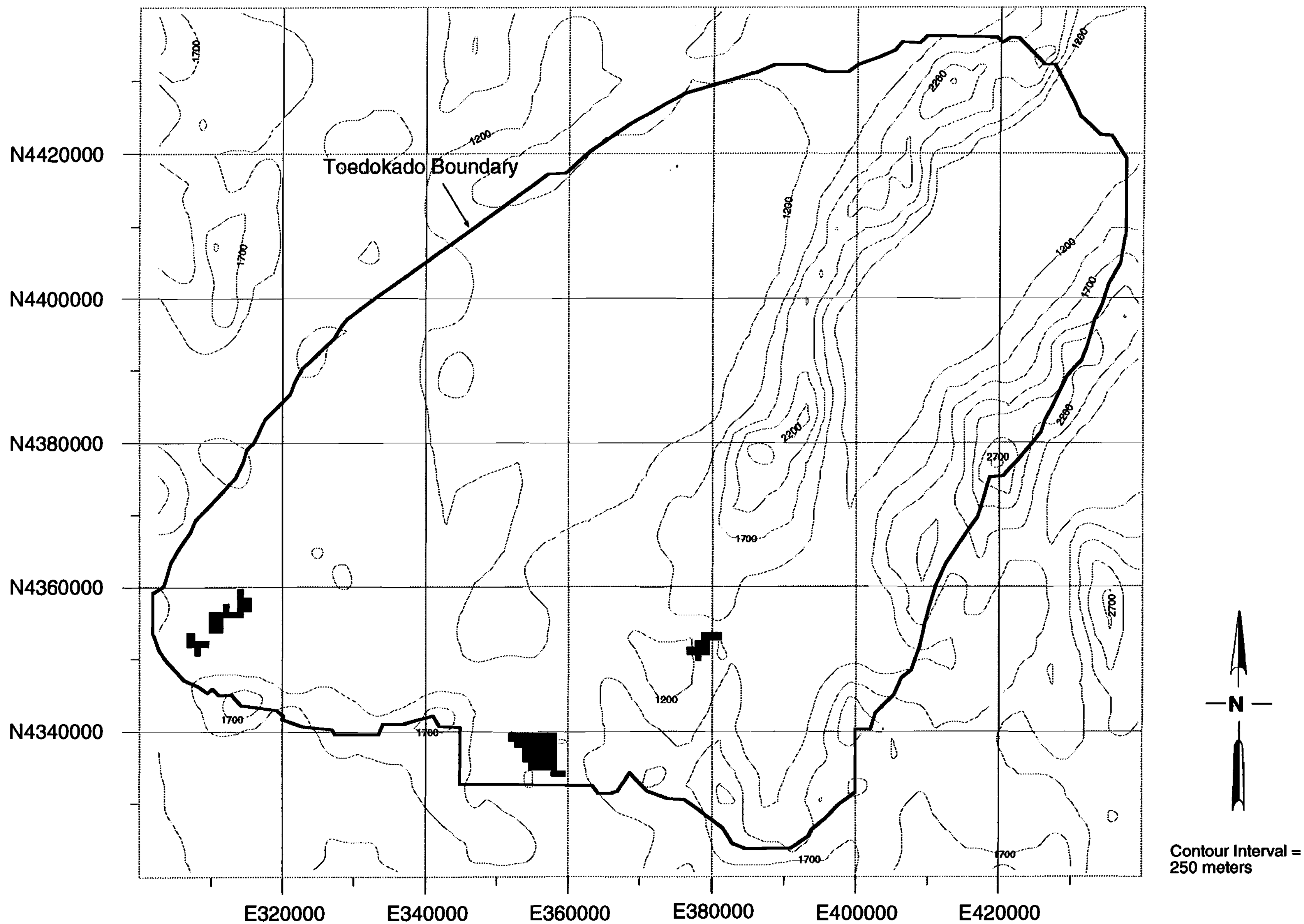

Figure 22. Distribution of dunes, sodic dunes habitats (Habitat Type 15) by square kilometer quadrat in Toedokado territory.

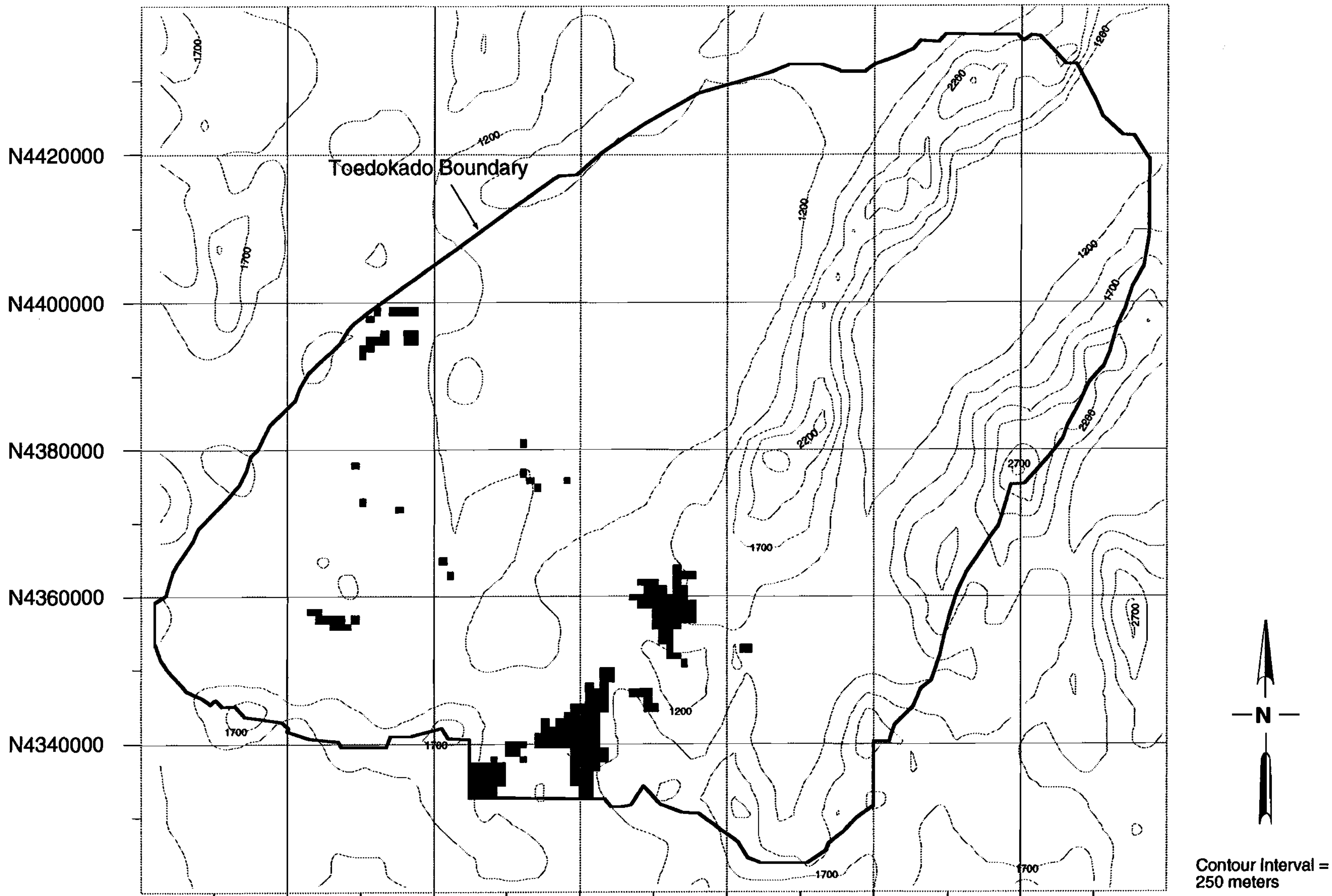

Figure 23. Distribution of sandy 5-8 in. precipitation zone; gravelly loam 4-8 in. precipitation zone; and dunes 4-8 in. precipitation zone habitats (Habitat Type 20) by square kilometer quadrat in Toedokado territory.

greasewood, shadscale, and inland saltgrass dominate the annual production of the habitat. These habitat types also contain one of the highest densities of seepweed (20 kg/ha) and iodine bush (11 kg/ha) in the study area. Vegetation frequently is restricted to coppice mounds, although isolated greasewood or shadscale shrubs occasionally may grow on intervening surfaces. Iodine bush is most common on coppice mounds, while inland saltgrass grows in patches along the lower edges of mounds intruding onto playa surfaces (Blank et al 1992:195).

Quadrats assigned to these habitat types are widely distributed through Toedokado territory (Figure 24). They are most common along the margins of Carson Lake, Carson Sink, and playas in Dixie Valley, as well as throughout the western Carson Desert.

Habitat Types 11, 11a, 11b. Sandy fans and sheets, Gravely loam, 4-6 in. precipitation zone

These occur at the juncture of lower piedmont slopes and upper alluvial and lake plains. Soils are well-drained, deep, and medium textured. Surface layers may contain high amounts of gravel or may be capped by alluvial and eolian sands. Quadrats assigned to these habitat types occur throughout the Carson Desert, west of Carson Lake, and southeast of the Hot Springs Mountains. They also occur north of Eightmile Flat and along the western toe of the Clan Alpine Range (Figure 25).

The vegetation is 60 percent grasses, 5 percent forbs, and 35 percent shrubs. Annual production is 390 kilograms per hectare in normal years. Indian ricegrass yields approximately 200 kilograms per hectare in normal years; needleandthread and winterfat are also common. The dominant shrub is Bailey's greasewood, but four-wing saltbrush and shadscale occur in minor quantities. These habitat types contain higher densities of Desert thorn (11 kg/ha) than any other habitat in Toedokado territory. Occasional riparian areas will bear localized patches of creeping wild rye, wheatgrass, and Great Basin wildrye (see Habitat 6). Raven and Elston (1989:85) discuss these habitat types in detail.

The productivity of Indian ricegrass stands in this habitat is well documented. An example of Habitat Type 11 north of the Hot Springs Mountains produced over 40,000,000 Indian ricegrass seeds per hectare between June and August of 1977 (Young et al. 1983:85). These seeds are an important food source for heteromyid rodents, such as kangaroo rats, that congregate in the sands of the habitat (McAdoo et al. 1983:61-64).

Habitat Type 14. Sodic Terrace

This habitat type occurs on fan skirts, beach terraces, beach plains, alluvial flats, and lake plain terraces. Quadrats assigned to Habitat Type 14 occur in small clusters west of Carson Sink and south of Carson Lake (Figure 26). Soils are deep, moderately well-drained alluvial or lacustrine sediments that may be strongly alkaline. The potential natural vegetation is 25 percent grasses, 5 percent forbs, and 70 percent shrubs with annual herbaceous production yields of 390 kilograms per hectare. Shadscale, black greasewood, and Indian ricegrass are dominant plants. Habitat Type 14 is notable because it supports the second largest (108 kg/ha) representation of shadscale in the study area, while seepweed is relatively well represented here (11 kg/ha). The co-occurrence of large quantities of black greasewood (99 kg/ha) and shadscale indicates that Habitat Type 14 would be included in the Big Greasewood-Shadscale Association described by Billings (1945:14). Readers are referred to Raven and Elston (1989:86) for additional discussion of this habitat type.

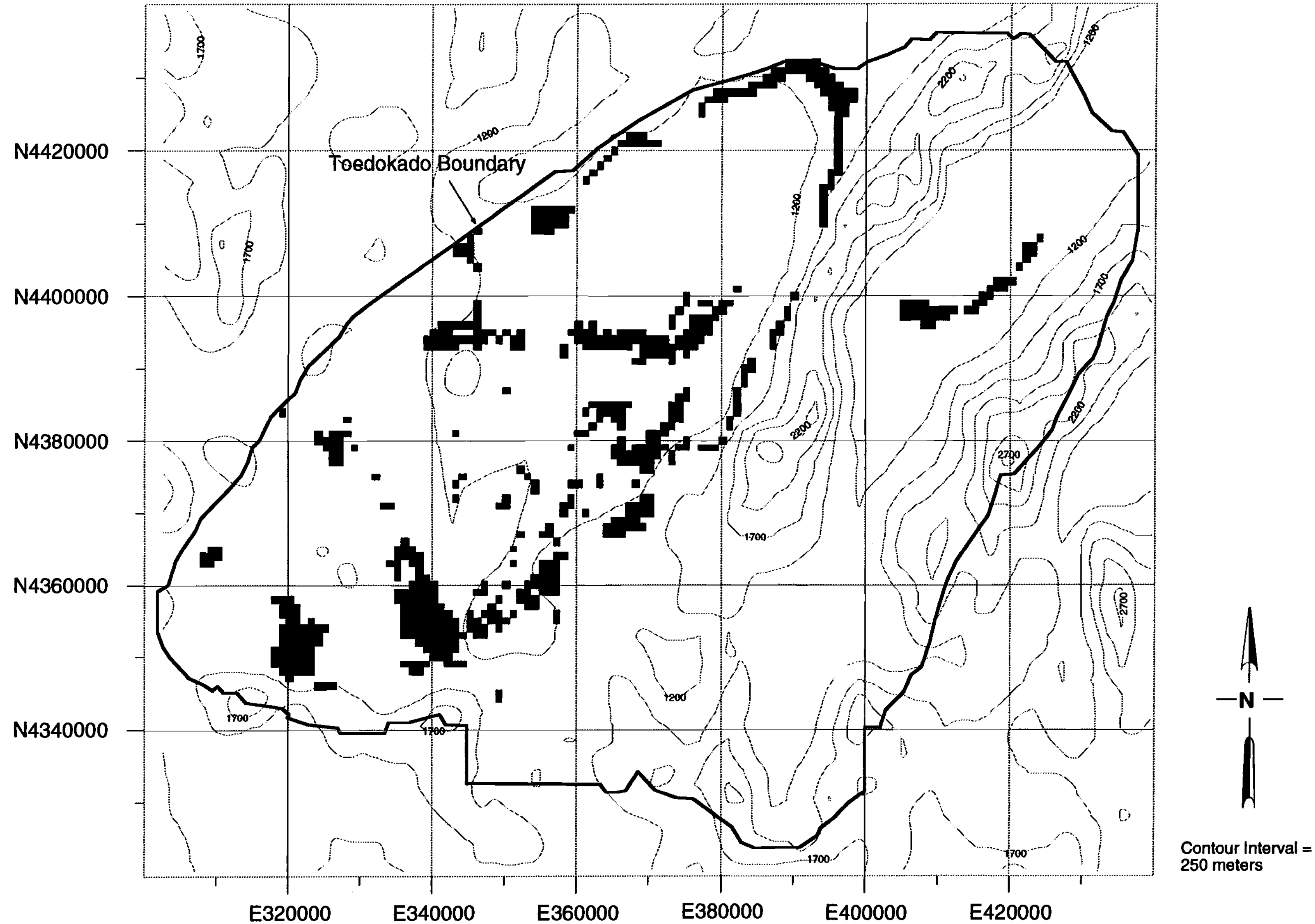

Figure 24. Distribution of sodic flat 4-8 in. precipitation zone habitat (Habitat Types 03, 03a, 03b) by square kilometer quadrat in Toedokado territory.

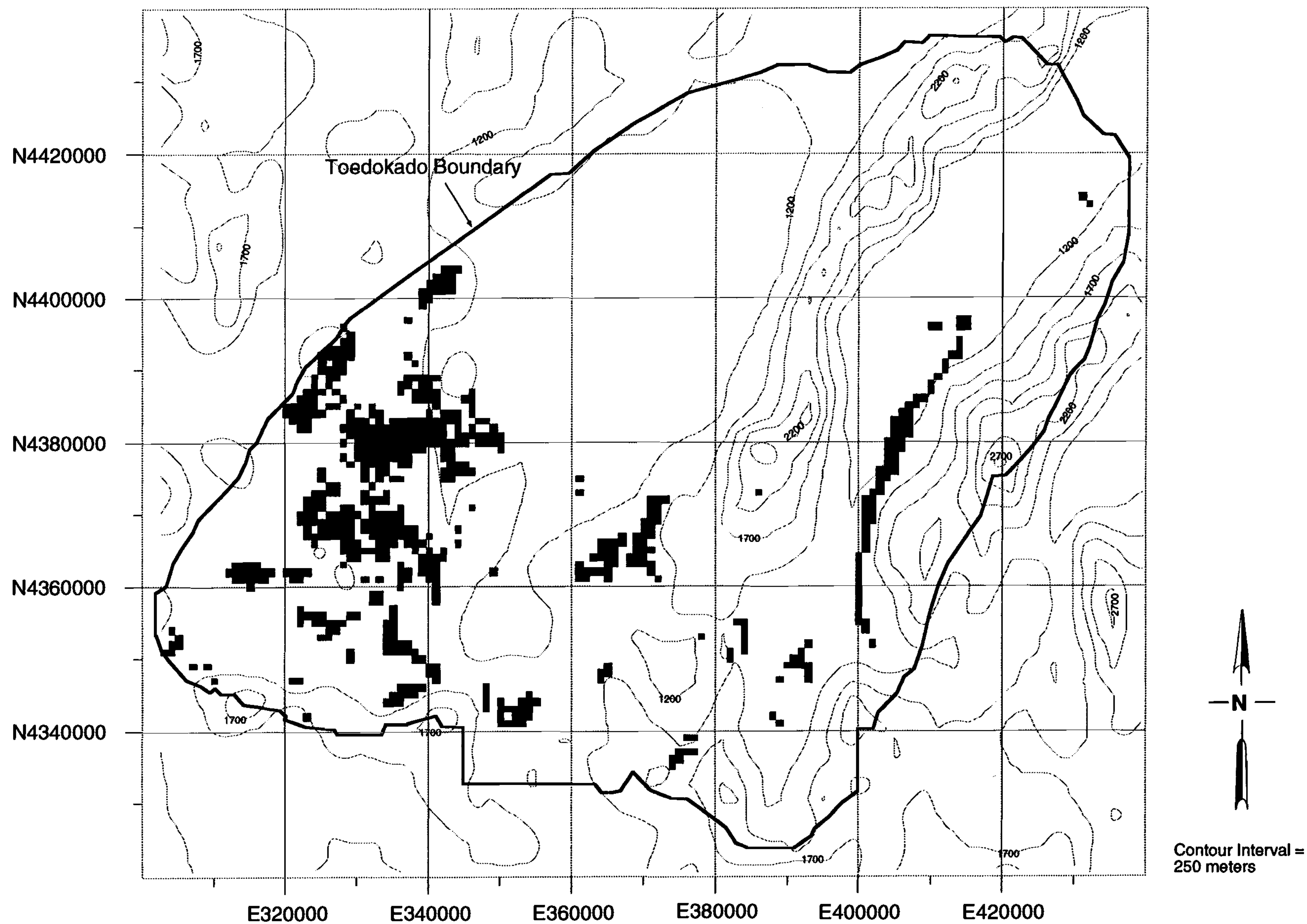

Figure 25. Distribution of sandy fans and sheets, gravelly loam, 4-6 in. precipitation zone habitats (Habitat Types 11, 11a, 11b) by square kilometer quadrat in Toedokado territory.

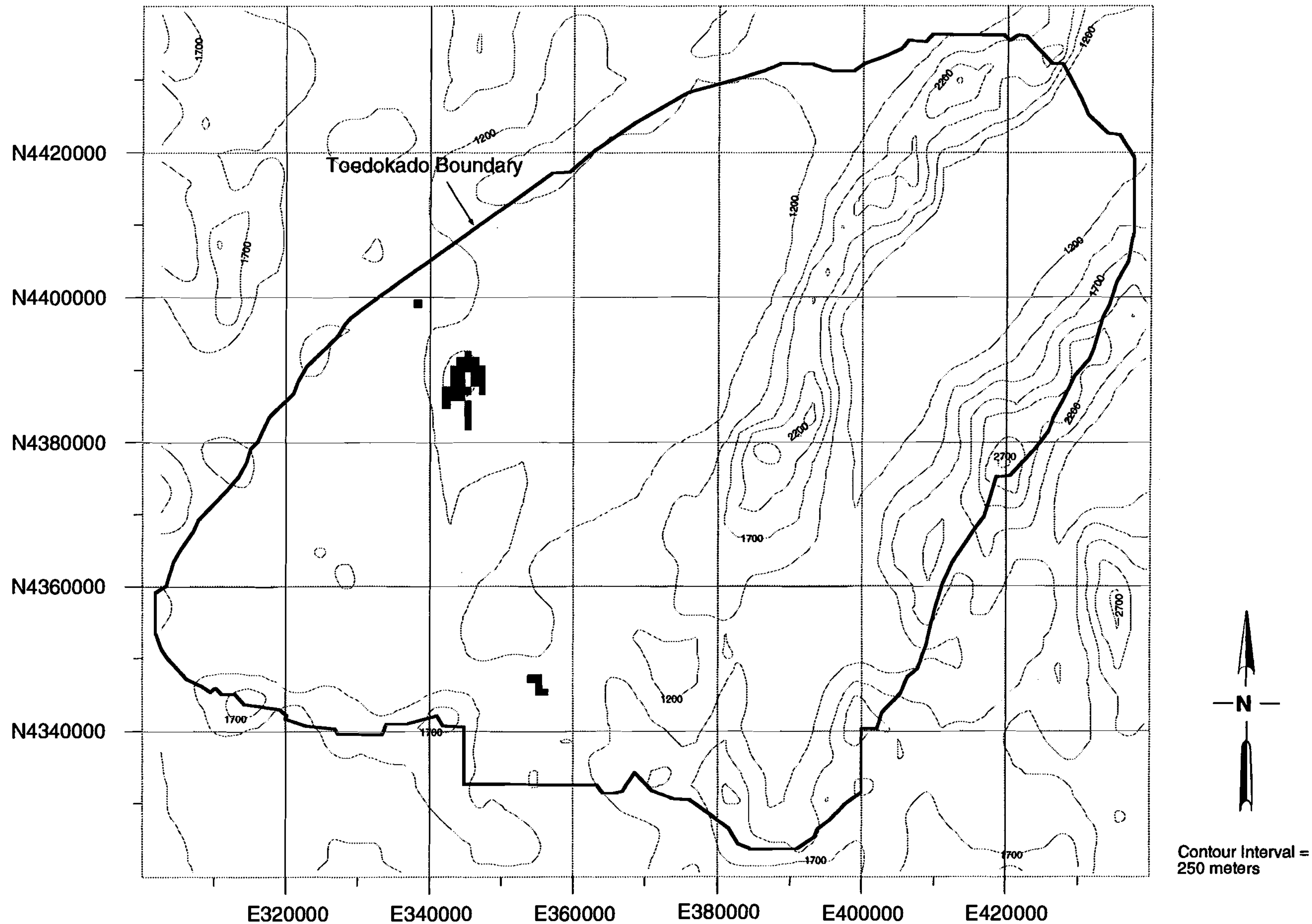

Figure 26. Distribution of sodic terrace habitats (Habitat Type 14) by square kilometer quadrat in Toedokado territory.

Habitat Type 19. Coarse Gravelly Loam 5-8 in. precipitation zone

Habitat Type 19 occupies deep, well-drained, coarse textured soils on piedmont slopes and lake plains. Quadrats assigned to Habitat Type 19 are dispersed around the margins of Toedokado territory (Figure 27). A thin (10 to 25 cm) surface sand sheet may overlie examples of this habitat. Slopes vary from 2 to 15 percent. The native flora are mostly Indian ricegrass, Bailey's greasewood, shadscale, and bud sagebrush. It is the second must productive habitat for Bailey's greasewood in the model, clearly an example of the Little Greasewood-Shadscale Association described by Billings (1945:6). It is half grasses, 45 percent shrubs, and the remainder forbs. In a normal year, this habitat type will produce approximately 400 kilograms per hectare. However, richer patches of Great Basin wildrye, sedge, rush, and western wheatgrass occasionally occur around seeps and springs in this habitat (see Habitat 55).

Habitat Types 09, 09a, 09b. Sandy Fans and Sheets, Sodic Sands- Sodic Flat 4-8 in., Sodic Flat 3-6 in.

Raven and Elston (1989:79-80) identified and described these habitat types, which occur on alluvial flats, fan skirts and sheets, lake plains, and lower piedmont slopes, commonly south and west of Carson Sink (Figure 28). Soils are deep, well-drained alluvial sediments, frequently capped by eolian sands. Vegetation production achieves 360 kilograms per hectare in normal years: 58 percent grasses, 6 percent forbs, and 36 percent shrubs. Black greasewood and Indian ricegrass dominate, but shadscale, desert thorn, and inland saltgrass are present in small quantities. Frequently, these habitat types lie near standing perennial water containing productive marshes of cattail, creeping spikerush, and alkali bulrush. Rich patches of creeping wild rye, wheatgrass, and Great Basin wildrye may occur along stream and river courses which occasionally flow through these habitats (see Habitat Type 6).

Habitat Types 38, 38b. Sodic Dune, Flat.

Quadrats assigned to these habitat types are most common along the northeastern margins of Carson Sink. They also occur in southern Dixie Valley, Salt Wells Basin, Rawhide Flat, and in scattered locations south and west of Carson Lake (Figure 29). These habitat types are situated where stabilized sand dunes and alluvial flats and lake plains co-occur. Soils tend to be deep, well-drained eolian sands or mixed alluvium. Slopes vary from negligible to 15 percent. Floral composition is 65 percent shrubs, 30 percent grasses, and 5 percent forbs. Potential native vegetation is dominated by black greasewood, with notable inclusions of Indian ricegrass and one of the best representations of iodine bush (11 kg/ha) and seepweed (10 kg/ha) in Toedokado territory. Plant production averages 400 kilograms per hectare in normal years.

Habitat Type 13. Sodic Flat 4-8 in. precipitation zone, Gravelly loam 4-6 in. precipitation zone

This habitat type is on well-drained, mixed alluvium, with slopes capped by abundant rock fragments. Landforms associated with Habitat Type 13 include lake plains and terraces, lower alluvial flats, and lower piedmont slopes. Quadrats assigned to Habitat Type 13 are most extensive along the eastern flank of Carson Sink, but isolated patches are dispersed throughout Dixie Valley and the western Carson Desert (Figure 30).

Total vegetation production is 335 kilograms per hectare in normal years of which 20 percent is grasses, 5 percent is forbs, and 75 percent is shrubs. Shadscale, Indian ricegrass, and inland saltgrass are common; black greasewood dominates on alluvial flats and lake plains, whereas Bailey's greasewood

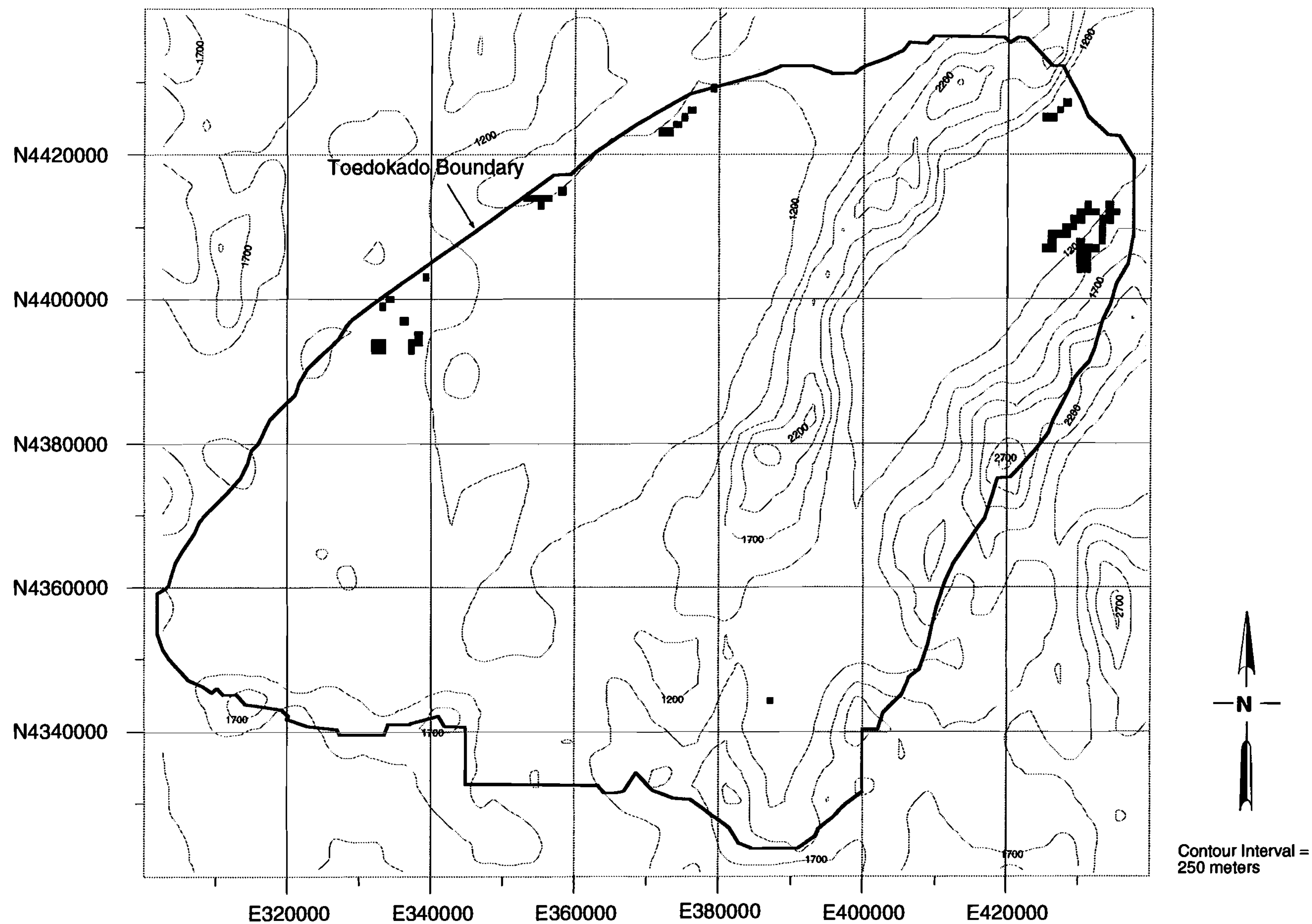

Figure 27. Distribution of coarse gravelly loam 5-8 in. precipitation zone habitat (Habitat Type 19) by square kilometer quadrat in Toedokado territory.

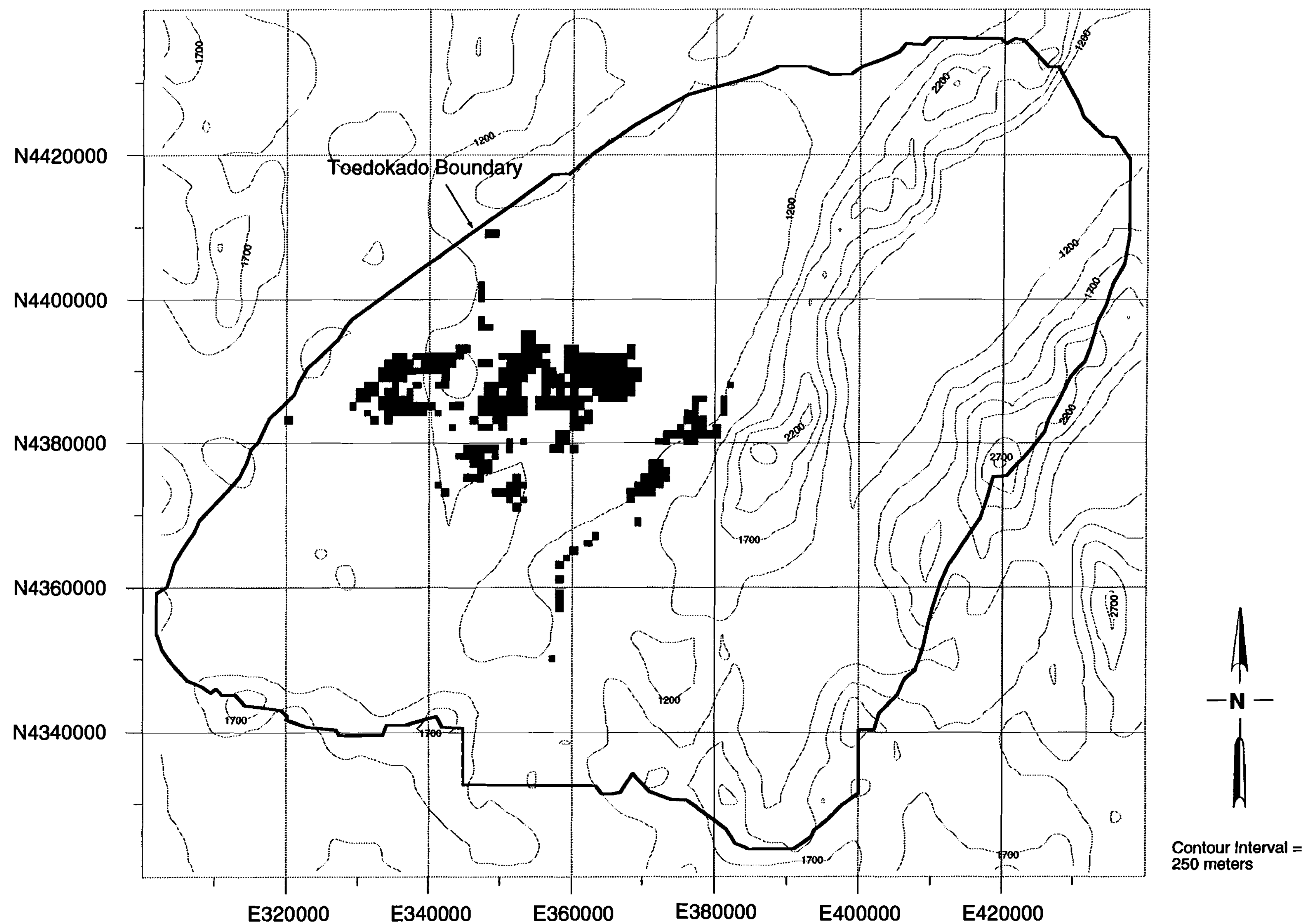

Figure 28. Distribution of sandy fans and sheets, sodic sands-sodic flat 4-8 in. precipitation zone, sodic flat 3-6 in. precipitation zone habitats (Habitat Types 09, 09a, 09b) by square kilometer quadrat in Toedokado territory.

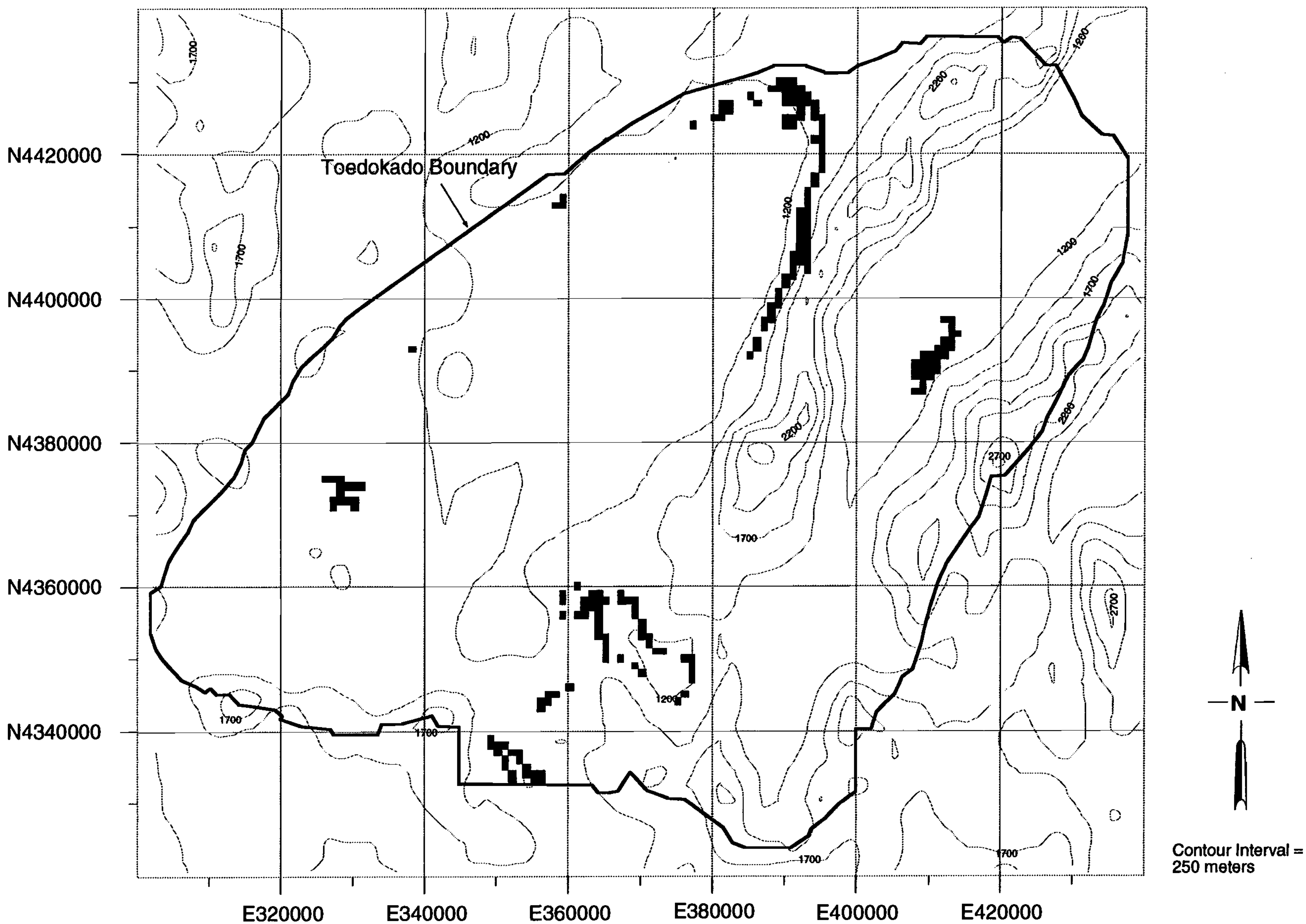

Figure 29. Distribution of sodic dune and sodic flat habitats (Habitat Types 38, 38b) by square kilometer quadrat in Toedokado territory.

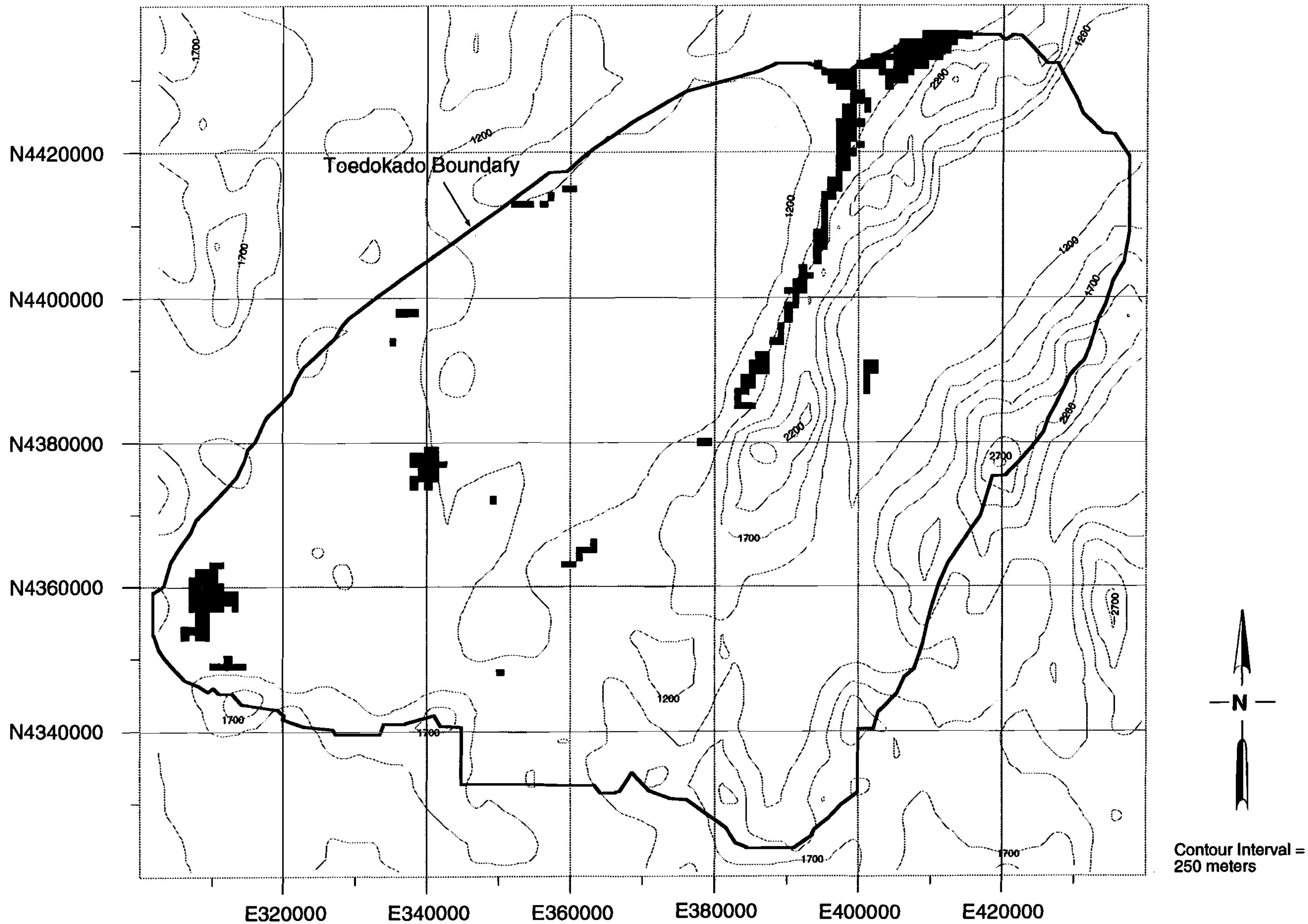

Figure 30. Distribution of sodic flat 4-8 in. precipitation zone, gravelly loam 4-6 in. precipitation zone habitats (Habitat Type 13) by square kilometer quadrat in Toedokado territory.

is more common on piedmont slopes. Seepweed occurs in relatively high densities (10 kg/ha). Raven and Elston (1989:79) provide additional description.

Habitat Types 42, 42c. Stony Loam 4-8 in. precipitation zone

These habitat types occupy summits and side slopes of low hills and upper piedmont slopes of all exposures, at gradients varying from 8 to 30 percent. Soils are shallow, well-drained, and formed from basalt bedrock residuum; gravels litter the surface and profiles contain abundant rock fragments. Quadrats assigned to this habitat occur only in the southwestern portion of the study area, most abundantly in the Desert, Dead Camel, and Cocoon Mountains (Figure 31).

Plant production is approximately 400 kilograms per hectare in normal years. The native flora is half shrubs, 45 percent grasses, and 5 percent forbs; Indian ricegrass, Bailey's greasewood, and shadscale dominate.

Habitat Types 46, 46c. Loamy Slope 5-8 in. precipitation zone

Loamy slopes are on hills and lower mountain slopes of all aspects, but only on southerly exposures at upper elevations. Slopes vary from 30 to 50 percent gradient. Soils typically are very shallow. Surfaces are medium to coarse textured, very gravelly, and lightly to strongly alkaline. Quadrats assigned to these habitat types occur throughout the lower foothills of the Stillwater, Clan Alpine, and Fairview Mountains (Figure 32).

Vegetation composition is 55 percent shrubs, 40 percent grasses, and 5 percent forbs. Dominants include Indian ricegrass and shadscale, with bud sagebrush and desert needlegrass comprising significant components of the community. These habitats are types notable for their third highest representation of shadscale in the study area (101 kg/ha). Production of vegetation averages 300 kilograms per hectare in normal years.

Habitat Types 56, 56c. Loamy Slope 8-10 in. precipitation zone, Gravelly Loam 4-8 in. precipitation zone, Stony Slope 4-8 in. precipitation zone, Barren Gravelly Slope 4-8 in. precipitation zone

These habitat types occur on piedmont slopes, upper lake plains, and terraces and alluvial fans. Soils are shallow, well-drained, medium to coarse textured with gravelly inclusions. They are most common on lower slopes of the Stillwater, Clan Alpine, and Fairview Mountains (Figure 33). Potential natural vegetation is mostly Bailey's greasewood, shadscale, and Indian ricegrass; however, steep northerly side slopes support Wyoming big sagebrush and Thurber needlegrass. Annual air-dry production of herbage may reach 300 kilograms per hectare in normal years of which 52 percent are shrubs, 43 percent are grasses, and 5 percent are forbs.

Habitat Types 10, 10a 10b. Gravelly loam 4-8 in. precipitation zone

These habitat types are widespread throughout Toedokado territory, occurring throughout Dixie Valley, Fairview Valley, Salt Wells Basin, and the Carson Desert west of Carson Lake (Figure 34). They occupy piedmont slopes and upper lake plains and terraces. Slope gradient ranges from 2 to 15 percent. Soils are well-drained, medium to fine textured sediments intermixed with rock fragments. Vegetation production is only 280 kilograms per hectare in a normal year. The potential natural vegetation community is 30 percent grasses, 5 percent forbs, and 65 percent shrubs. Bailey's greasewood,

Figure 31. Distribution of stony loam 4-8 in. precipitation zone habitats (Habitat Types 42, 42c) by square kilometer quadrat in Toedokado territory.

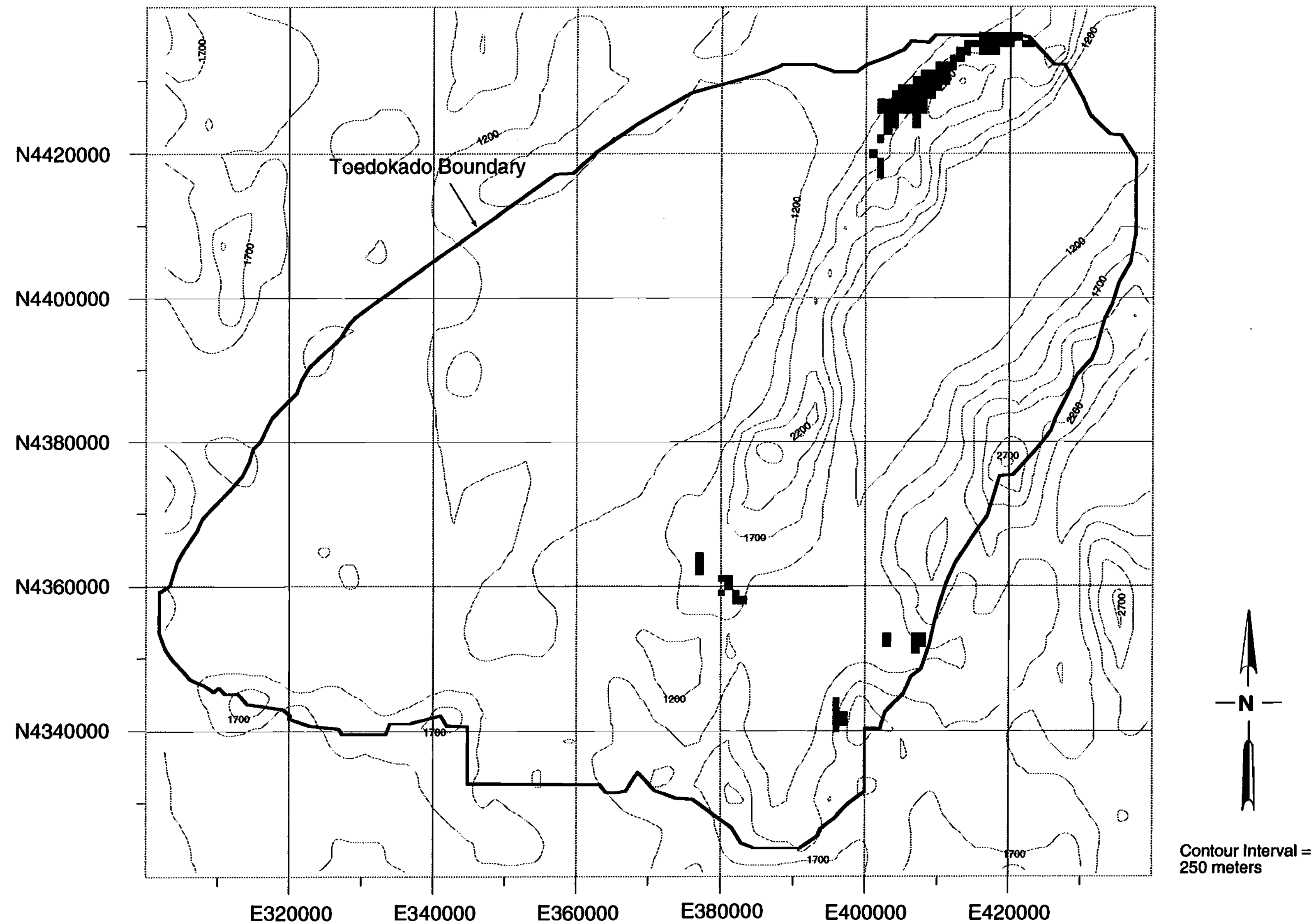

Figure 32. Distribution of loamy slope 5-8 in. precipitation zone habitats (Habitat Types 46, 46c) by square kilometer quadrat in Toedokado territory.

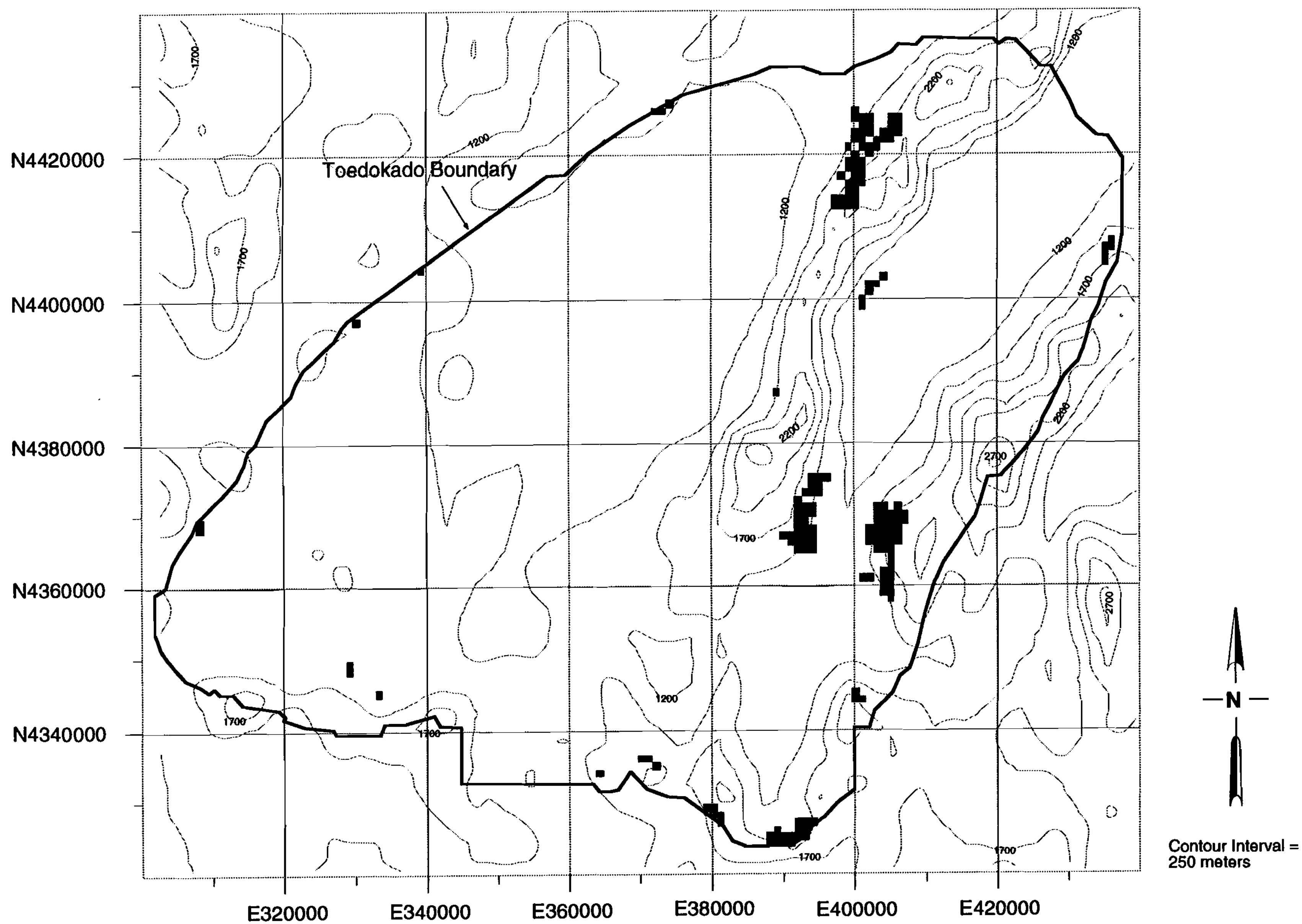

Figure 33. Distribution of loamy slope 8-10 in. precipitation zone, gravely loam 4-8 in. precipitation zone, stony slope 4-8 in. precipitation zone, barren gravely slope 4-8 in. precipitation zone habitats (Habitat Types 56, 56c) by square kilometer quadrat in Toedokado territory..

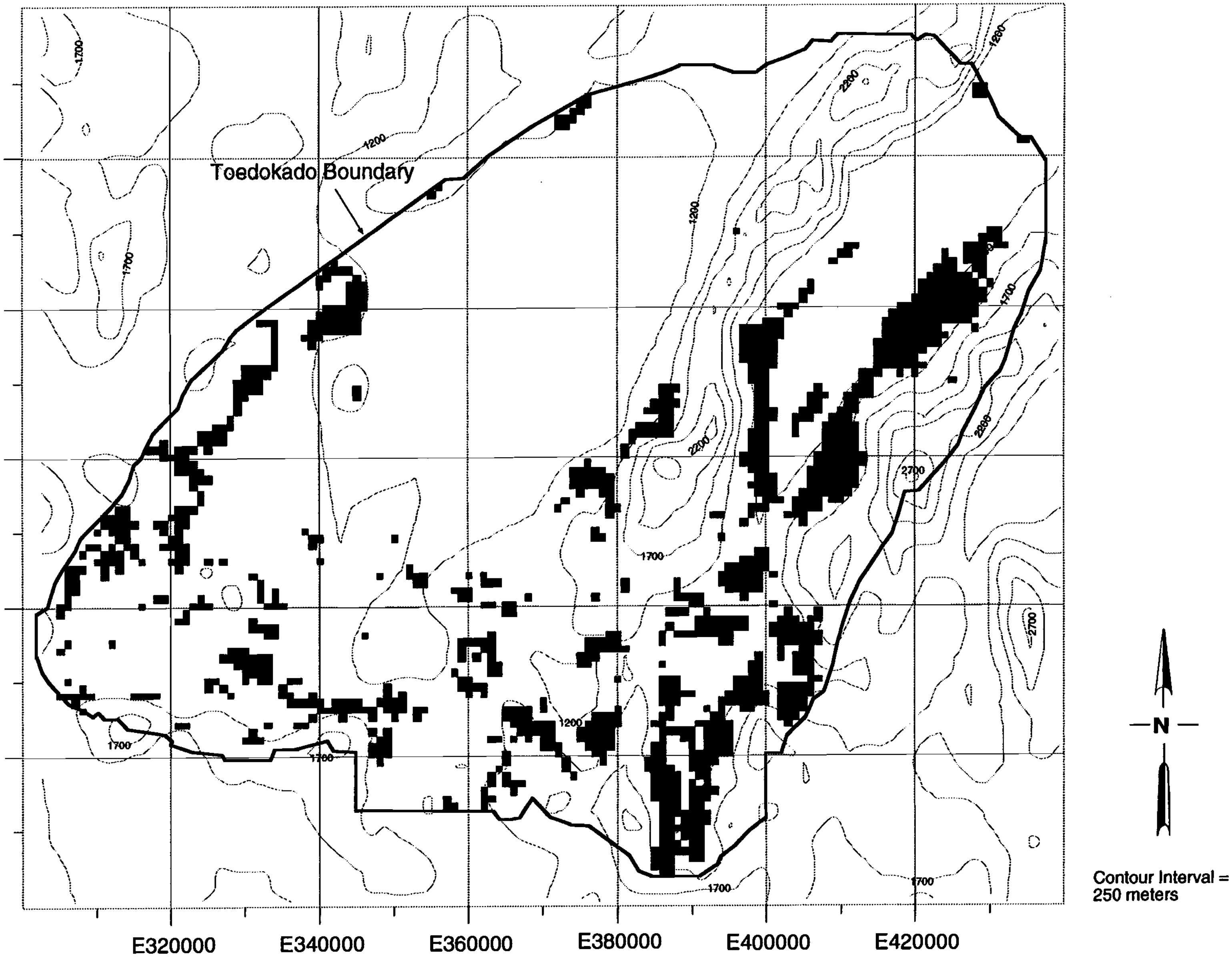

Figure 34. Distribution of gravelly loam 4-8 in. precipitation zone habitats (Habitat Types 10, 10a, 10b) by square kilometer quadrat in Toedokado territory.

shadscale, and Indian ricegrass dominate. Readers are referred to Raven and Elston (1989:80) for additional discussion of this habitat.

Habitat Type 21. Gravelly Loam 4-8 in. precipitation zone, Valley Wash 4-8 in. precipitation zone

This habitat type appears along piedmont slopes, lake plains and terraces, alluvial fans and flats. Habitat Type 21 soils are well-drained, formed in deep alluvial or lacustrine sediments sometimes capped by a thin layer of rock fragments. Slopes range from 2 to 15 percent. The habitat type is most common in Dixie and Fairview Valleys (Figure 35). This habitat type is chiefly shrubs (67 percent), with 25 percent grasses, and the remaining 8 percent in weedy forbs. Dominants include Bailey's greasewood, shadscale, and Indian ricegrass. Total plant production is relatively low, yielding 300 kilograms per hectare in a normal year.

Habitat Type 49. Gravelly Loam 4-8 in. precipitation zone, Stony Slope 4-8 in. precipitation zone

This habitat type occupies piedmont slopes varying from 2 to 15 percent in gradient. Soils are shallow, well-drained, and gravelly. Assigned quadrats occur throughout the southern portion of the study area (Figure 36). Potential native plant composition is 67 percent shrubs, 28 percent grass, and 5 percent forbs, dominated by Bailey's greasewood, shadscale, and Indian ricegrass. Vegetation production averages 200 kilograms per hectare in normal years.

Habitat Type 26. Gravelly Loam 4-8 in. precipitation zone, Barren Gravelly Slope 4-8 in. precipitation zone

This habitat type occupies slopes of piedmonts, hills, and lower elevation mountains, as well as side slopes of erosional remnants of alluvial fans. Soils are gravelly, shallow, well-drained, and medium to coarse textured; surfaces may contain high amounts of cobbles and gravels. Slopes vary from 2 to 50 percent gradient. Dominant vegetation includes shadscale, Bailey's greasewood, and Indian ricegrass. Potential vegetation consists of 55 percent shrubs, 40 percent grasses, and 5 percent forbs, yielding only 200 kilograms per hectare in normal production years. Most examples of this habitat are north of Salt Wells Basin and east of the Virginia Range (Figure 37).

Habitat Type 40. Stony slope 4-8 in. precipitation zone

This habitat type is located on lower mountains, hills, and piedmont slopes. Slope gradient varies between 15 and 50 percent. Soils are shallow and well-drained medium to coarse textured sediments with abundant gravels. Examples occur in the southern portion of the study area, in the Fairview, Cocoon, Dead Camel, and Desert Mountains and in the hills and ridges of the western Clan Alpine Range (Figure 38). Dominant plants include shadscale, Bailey's greasewood, and Indian ricegrass. Plant production averages 200 kilograms per hectare in average years. Composition is 70 percent shrubs, 25 percent grasses, and 5 percent forbs.

Habitat Types 18, 18b, 18c. Barren Gravelly Slope 4-8 in. precipitation zone

These habitat types lie along side slopes of lower mountains and hills, and on dissected erosional fan remnants. Steep slopes (30 to 50 percent) and sparse vegetation are characteristic. Soils are shallow and well-drained, with cobbly to gravelly surfaces. Examples of the habitat occur throughout the study area but are most abundant along the northwestern margins of Dixie Valley (Figure 39).

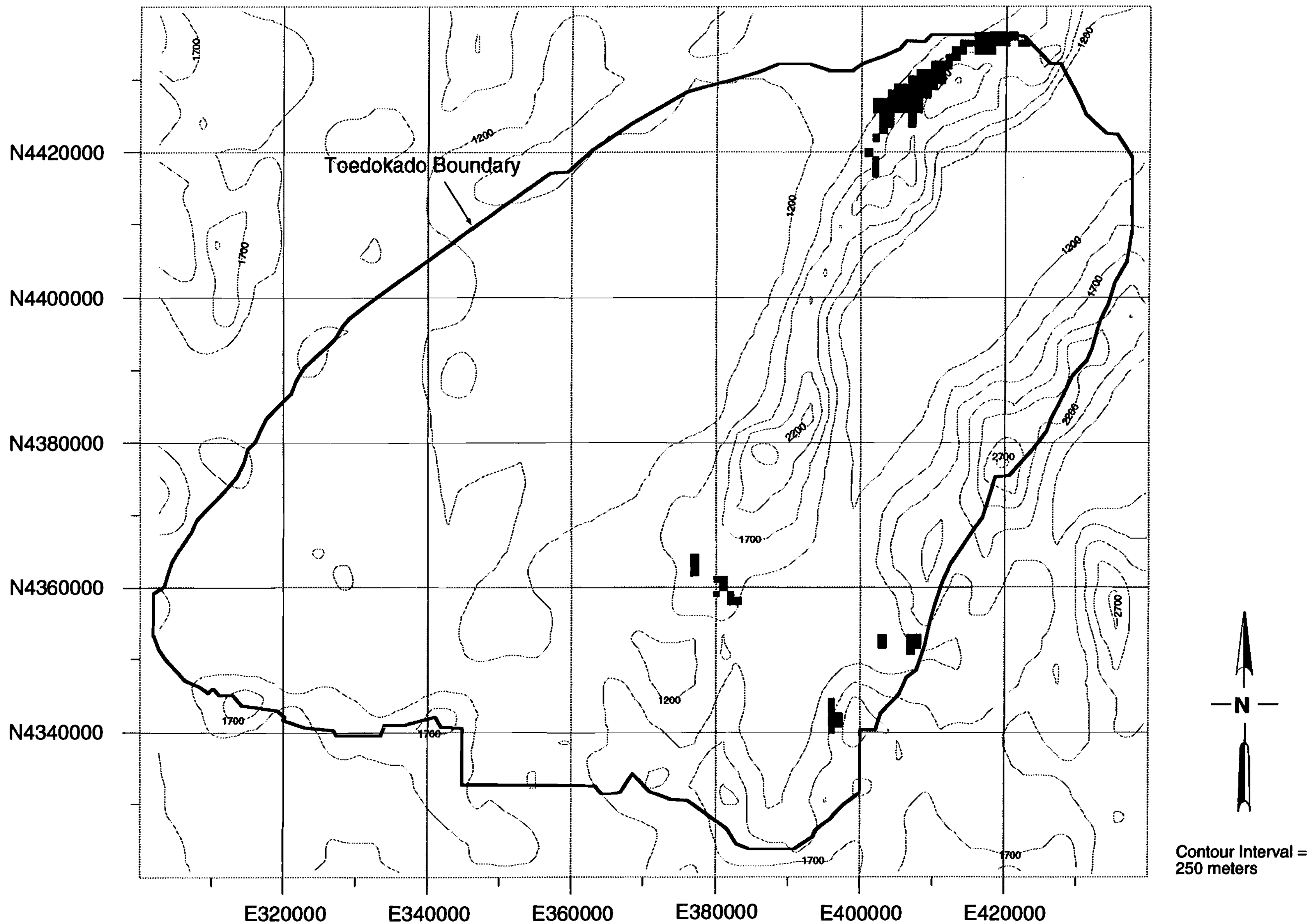

Figure 32. Distribution of loamy slope 5-8 in. precipitation zone habitats (Habitat Types 46, 46c) by square kilometer quadrat in Toedokado territory.

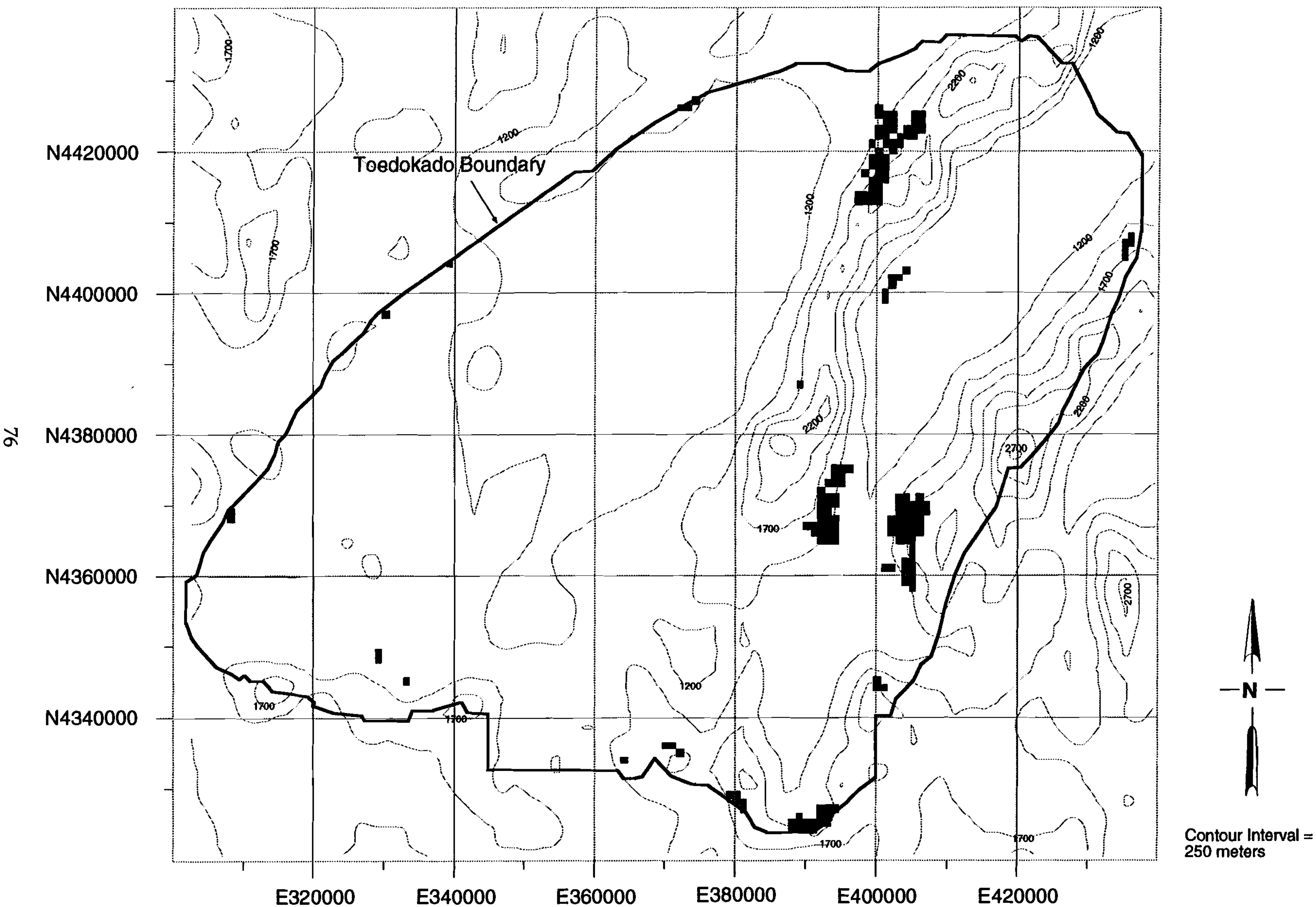

Figure 33. Distribution of loamy slope 8-10 in. precipitation zone, gravely loam 4-8 in. precipitation zone, stony slope 4-8 in. precipitation zone, barren gravely slope 4-8 in. precipitation zone habitats (Habitat Types 56, 56c) by square kilometer quadrat in Toedokado territory..

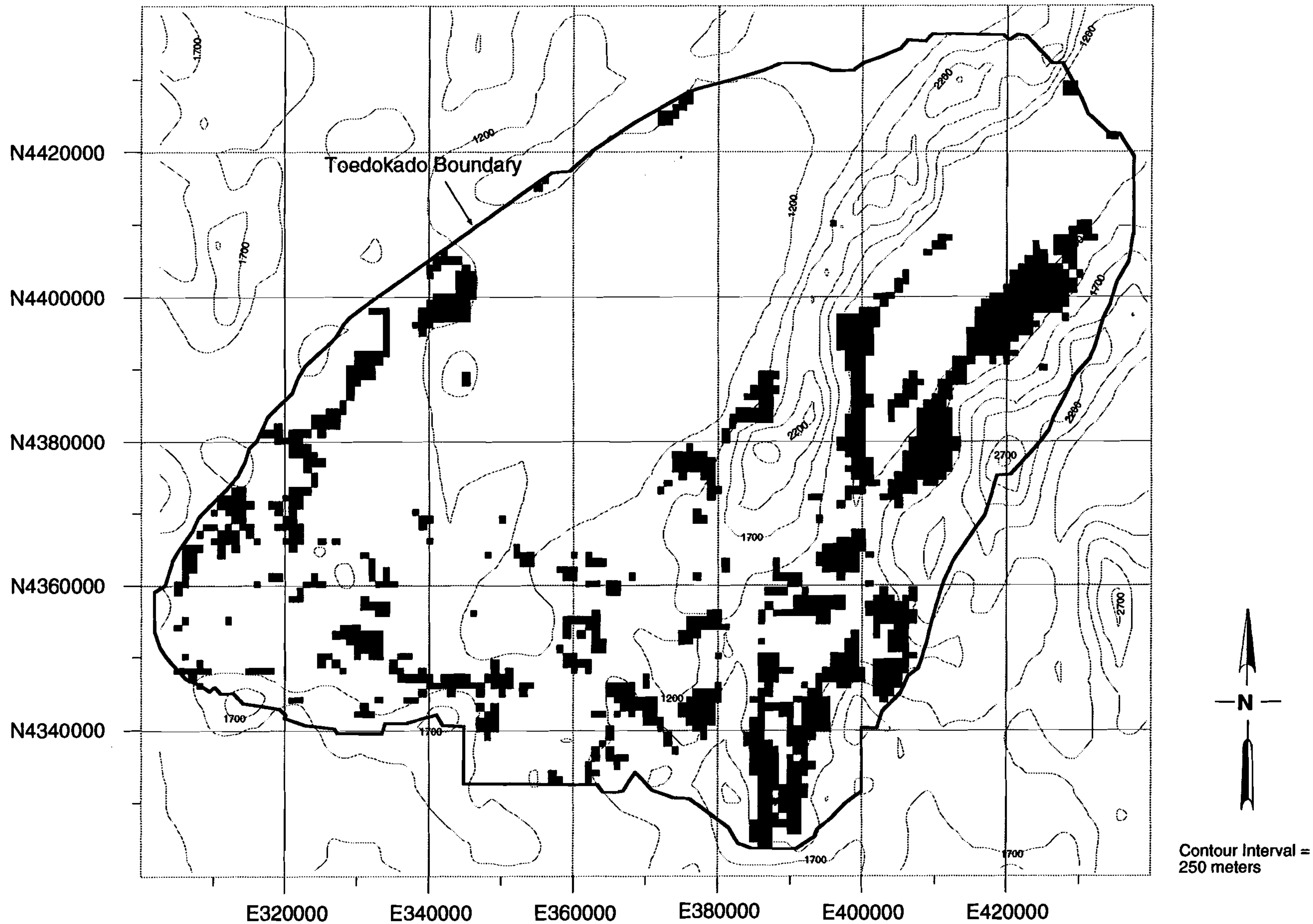

Figure 34. Distribution of gravelly loam 4-8 in. precipitation zone habitats (Habitat Types 10, 10a, 10b) by square kilometer quadrat in Toedokado territory.

shadscale, and Indian ricegrass dominate. Readers are referred to Raven and Elston (1989:80) for additional discussion of this habitat.

Habitat Type 21. Gravelly Loam 4-8 in. precipitation zone, Valley Wash 4-8 in. precipitation zone

This habitat type appears along piedmont slopes, lake plains and terraces, alluvial fans and flats. Habitat Type 21 soils are well-drained, formed in deep alluvial or lacustrine sediments sometimes capped by a thin layer of rock fragments. Slopes range from 2 to 15 percent. The habitat type is most common in Dixie and Fairview Valleys (Figure 35). This habitat type is chiefly shrubs (67 percent), with 25 percent grasses, and the remaining 8 percent in weedy forbs. Dominants include Bailey's greasewood, shadscale, and Indian ricegrass. Total plant production is relatively low, yielding 300 kilograms per hectare in a normal year.

Habitat Type 49. Gravelly Loam 4-8 in. precipitation zone, Stony Slope 4-8 in. precipitation zone

This habitat type occupies piedmont slopes varying from 2 to 15 percent in gradient. Soils are shallow, well-drained, and gravelly. Assigned quadrats occur throughout the southern portion of the study area (Figure 36). Potential native plant composition is 67 percent shrubs, 28 percent grass, and 5 percent forbs, dominated by Bailey's greasewood, shadscale, and Indian ricegrass. Vegetation production averages 200 kilograms per hectare in normal years.

Habitat Type 26. Gravelly Loam 4-8 in. precipitation zone, Barren Gravelly Slope 4-8 in. precipitation zone

This habitat type occupies slopes of piedmonts, hills, and lower elevation mountains, as well as side slopes of erosional remnants of alluvial fans. Soils are gravelly, shallow, well-drained, and medium to coarse textured; surfaces may contain high amounts of cobbles and gravels. Slopes vary from 2 to 50 percent gradient. Dominant vegetation includes shadscale, Bailey's greasewood, and Indian ricegrass. Potential vegetation consists of 55 percent shrubs, 40 percent grasses, and 5 percent forbs, yielding only 200 kilograms per hectare in normal production years. Most examples of this habitat are north of Salt Wells Basin and east of the Virginia Range (Figure 37).

Habitat Type 40. Stony slope 4-8 in. precipitation zone

This habitat type is located on lower mountains, hills, and piedmont slopes. Slope gradient varies between 15 and 50 percent. Soils are shallow and well-drained medium to coarse textured sediments with abundant gravels. Examples occur in the southern portion of the study area, in the Fairview, Cocoon, Dead Camel, and Desert Mountains and in the hills and ridges of the western Clan Alpine Range (Figure 38). Dominant plants include shadscale, Bailey's greasewood, and Indian ricegrass. Plant production averages 200 kilograms per hectare in average years. Composition is 70 percent shrubs, 25 percent grasses, and 5 percent forbs.

Habitat Types 18, 18b, 18c. Barren Gravelly Slope 4-8 in. precipitation zone

These habitat types lie along side slopes of lower mountains and hills, and on dissected erosional fan remnants. Steep slopes (30 to 50 percent) and sparse vegetation are characteristic. Soils are shallow and well-drained, with cobbly to gravelly surfaces. Examples of the habitat occur throughout the study area but are most abundant along the northwestern margins of Dixie Valley (Figure 39).

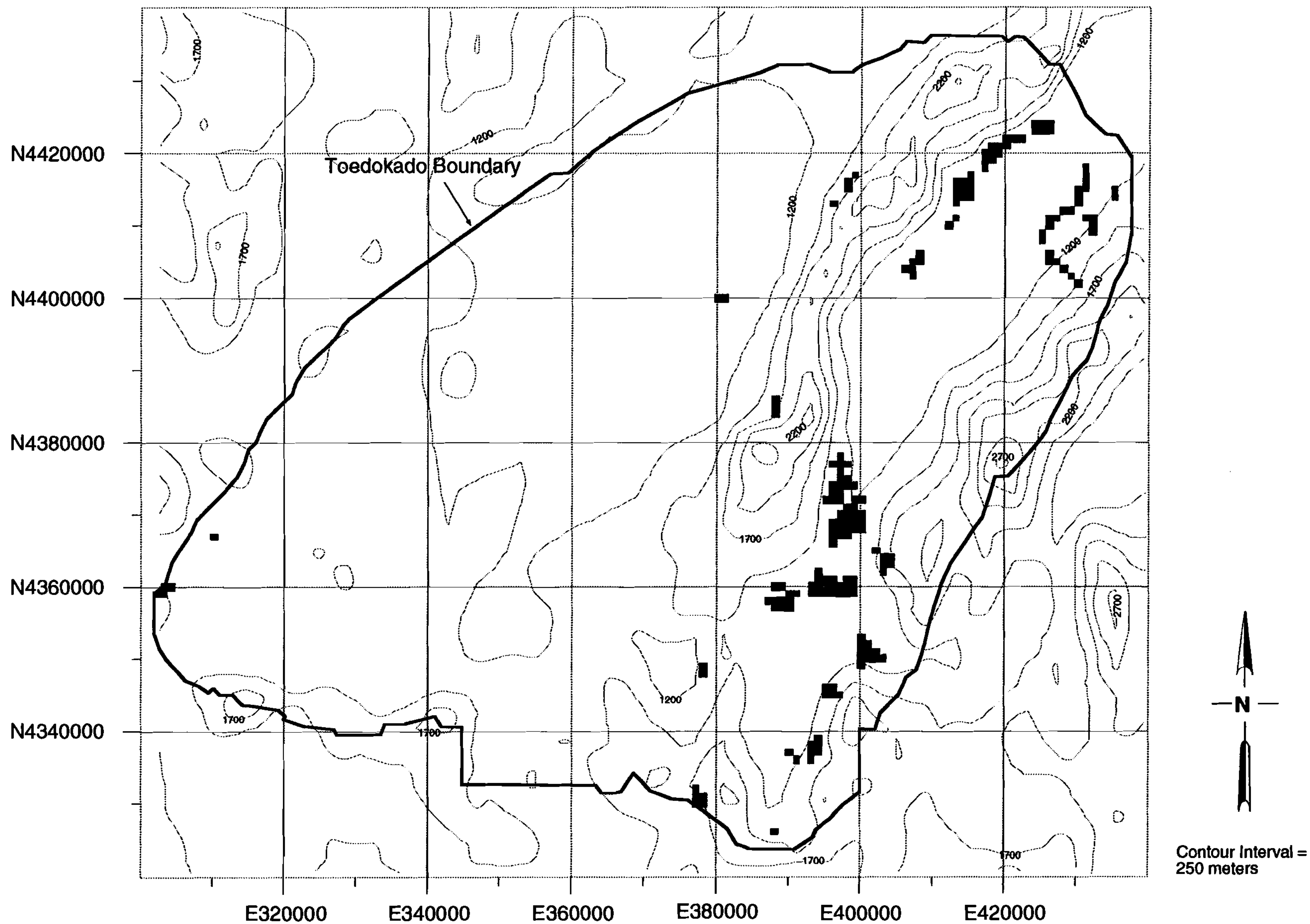

Figure 35. Distribution of gravelly loam 4-8 in. precipitation zone, valley wash 4-8 in. precipitation zone habitats (Habitat Type 21) by square kilometer quadrat in Toedokado territory.

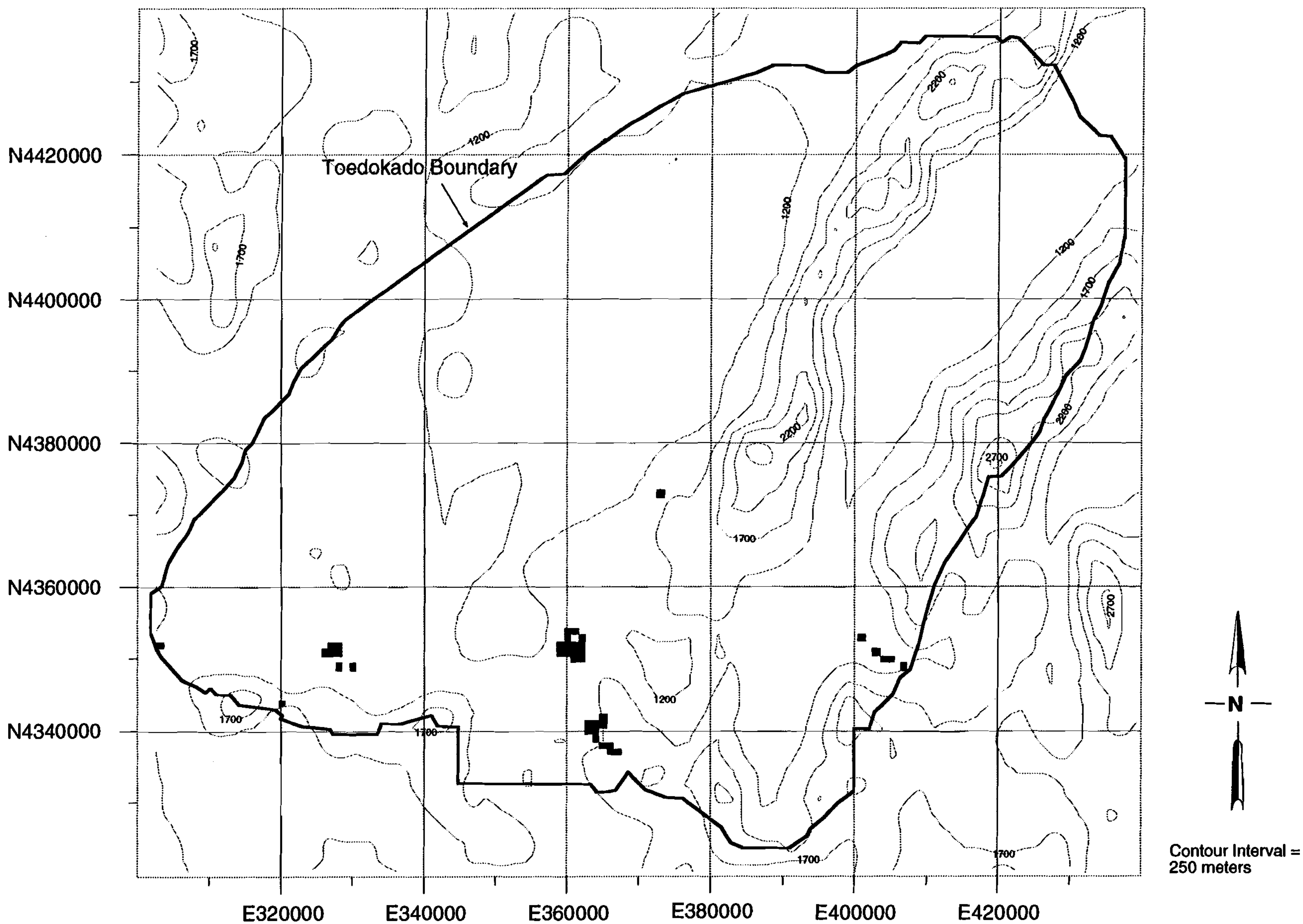

Figure 36. Distribution of gravelly loam 4-8 in. precipitation zone, stony slope 4-8 in. precipitation zone habitats (Habitat Type 49) by square kilometer quadrat in Toedokado territory.

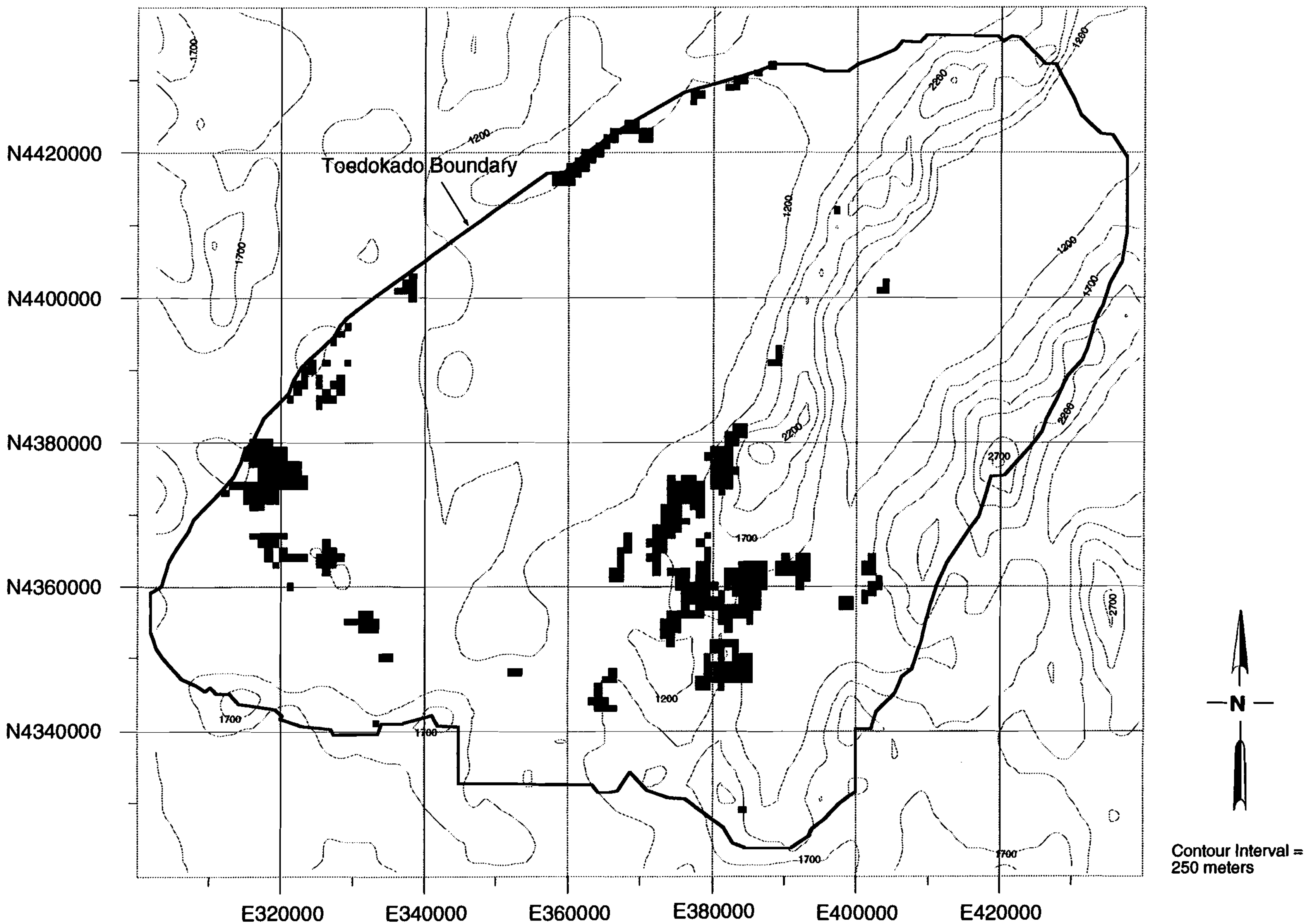

Figure 37. Distribution of gravelly loam 4-8 in. precipitation zone, barren gravelly slope 4-8 in. precipitation zone habitats (Habitat Type 26) by square kilometer quadrat in Toedokado territory.

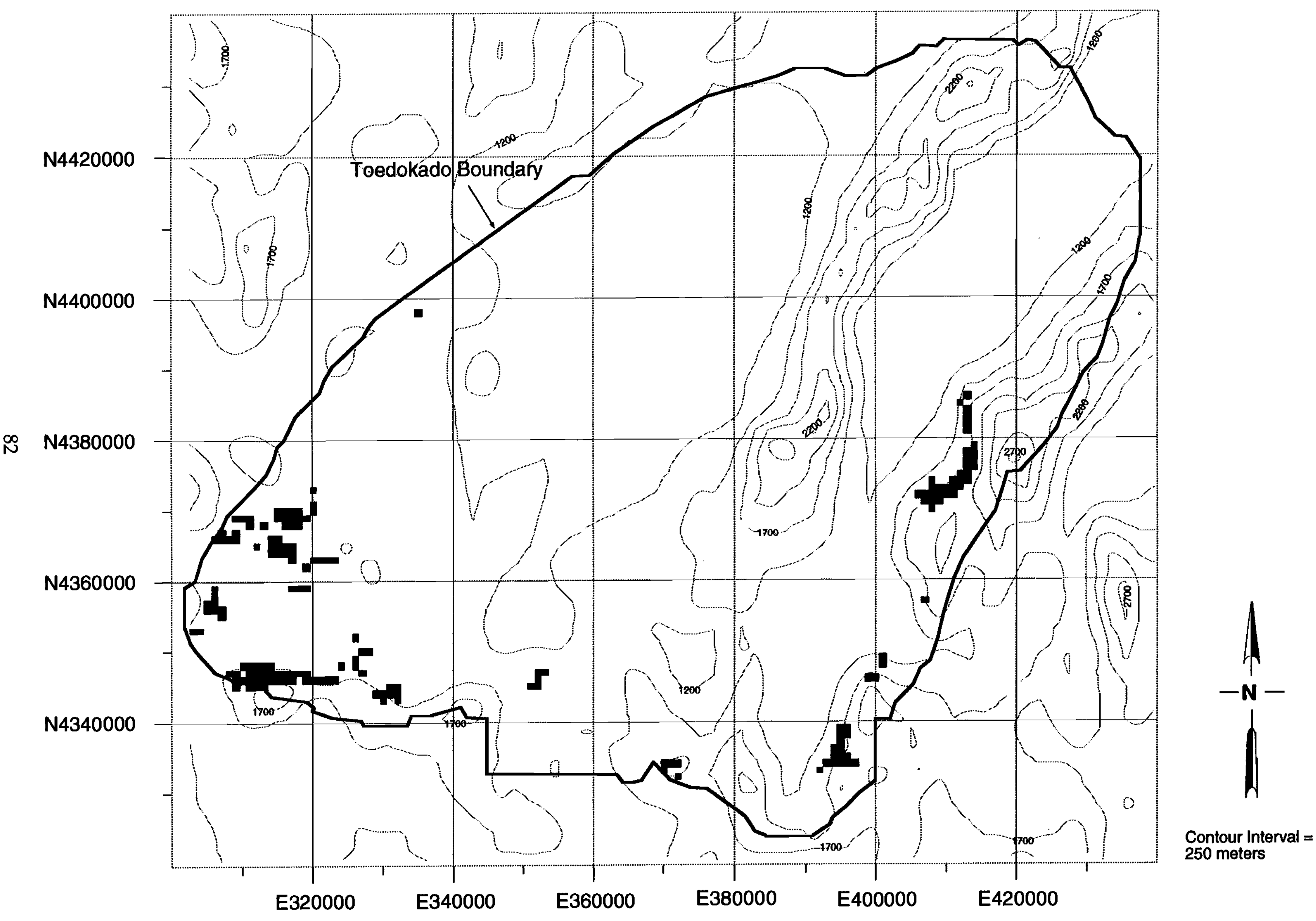

Figure 38. Distribution of stony slope 4-8 in. precipitation zone habitats (Habitat Type 40) by square kilometer quadrat in Toedokado territory.

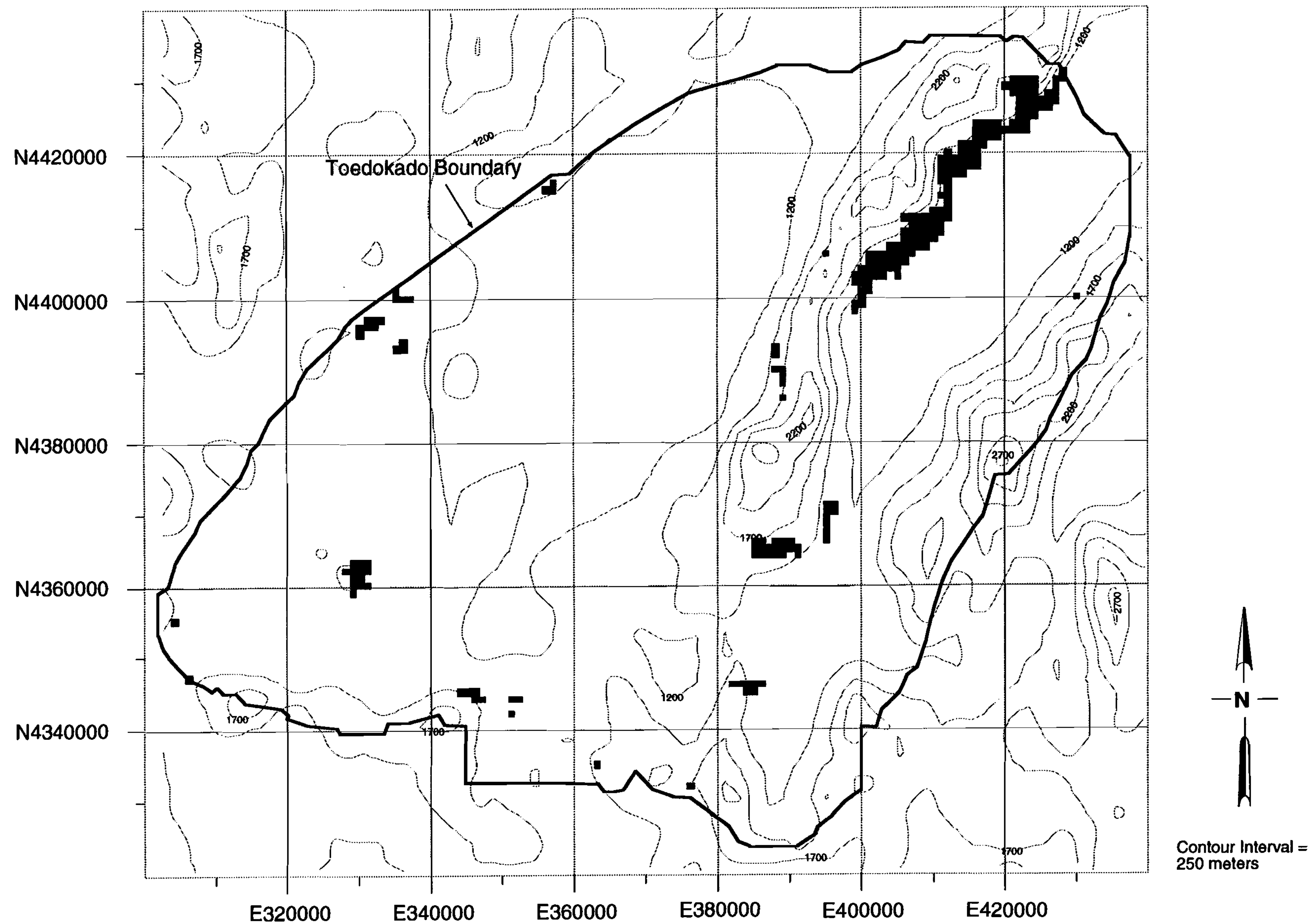

Figure 39. Distribution of barren gravelly slope 4-8 in. precipitation zone habitats (Habitat Types 18, 18b, 18c) by square kilometer quadrat in Toedokado territory.

Shadscale and Indian ricegrass dominate the potential natural vegetation. Plant production yields are extremely low (100 kg/ha), lower than all other habitats save abiotic playas and badlands. However, seeps and springs that will support localized patches of more productive plant communities (see Habitats 51 and 55) frequently occur in this habitat.

Sagebrush Associations

We include habitats in Sagebrush Associations when their dominant shrub is sagebrush and they are not tied to a perennial water source. Dominant grass is usually needlegrass (Stipa spp.), although wild ryes and Indian ricegrass are common (Young et al 1976:191). Sagebrush dominated communities tend to occupy alluvial fans and lower mountain slopes above 1525 m (5003 ft amsl) elevation, a boundary determined by preference of sagebrush for precipitation of more than 15 cm a year (Billings 1945:18; Cronquist et al 1986:90). However, the low salinity of the Lahontan sands at lower elevations frequently permits sagebrush to grow as a minor element in Greasewood-saltbush communities (Young et al. 1990:260). Table 12 summarizes the plant species composition of these habitats in kilograms per hectare.

Table 12. Composition of Sagebrush and Montane Habitat Types, by Weight (kg/ha).

Habitat Type Common name	Genus/species	31	37	27	48	52	35	44	47	34
Grasses										
bluegrass	*Poa*	0	0	0	0	0	0	0	8	0
bottlebrush squirreltail	*Sitanion hystrix*	22	11	15	10	19	13	10	18	11
Canby bluegrass	*Poa canbyi*	0	0	0	0	0	0	0	12	21
Cusick bluegrass	*Poa cusickii*	0	0	0	0	0	0	0	4	2
desert needlegrass	*Stipa speciosa*	22	11	2	94	43	6	118	54	0
galleta	*Hilaria jamesii*	0	0	10	6	0	4	0	0	0
Great Basin wildrye	*Elymus cinereus*	0	11	5	5	5	13	0	24	0
Idaho fescue	*Festuca idahoensis*	0	0	0	0	0	0	0	24	9
Indian ricegrass	*Oryzopsis hymenoides*	128	56	146	33	43	45	10	12	7
King desertgrass	*Blepharidachne kingii*	0	0	2	0	0	0	0	0	0
muttongrass	*Poa fendlerana*	0	0	0	0	0	0	0	4	0
needleandthread	*Stipa comata*	50	11	33	5	5	6	0	9	0
needlegrass	*Stipa*	0	0	0	0	0	0	0	6	0
sand dropseed	*Sporobolus cryptandrus*	0	0	5	5	0	0	0	0	0
Sandberg bluegrass	*Poa secunda*	22	28	15	19	19	22	17	2	18
sedge	*Carex*	0	0	5	0	0	0	0	0	0
thickspike wheatgrass	*Agropyron dasystachyum*	0	0	5	0	0	0	0	0	0
Thurber needlegrass	*Stipa thurberiana*	17	168	0	83	83	140	0	120	50
Webber ricegrass	*Stipa webberi*	17	0	0	0	0	0	0	0	0
western needlegrass	*Stipa occidentalis*	0	0	0	0	0	0	0	4	0
western wheatgrass	*Agropyron smithii*	0	0	5	0	0	0	0	0	0
wheatgrass	*Agropyron*	0	0	20	0	0	0	0	0	0
Forbs										
arrowleaf balsamroot	*Balsamorhiza sagittata*	0	0	0	0	0	0	0	6	4
biscuitroot	*Lomatium* sp.	0	0	0	0	0	0	0	6	0
bitterroot	*Lewisia rediviva*	0	0	0	0	0	4	0	0	0
buckwheat	*Eriogonum*	11	11	7	15	15	6	7	12	0
desertbroom	*Baccharis sarothroides*	0	0	0	0	0	0	0	0	11
gilia	*Gilia*	0	0	0	0	0	0	7	0	0
globemallow	*Sphaeralcea*	11	11	15	10	5	6	0	6	0
hawksbeard	*Crepis* sp.	0	0	0	0	0	0	0	4	0
lupine	*Lupinus*	0	0	0	0	0	0	0	3	0
milkvetch, locoweed	*Astragalus*	11	0	0	0	0	3	0	0	0
penstemon	*Penstemon*	0	11	0	10	5	6	0	0	0
phlox	*Phlox*	11	0	0	0	0	3	7	0	0
prickly gilia	*Leptodactylon*	0	11	0	5	9	6	0	0	0
prince's plume	*Stanleya pinnata*	0	0	2	5	0	0	0	0	0
tapertip hawksbeard	*Crepis acuminata*	0	0	0	0	4	0	0	6	11

Table 12, continued.

Habitat Type Common name	Genus/species	31	37	27	48	52	35	44	47	34
Shrubs										
Anderson peachbrush	*Prunus andersonii*	0	0	0	0	0	0	0	12	0
Anderson wolfberry	*Lycium andersonnii*	0	0	0	10	0	0	0	0	0
antelope bitterbrush	*Purshia tridentata*	0	0	0	0	0	0	0	0	31
Bailey's greasewood	*S. vermiculatus baileyi*	17	0	30	5	0	4	10	6	0
Basin big sagebrush	*A. tridentata tridentata*	0	0	45	0	0	0	0	0	0
big/tall sagebrush	*Artemisia tridentata*	0	0	0	0	0	0	0	30	0
black sagebrush	*Artemisia arbuscula nova*	0	0	0	0	0	50	0	0	0
bud sagebrush	*Artemisia spinescens*	17	0	35	5	0	0	10	6	0
burrobrush	*Hymenoclea*	0	0	0	5	0	0	0	0	0
Cooper wolfberry	*Lycium cooperi*	0	0	2	0	0	0	0	0	0
currant	*Ribes*	0	0	0	0	0	0	0	0	4
Douglas rabbitbrush	*Chrysothamnus vicidiflorus*	17	17	12	10	9	13	10	18	0
four-winged saltbush	*Atriplex canescens*	17	0	15	0	0	0	0	0	0
green ephedra	*Ephedra viridis*	0	0	0	0	0	0	0	12	0
hopsage	*Grayia spinosa*	99	28	25	33	20	19	17	6	0
horsebrush	*Tetradymia* sp.	0	0	0	0	0	0	10	0	0
little horsebrush	*Tetradymia glabrata*	17	17	2	28	15	13	0	0	0
low sagebrush	*Artemisia arbuscula*	0	0	0	0	0	0	0	24	0
Mormon tea	*Ephedra*	0	0	3	0	0	4	0	0	4
mountain big sagebrush	*Artemisia vesayana*	0	0	0	0	0	0	0	42	75
Nevada dalea	*Psorothamnus polydenis*	0	0	6	0	0	0	0	0	0
Nevada ephedra	*Ephedra nevadensis*	22	22	2	19	24	9	10	6	0
oceanspray	*Holodiscus*	0	0	0	0	0	0	0	0	0
prickleleaf	*Hecastocleis shockleyi*	0	0	0	7	0	0	0	0	0
purple sage	*Salvia dorrii carnosa*	0	0	0	0	15	0	0	0	0
rabbitbrush	*Chrysothamnus*	0	0	0	5	5	0	0	0	0
sagebrush	*Artemisia*	0	0	0	0	0	0	101	30	0
serviceberry	*Amelanchier*	0	0	0	0	0	0	0	12	14
shadscale	*Atriplex confertifolia*	17	0	25	5	5	4	10	0	0
snowberry	*Symphoricarpos*	0	0	0	0	0	0	0	12	0
winterfat; bluegum eucalyptus	*Eurotia lanata*	22	0	61	0	0	4	0	6	0
Wyoming big sagebrush	*A. tridentata wyomingensis*	140	168	0	90	138	85	0	42	43
Trees										
pinyon	*Pinus monophylla*	0	0	0	0	0	0	0	6	25
Utah juniper	*Juniperus osteosperma*	0	0	0	0	0	0	0	12	11

Habitat Type 31. Droughty Loam 8-10 in. precipitation zone

Habitat Type 31 occupies summits and side slopes of piedmont slopes, inset fans, and on all exposures of rock pediments. Soils are well-drained and vary from shallow to moderately deep. Surfaces are coarse textured, sometimes with a high volume of rock fragments in profile. Slopes vary from 2 to 15 percent gradient. The habitat type appears in discrete clusters in the Stillwater, Clan Alpine, Fairview, and Sand Springs Mountains (Figure 40).

Native plants include Wyoming big sagebrush, Indian ricegrass, and hopsage. The habitat bears the highest quantities of needleandthread of any habitat in the study area (56 kg/ha). The vegetation is 55 percent shrubs, 40 percent grasses, and 5 percent forbs. Plant production averages 600 kilograms per hectare in normal years.

Habitat Types 37, 37b, 37c. Loamy Slope 8-10 in. precipitation zone

These habitat types sit on the side slopes of rock pediments, rolling hills, and all exposures of lower mountains, restricted somewhat to steep, northerly aspects at lower elevations (Figure 41). Slope

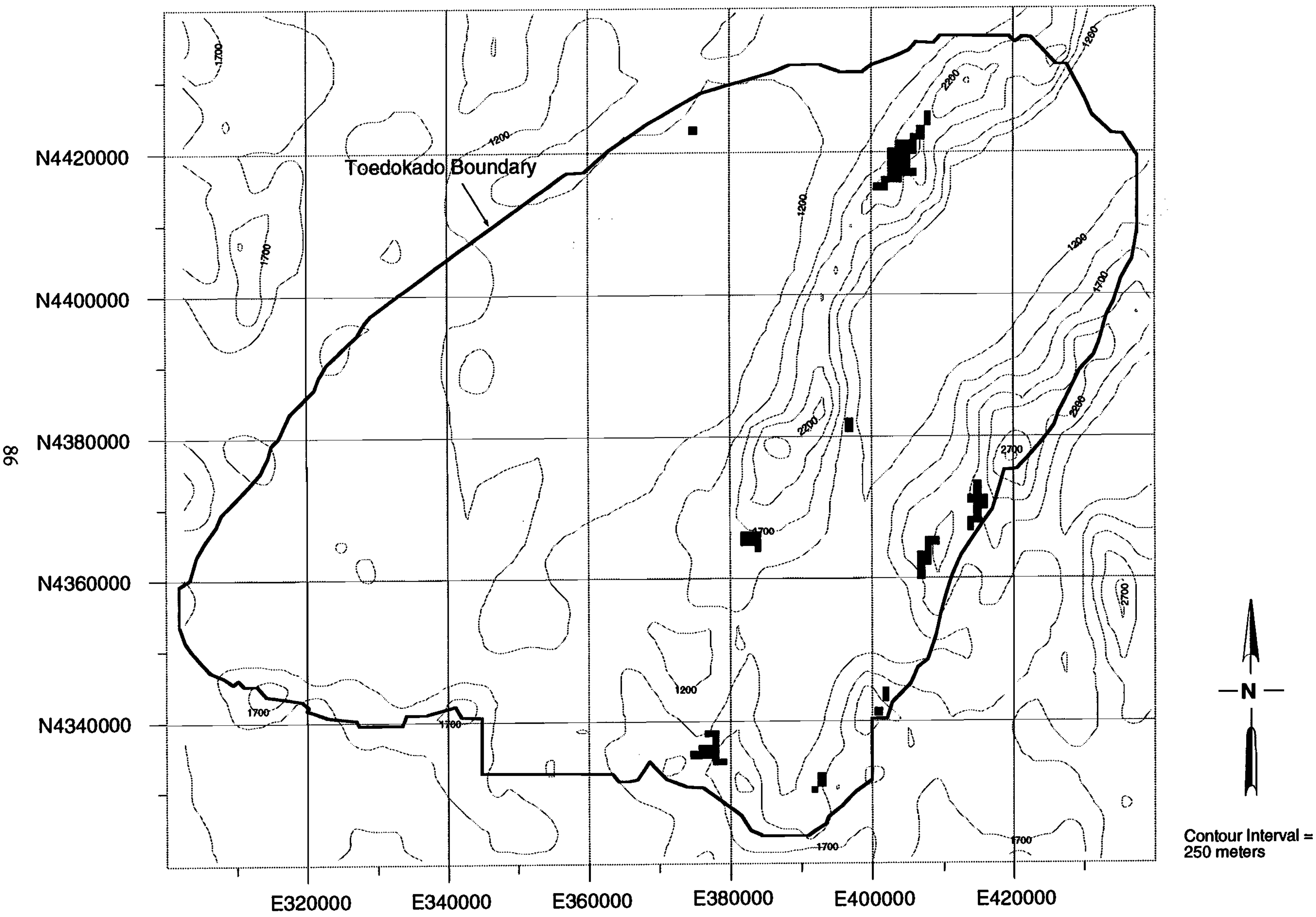

Figure 40. Distribution of droughty loam 8-10 in. precipitation zone habitats (Habitat Type 31) by square kilometer quadrat in Toedokado territory.

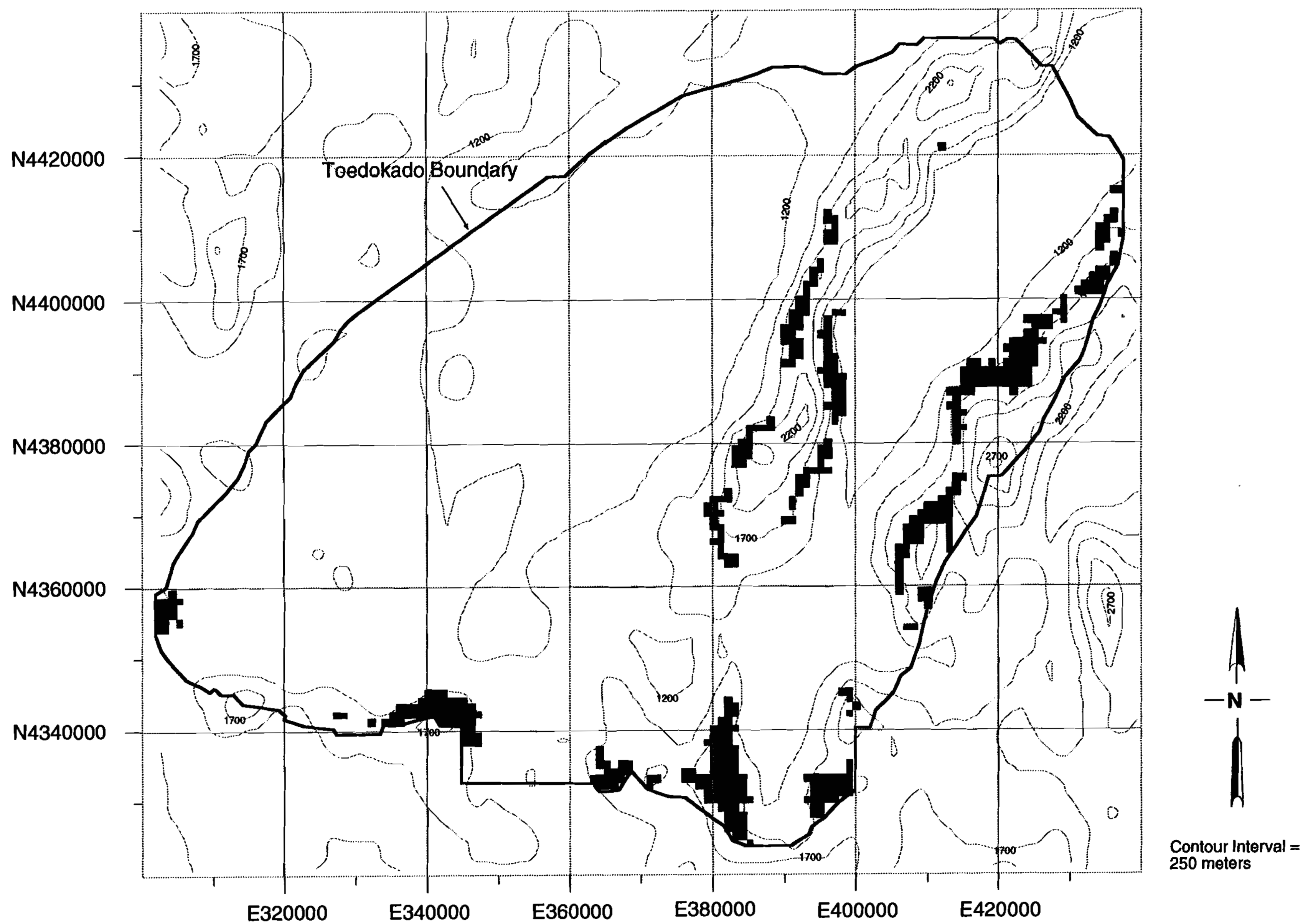

Figure 41. Distribution of loamy slope 8-10 in. precipitation zone habitats (Habitat Types 37, 37b, 37c) by square kilometer quadrat in Toedokado territory.

varies from 15 to 25 percent gradient. Soils are shallow, well drained, medium to coarse textured with high amounts of surface gravel. Thurber needlegrass and Wyoming big sagebrush dominate, although a notable component of Indian ricegrass is present. The vegetation is one half grasses, 45% shrubs, and 5% forbs. Production averages 600 kg/ha for a normal year.

Habitat Type 27. Coarse Silty 4-8 in. precipitation zone, Gravelly Loam 4-8 in. precipitation zone, Sandy 8-10 in. precipitation zone

Habitat Type 27 occupies piedmont slopes near inset fans, lake plains and terraces, and alluvial flats. Slopes vary from 0 to 15 percent. Soils typically form in deep, well-drained, medium to coarse textured alluvial surfaces. Examples of this habitat occur as discrete patches in the southern foothills of the Stillwater Mountains, in the Cocoon Mountains, and in the Virginia Range (Figure 42).

The potential natural vegetation is 53 percent grasses, 42 percent shrubs, and 5 percent forbs. Dominant plant taxa include Indian ricegrass, winterfat, Basin big sagebrush, needleandthread, bud sagebrush, with notable inclusions of Bailey's greasewood, shadscale, hopsage, and wheatgrass. Indian ricegrass, big sagebrush, and rhizomatous wheatgrass proliferate at upper elevations and inset fans. Notably, these habitat types have the largest quantities of winterfat (61 kg/ha) of any in the study area. Plant production approximates 500 kilograms per hectare in a normal year.

Habitat Types 48, 48c. Loamy Slope 8-10 in. precipitation zone, Eroded Granitic Slope

These habitat types occur on side slopes of hills, rock pediments, and lower mountains where slopes vary from 15 to 75 percent gradient. Soils are derived from eroded granitic bedrock. They are shallow, well-drained, moderately coarse textured with surface gravel. Examples occur almost exclusively in the Sand Springs Mountains (Figure 43).

Plant production is moderate for the study area, averaging 500 kilograms per hectare in normal years. The potential native vegetation is one half grasses, 45 percent shrubs, and 5 percent forbs. Dominant plant taxa include desert needlegrass, Wyoming big sagebrush, and Thurber needlegrass, with notable inclusions of Indian ricegrass and hopsage.

Habitat Type 35, 35c. Shallow Calcareous Loam 8-10, Loamy Slope 8-10

Habitat Types 35 and 35c occupy side slopes of rock pediments, rolling hills, and mountains at elevations from 1500 to 1800 meters (4920 to 5904 ft amsl). Slope varies in gradient from 15 to 30 percent. Soils are shallow, well-drained, and gravelly. Quadrats assigned to these habitat types occur almost exclusively in the Clan Alpine and Fairview Mountains (Figure 44).

The vegetation composition is half grasses, 43 percent shrubs and 7 percent forbs. Thurber needlegrass, Wyoming big sagebrush, black sagebrush, and Indian ricegrass proliferate in these habitat types, which also includes minor quantities of Sandberg's bluegrass and hopsage. Notably, bitterroot is a perennial forb unique to this habitat. Vegetation production is moderate for the study area, approximately 400 kilograms per hectare.

Habitat Types 44, 44b, 44c. Shallow Claypan 8-10 in. precipitation zone

Shallow claypan surfaces occur on upper fan piedmonts, hills and lower mountain summits and side slopes on all aspects; however, at elevations between 1350 and 1700 meters (4429 and 5578 ft amsl), this

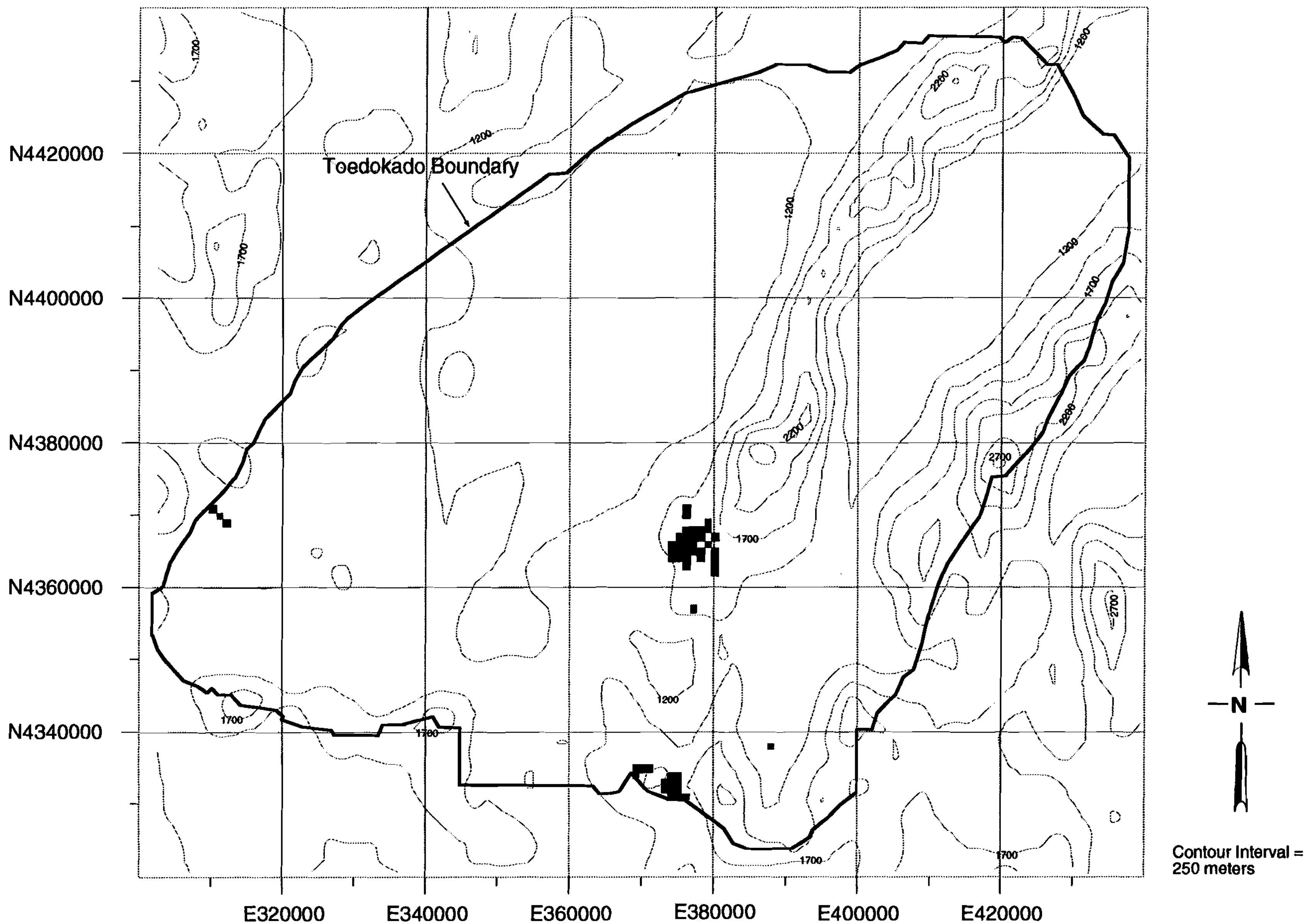

Figure 42. Distribution of coarse silty 4-8 in. precipitation zone, gravelly loam 4-8 in. precipitation zone, sandy 8-10 in. precipitation zone habitats (Habitat Type 27) by square kilometer quadrat in Toedokado territory.

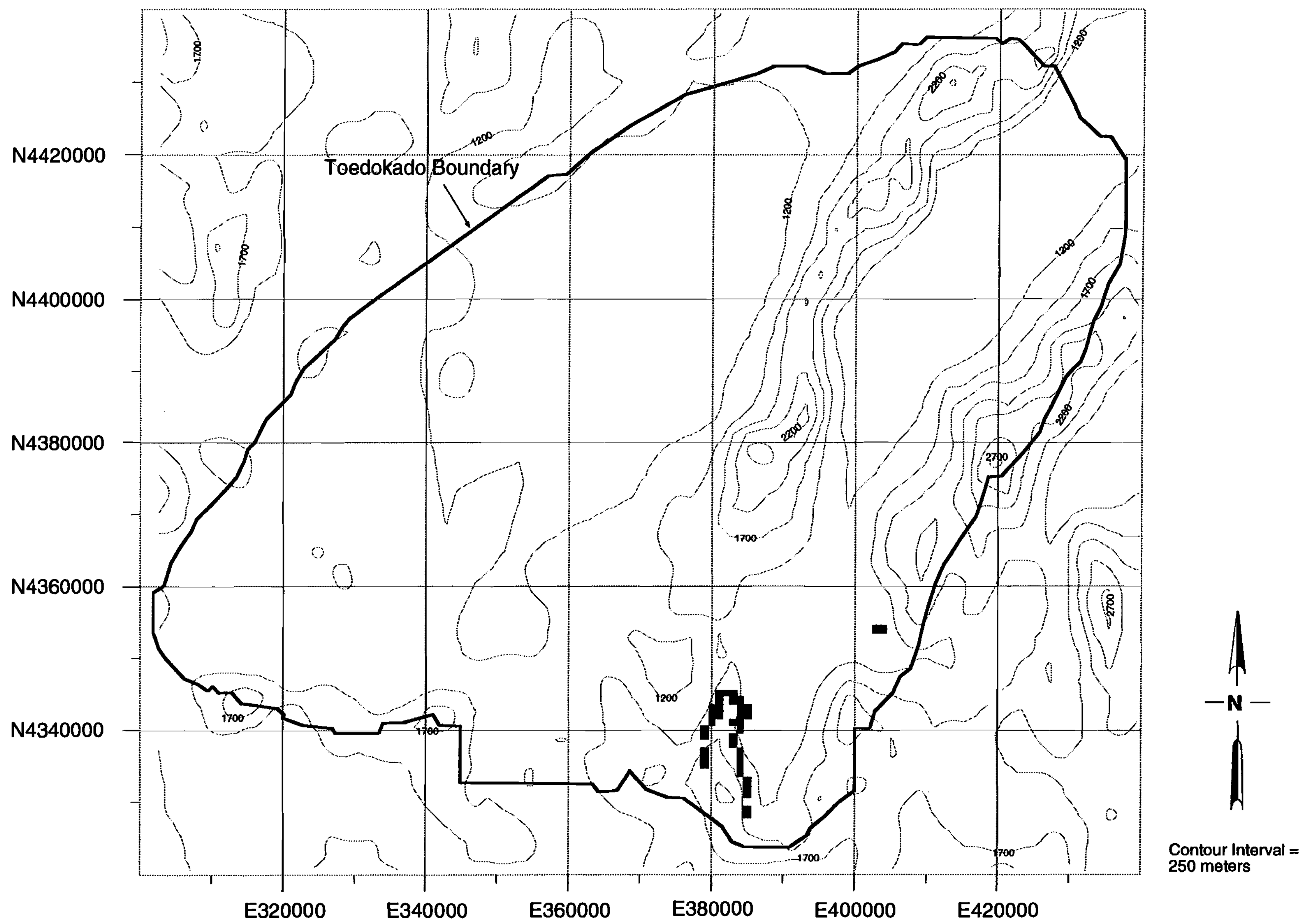

Figure 43. Distribution of loamy slope 8-10 in. precipitation zone, eroded granitic slope habitats (Habitat Types 48, 48c) by square kilometer quadrat in Toedokado territory.

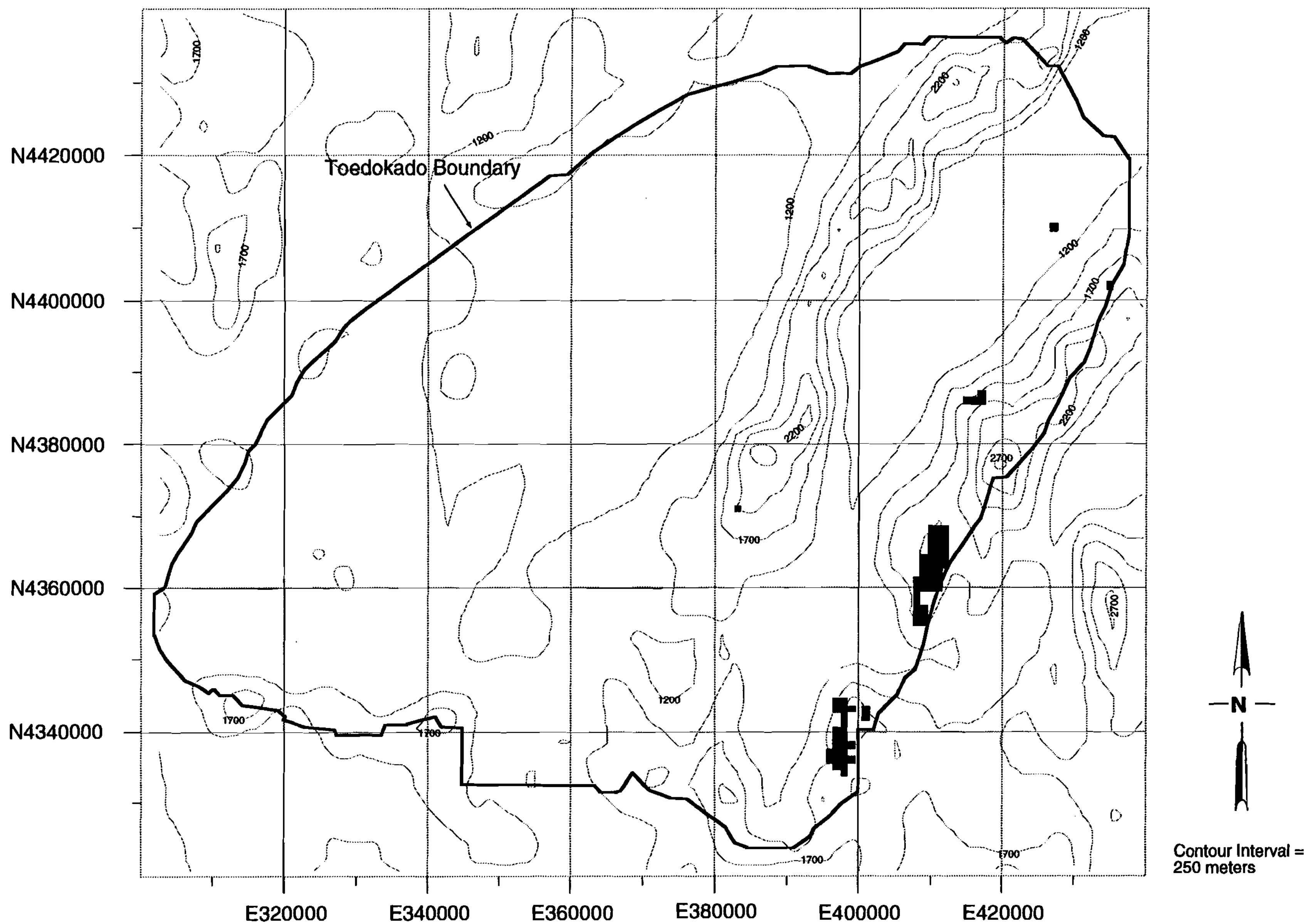

Figure 44. Distribution of shallow calcareous loam 8-10 in. precipitation zone, loamy slope 8-10 in. precipitation zone habitats (Habitat Types 35, 35c) by square kilometer quadrat in Toedokado territory.

habitat is restricted to northern aspects. Soils are shallow and well-drained. Surfaces are coarse textured and may be gravely or cobbly. Surface runoff is rapid and the potential for sheet and rill erosion grows as slope increases. Slopes vary from 15 to 50 percent. Examples of these habitat types occur most extensively in the Stillwater Mountains, but a few cases occur in the Desert Mountains as well (Figure 45).

Plant production averages 300 kilograms per hectare in normal years. The climax flora is one half grasses, 45 percent shrubs, and 5 percent forbs. Dominants include desert needlegrass and Wyoming big sagebrush. The representation of desert needlegrass is higher in this habitat (118 kg/ha) than in any other in the study area.

Montane Associations

Habitats are montane if their distributions exceed 1980 m (6496 ft amsl) elevation. We classify two montane habitats in Toedokado territory; the understories of both are dominated by sagebrush and needlegrass. Table 12 summarizes the species composition of these habitats in kilograms per hectare.

Both montane habitats encompass considerable variability in vegetation that suggests additional habitat definition. However, the available soil and range studies for montane areas were conducted before the final formulation of current montane range types, rendering it difficult to distinguish separate associations of range type reliably. Moreover, the square kilometer resolution of the present model usually fails to distinguish a great deal of environmental variability in mountainous uplands because of the vertical relief typical of these areas. Therefore, we propose only two habitats for the montane zone based on current data.

Habitat Types 47, 47b, 47c. Cobbly Claypan 12-14 in. precipitation zone, Loamy slope 10-12 in. precipitation zone

These habitat types occur on mountain valley fans, summits and side slopes, which vary from 4 to 75 percent in slope and between 1830 and 2800 m (6004 and 9187 ft amsl) above sea level. Its distribution is primarily in the Stillwater and Clan Alpine Mountains (Figure 46). Soils generally are deep (except on steep slopes), well-drained, and formed in the residuum of volcanic parent material. Surfaces are stony, cobbly or very gravely. Permeability is moderate and surface runoff rapid.

In general, vegetation composition is 52 percent grasses, 38 percent shrubs and trees, and 10 percent forbs. The native plant association is mostly Thurber needlegrass, Wyoming and mountain big sagebrush, and Idaho fescue, with notable inclusions of bluegrass and Idaho fescue. Production averages about 600 kilograms per hectare in normal years. Some pinyon and juniper saplings may grow on this habitat, but it lacks a diagnostically woodland overstory.

Lower slopes may include minor occurrences of greasewood, spiny hopsage, winterfat, little horsebrush. Notably, biscuitroot occurs only on lower slopes. Wyoming big sagebrush, green ephedra, Anderson peachbush, serviceberry, Thurber needlegrass, and currant are more common on higher slopes. Finally, mountain big sagebrush, snowberry, arrowleaf balsamroot, and Idaho fescue are most abundant on steeper, upper slopes, and mountain summits. Highly productive (2000 kg/ha) communities dominated by Great Basin wildrye may occur localized around seeps and springs in these habitat types (see Habitat Type 51).

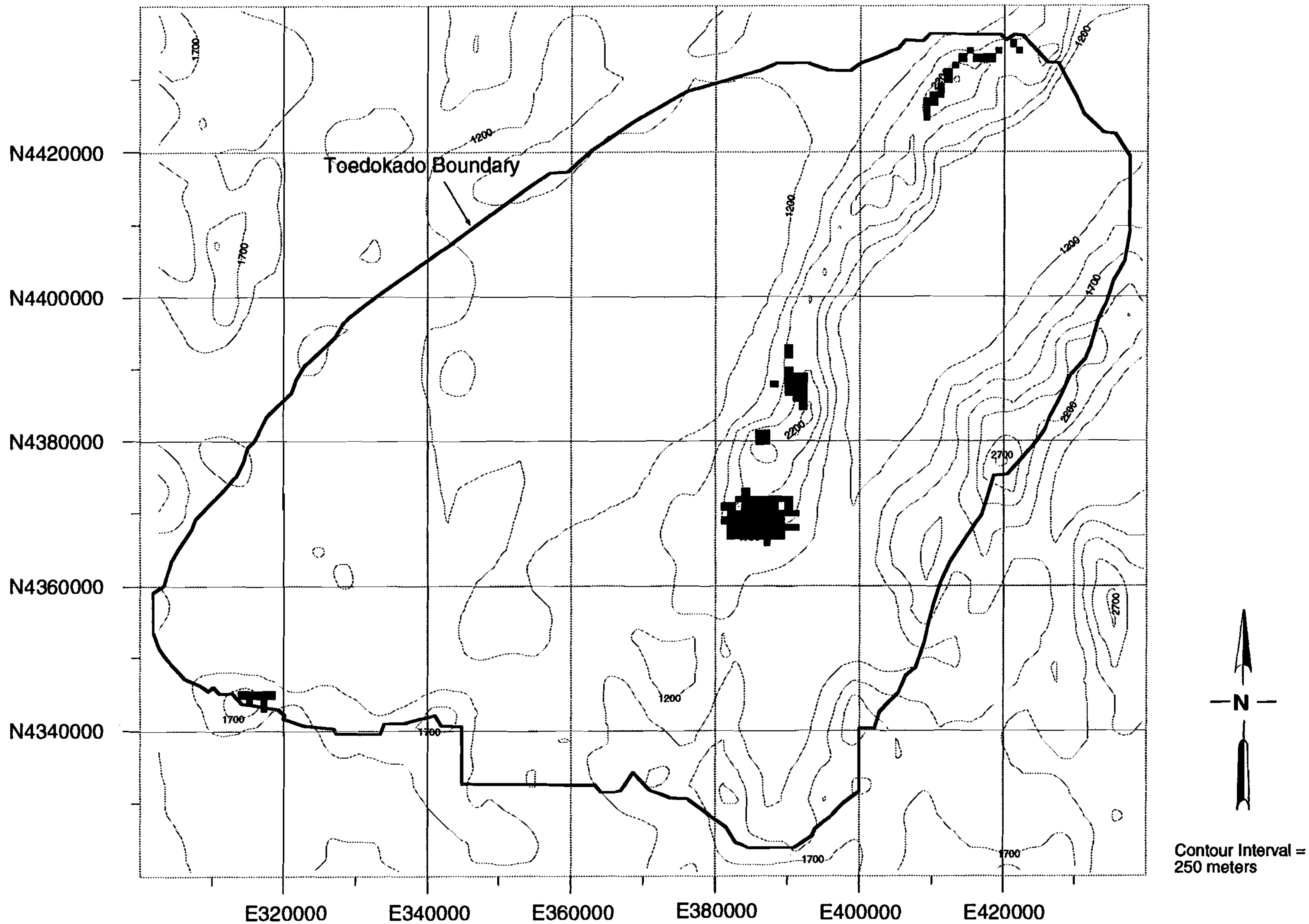

Figure 45. Distribution of shallow claypan 8-10 in. precipitation zone habitats (Habitat Types 44, 44b, 44c) by square kilometer quadrat in Toedokado territory.

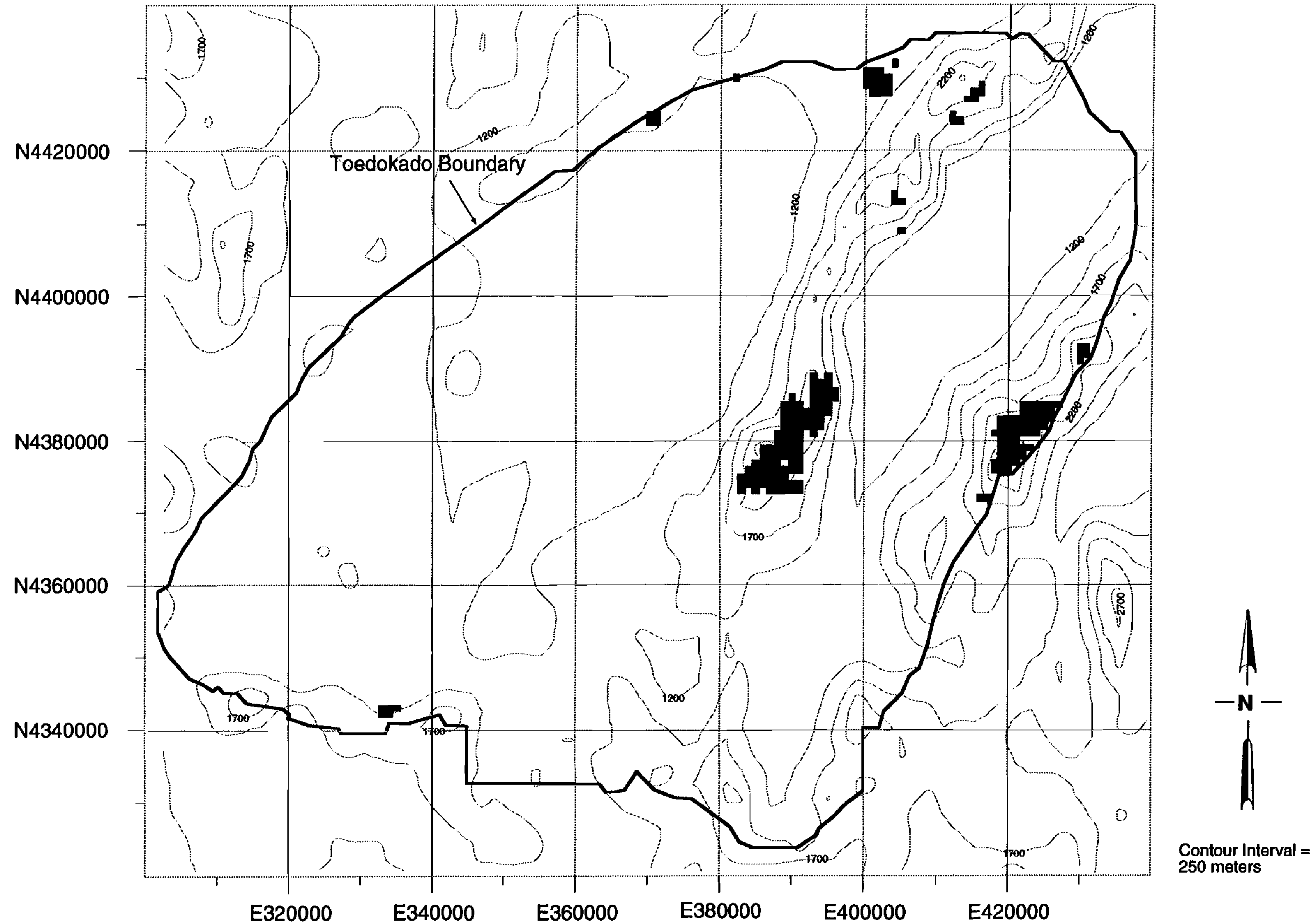

Figure 46. Distribution of cobbly claypan 12-14 in. precipitation zone, loamy slope 10-12 in. precipitation zone habitats (Habitat Types 47, 47b, 47c) by square kilometer quadrat in Toedokado territory.

Habitat Types 34, 34b, 34c. Pinyon-Juniper Woodland

Pinyon-Juniper woodland inhabits mountain side slopes at elevations extending from 1800 to 2900 meters (5906 to 9515 ft amsl) above sea level where slopes vary from 30 to 50 percent. Soils are moderately deep, well-drained, and dominated by gravels. Runoff is moderate to rapid, with moderate to high potential for sheet and rill erosion depending on slope. Pinyon-Juniper woodlands occur exclusively in the Stillwater, Clan Alpine, and Fairview Mountains (Figure 47).

Pinyon and juniper trees are typical, with overstory canopies ranging from 20 to 35 percent. The composition of the overstory ranges from 50 to 70 percent Utah juniper to 90 percent pinyon; pinyon tends to prevail on northern aspects and at higher elevations, whereas juniper prefers southern exposures and lower elevations.

The understory is predominately mountain big sagebrush, Thurber needlegrass, and Wyoming big sagebrush, with notable inclusions of antelope bitterbrush and bluegrass. Currant, oceanspray, Idaho fescue, tapertip hawkbeard, and arrowleaf balsam root are common. Small stands of mountain mahogany (*Cercocarpus* sp.) have been observed along lower treelines of the Clan Alpine Mountains (USDI Bureau of Land Management 1991), but these are not catalogued in range type descriptions. Pinyon-Juniper woodlands are rich foraging areas for a variety of birds, and large and small mammals (USDA Soil Conservation Service 1991).

Understory vegetation is one half grasses, 40 percent shrubs, and 10 percent forbs. Understory production averages 400 kilograms per hectare in normal years for areas with 20-35 percent overstory canopies. Springs and seeps in pinyon-juniper woodlands bear localized but highly productive (2000 kg/ha) communities of Great Basin wildrye, sedge, rush, and western wheatgrass (see Habitat 51).

Fire is a significant determinant of flora of this habitat. The landscape that has not burned for a number of years typically will have a canopy cover of 20 to 30 percent. A fire may drastically reduce the overstory component of the landscape, enabling the understory to benefit from increased solar exposure. Under these conditions, elements of the habitat that occur in small or trace amounts may see increased growth and productivity. In particular, grasses and lupine are likely to proliferate the first few years after a fire, followed thereafter by currant, serviceberry, bitterbrush, and sagebrush, until finally the overstory is reestablished, perhaps 10 to 40 years later (USDA Soil Conservation Service 1992). Wildfire and successional renewal of woodlands dramatically affect understory plant production; annual air-dry production of the understory can be as high as 950 kilograms per hectare for wildfire disturbed areas, and as low as 125 kilograms per hectare for dense canopies of old woodlands.

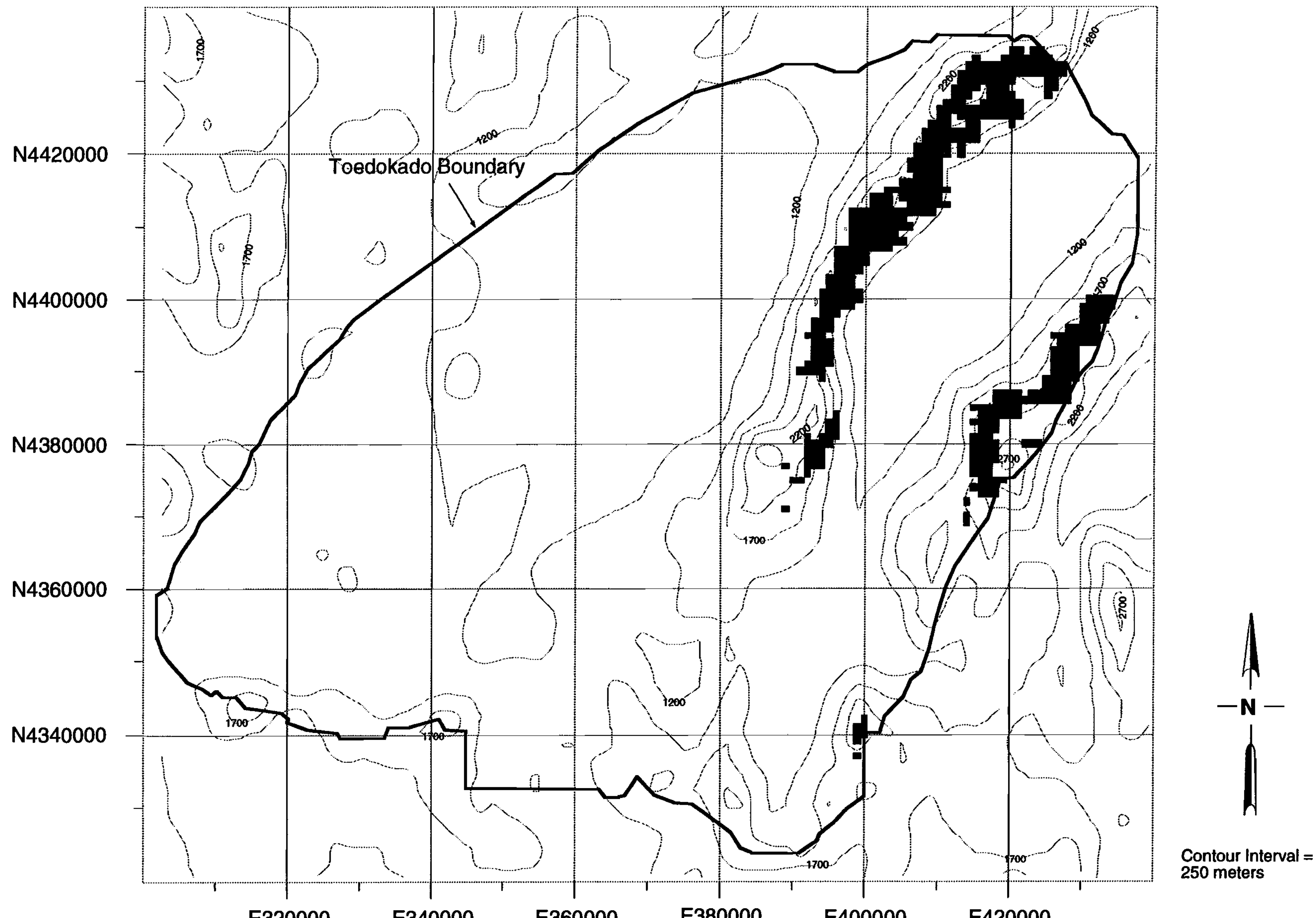

Figure 47. Distribution of pinyon-juniper woodland habitats (Habitat Types 34, 34b, 34c) by square kilometer quadrat in Toedokado territory.

Chapter 4. DISTRIBUTION AND AVAILABILITY OF RESOURCES

David Zeanah and Julia E. Hammett

The tessellated biogeography of the Carson Desert outlined in the previous chapter reflects a landscape of plant and animal resources whose quantity and quality are distributed unevenly in space and time. We turn now to the foraging potential, for ethnographic and prehistoric hunter-gatherers, of specific resources in that landscape. The following discussions revise and supplement information developed for the Stillwater model (Raven and Elston 1989), attending particularly to resources that were rare in the marshes of Stillwater but are more common in the larger Toedokado territory. We emphasize resources that are most abundant in the study area or are most profitable in terms of caloric costs and benefits. Spatial and seasonal distributions of plant resources are coined from habitat type mappings, that predict potential occurrences and yields of native plants. We emphasize plant resources because soil and range data directly monitor these resources and allow their distributions to be modeled reliably, but, concomitantly, we infer distributions of economically important game animals from the habitat model. These data in hand, we assess economic values for human foragers based on ethnographic, archaeological, biological, and experimental data.

Plants

In the following sections, we discuss economically important plants in detail, reviewing ethnographic and archaeological evidence for its use by hunter-gatherers in western North America and considering critical aspects of its autoecology and phenology that are pertinent to the current modeling exercise. We then analyze the distribution and abundance of each plant as predicted by the Toedokado habitat model and identify individual habitats where the species are most productive. Finally, we review available literature on the economic productivity and energetic cost-benefits of the species to hunter-gatherers.

Grasses

Following Raven and Elston (1989), we organize grasses by season of harvest (in the annual round). Grasses earliest to ripen are cool season grasses, of which the foliage develops early in spring and the grain ripens early to middle summer. Of these, Indian ricegrass is ubiquitous in the study area, and is considered a valuable food source by both ethnographic and archaeological sources. Other cool season grasses of the study area include needlegrass, bluegrass, saltgrass, meadow barley, squirreltail, and mat muhly. Among late season grasses, maturing in late summer and early fall, wildrye is considered particularly valuable. Other late season grasses include wheatgrass, sand dropseed, and alkali sacaton.

Indian Ricegrass

Ethnobotanists have documented the use of Indian ricegrass by aboriginal groups throughout the Great Basin and southwestern United States (Doebley 1984), including Hopi (Whiting 1939; Jones 1938), Zuni (Stevenson 1915), Apache (Jones 1938; Reagan 1929), Havasupai (Bohrer 1972), Navaho (Jones 1938), Gosiute (Chamberlain 1911:375), Surprise Valley Paiute (Kelly 1932:42), Owens Valley Paiute (Steward 1938), and Northern Paiute of Stillwater Marsh (Fowler 1992). Indian ricegrass has been recovered from archaeological sites throughout the Southwest (i.e., Bohrer 1972; Jones 1938; Winter

1993); Great Basin sites that have yielded evidence of its utilization include James Creek Shelter in the central Humboldt River basin (Thompson 1990), in Owens Valley at CA-INY-30 (Basgall and Wohlgemuth 1988), and Crater Middens (Bettinger 1989:285). Small quantities of ricegrass seed were observed in coprolites from Lovelock Cave (Roust 1967:57-59).

This perennial bunchgrass inhabits deserts and plains throughout the western United States, and is most abundant on dry, sandy soils where few other perennials compete (Hafenrichter et al. 1968:55). Seeds ripen in late spring and early summer and are ready to harvest by July (Wheat 1967:11). This is contrary to Raven and Elston (1989:92), who estimated its availability in late May and June, but is consistent with recorded observations of the date of seed ripening north of the Hot Springs Mountains (McAdoo et al. 1983). Altitude influences the date of seed maturation; ricegrass plants at higher elevation mature later in the season. Indian ricegrass is the dominant grass of range types in Toedokado territory that are between 1000 m (3281 ft amsl) and 1980 m (6496 ft amsl) elevation, suggesting potential for staging the ricegrass harvest. Indeed, the Toedokado took advantage of this phenological phenomenon to extend the harvest of ricegrass over a month by collecting seeds at progressively higher elevations (Fowler 1976, 1992:83).

Indian ricegrass is typically the dominant understory perennial grass of all greasewood-saltbush associations in the Lahontan Basin (Billings 1945:6; Young et al. 1976:202; Young et al. 1990:262). It germinates well and is a prolific seed producer on all sandy sediments of Pleistocene Lake Lahontan (Young et al. 1983:82-86, 1994:6). Ricegrass occurs in all the biotic habitats of Toedokado territory except wetland and abiotic Habitats 1, 2, 6, 28, 51, 54, and 55. In the remaining 34 habitats, the productivity of Indian ricegrass ranges from 4 to 302 kilograms per hectare. Habitats 16, 11, 20, 27, and 19 are the five most productive, bearing 302, 172, 161, 146, and 137 kilograms per hectare, respectively.

Figure 48 depicts the expected productivity of Indian ricegrass for normal years in Toedokado territory, revealing its widespread dispersion throughout the study area. Particularly productive stands associated with Habitat 16 occur in Fairview Valley, Salt Wells Basin, and the Dead Camel Mountains. Fowler (1992:39) notes that stands of Indian ricegrass north and east of Salt Wells are highly productive. Although the Toedokado Habitat model does not suggest that this area is the best of ricegrass patches in the study area, it does correspond to a cluster of quadrats assigned to Habitats 11, 20, and 27, the second, third, and fourth most productive habitats in the model.

Range management data indicate that Indian ricegrass can produce between 15 and 80 kilograms of seeds per hectare (Hafenrichter et al. 1968:55; USDA Soil Conservation Service 1990); Lahontan sand sheets of Habitat 11, north of Hot Springs Mountains, are known to have produced 64 kilograms per hectare of Indian ricegrass seeds (Young et al. 1983:85).

Ricegrass ripens unevenly and the grains adhere to the plant until ripe, rendering seed beaters ineffective. Fowler (1976:3-4) reports that the standard harvesting technique was to cut the clump of grass with a sharp knife, hold the clump over a fire long enough to ignite it, quickly transfer the dropping seeds to a buckskin, and douse the clump with water or green stems. Such flash burning removed the chaff and parched the seed without damaging it. Then grains and residue ash were sifted through a twined tray, grains were cleaned by hand, and cleaned grain was stored in sacks for future use.

Using similar methods, Simms (1987:119-121) found that harvesting and processing Indian ricegrass seeds returned between 300 and 400 calories per hour. Jones and Madsen (1991:71-73) conducted Indian ricegrass harvest experiments that produced average return rates of 333 calories per hour, while Larralde and Chandler's (1980:102) experiments returned an average 305 calories per hour. Consequently, 300 to 400 calories per hour seems an accurate estimate of the caloric return rate to hunter-gatherers harvesting Indian ricegrass.

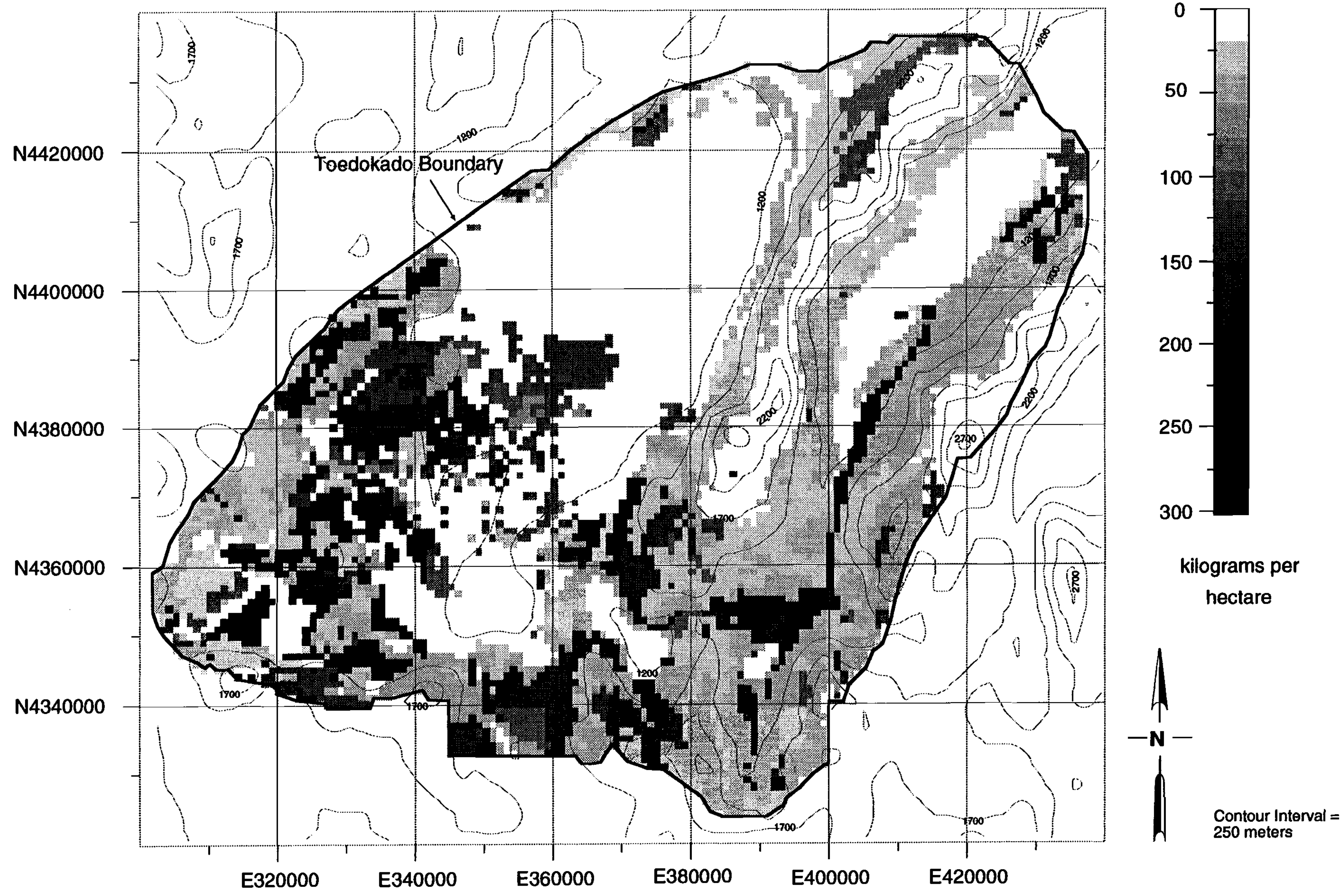

Figure 48. Normal year productivity of Indian ricegrass (kg/ha) in Toedokado territory.

Other Cool Season Grasses

Bluegrass is represented in the study area by Canby bluegrass, Cusick bluegrass, muttongrass, alkali bluegrass, Nevada bluegrass, and Sandberg's bluegrass. All are vernal-dominant grasses which grow rapidly in spring but are dormant in early summer (Hafenrichter et al. 1968:42).

Surprise Valley Paiute (Kelly 1932:99), Owens Valley Paiute (Steward 1933:243), and various northern and southern Nevada Paiute bands (Fowler 1986:76) used grains of Nevada bluegrass. Bluegrass seeds appeared in coprolites from Hogup Cave in northwest Utah (Bohrer 1972:202; Fry 1970:249), and muttongrass residues were at Tularosa Cave, New Mexico (Bohrer 1972:202).

Bluegrass is a component of 28 habitats in the Toedokado model, with the greatest abundance in Habitat 55-lowland springs. This habitat should maintain 1120 kilograms of bluegrass per hectare, albeit all alkali bluegrass. The next most prolific habitats for bluegrass are Habitat Type 51 (196 kg/ha), 6 (184 kg/ha), 5 (129 kg/ha), and 1 (94 kg/ha), all wetland habitats containing mixtures of Nevada bluegrass and alkali bluegrass. The remaining 22 habitats maintain from 6 to 62 kilograms per hectare of bluegrass representing a variety of bluegrass types, with Sandberg's bluegrass present in the majority of cases.

Figure 49 illustrates the distribution of all bluegrass species in the study area, indicating that the most productive stands occur in Dixie Valley and in the Carson River lowlands. Low density patches appear in the Clan Alpine, Stillwater, Fairview, Sand Springs, and Desert Mountains, and in Stillwater Marsh and Indian Lakes. Alkali and Nevada bluegrass are common in wet saline meadows as well as in somewhat drier sites at higher elevations. Canby bluegrass and Sandberg's bluegrass occur throughout sagebrush communities (Hafenrichter et al. 1968:42).

Experimental harvest and processing of two varieties of bluegrass (which, as it happens, do not occur in Toedokado territory) yielded caloric return rates of 418 and 491 calories per hour (Simms 1987:124-125). Since we lack harvest data on local species, we assume that Simms's figures are representative of caloric return rates of bluegrass in the Carson Desert, based on morphological similarities such as seed size and arrangement on plant (Steve Simms, personal communication, January 1995).

Needlegrass is represented in the study area by needleandthread, western needlegrass, desert needlegrass, Webber ricegrass, and Thurber needlegrass. The seeds of these perennial bunch grasses ripen from middle to late summer. Ethnographic evidence of their use as food is best for desert needlegrass, a food of the Owens Valley Paiute (Steward 1933:243; Fowler 1986:77) and Kawaiisu (Fowler 1986:77).

Needlegrass usually is the dominant perennial grass in all the sagebrush community associations in the Carson Desert (Young et al. 1976). It is present in 28 of the 41 habitats, with values ranging from 3 to 193 kilograms per hectare in years of normal rainfall. The top producing habitats are 47 (193 kg/ha), 48 (182 kg/ha), 35 (152 kg/ha), 52 (131 kg/ha), and 44 (118 kg/ha). The projected distribution of needlegrass in normal years is presented in Figure 50, where we see the best patches in the Sand Springs, Dead Camel, Fairview, Clan Alpine, and Stillwater Mountains.

The energetic costs and benefits of using needlegrass are unknown, although Raven and Elston (1989:98) suggest that, based on similarity of seed size, yields should fall "somewhere within the range of squirreltail and sand dropseed," or between 100 and 300 calories per hour as estimated by Simms (1987). We follow Raven and Elston in the present exercise.

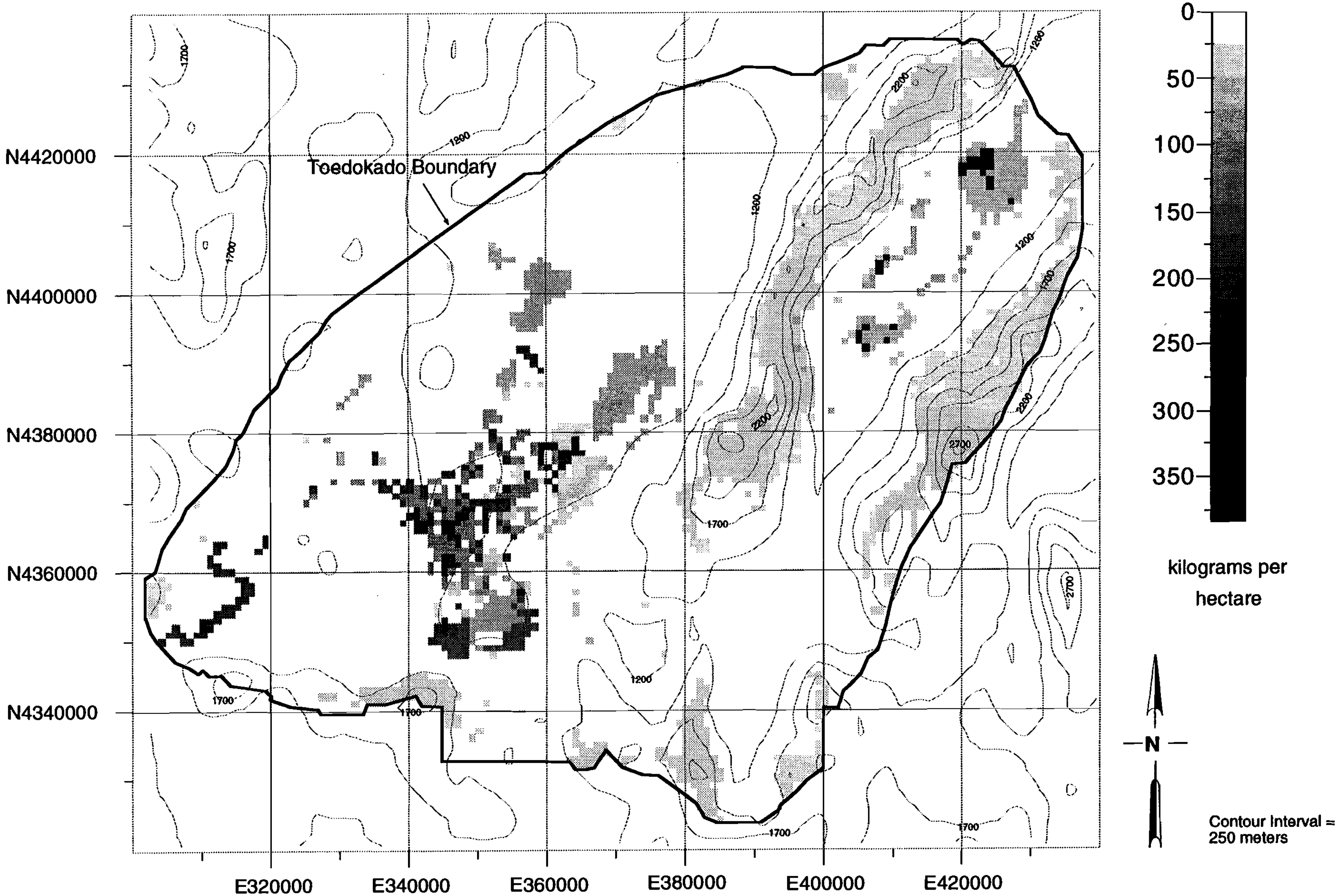

Figure 49. Normal year productivity of bluegrass (kg/ha) in Toedokado territory.

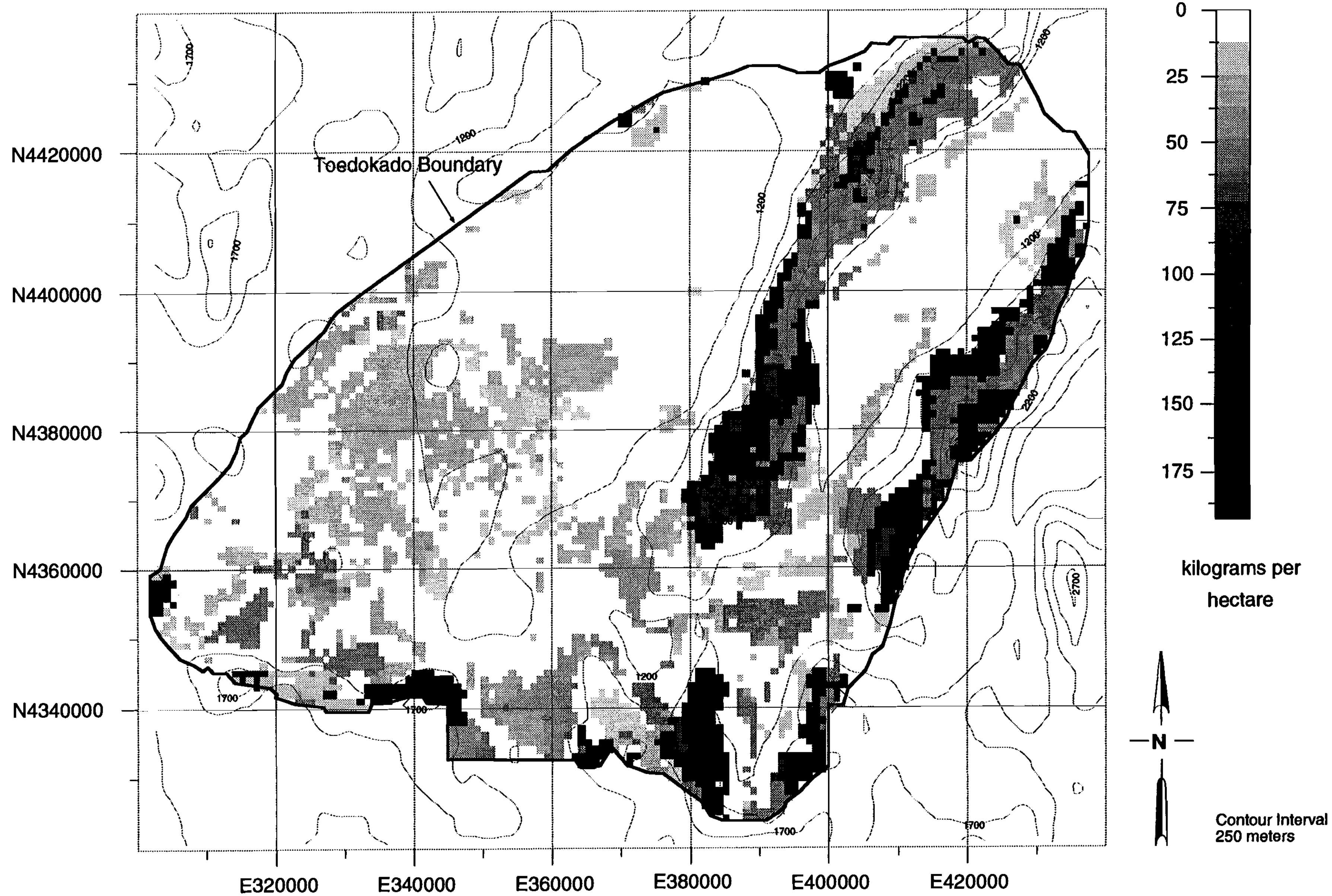

Figure 50. Normal year productivity of needlegrass (kg/ha) in Toedokado territory.

Inland saltgrass is a low perennial with extensively creeping scaly rhizomes (Chase 1971:175), the grains of which begin to ripen in late June. It is tolerant of highly saline soils but requires moisture; consequently, extensive stands of inland saltgrass tend to occur around the margins of playa lakes and shallow stream channels (Billings 1945:16-17; Hamilton and Auble 1993:4, 14). Saltgrass occurs in 14 of 41 habitats identified in the model in densities ranging from 4 to 224 kilograms per hectare. The most productive habitats are lowland riparian or lowland spring, 55 (224 kg/ha), 6 (211 kg/ha), 28 (207 kg/ha), 4 (171 kg/ha), and 5 (151 kg/ha). Densities are highest in the Carson River lowlands and around the margins of Humboldt Salt Marsh in Dixie Valley, as illustrated in Figure 51. Simms (1987:112) estimates that the caloric return rate of inland saltgrass seeds is between 140 and 160 calories per hour.

Meadow barley is a perennial grass used by the Surprise Valley Paiute (Doebley 1984:55; Kelly 1932:99) of the northwestern Great Basin. It occurs in moist places (Munz and Keck 1968:1508-1509), flowering from June until October, thus ripening for harvest beginning in late summer. The grains are respectable in size, nearing those of Indian ricegrass. Meadow barley occurs only in Habitat Type 4-lowland riparian and Habitat Type 51-upland springs, where, respectively, 92 and 20 kilograms per hectare of foliage are produced in normal years. Simms's (1987:116-117) experiments indicate foxtail barley returns about 200 calories per hour, a reasonable estimate for meadow barley as well.

Bottlebrush squirreltail is a perennial bunchgrass food of the Owens Valley Paiute, Panamint Shoshone, Western Shoshone (Fowler 1986:76), and Surprise Valley Paiute (Kelly 1932:99). The grains are arranged on long spikes or seed heads protected by bristly spreading awns. Thus, processing the grain requires flash burning or parching, at a minimum. Although it occurs in 35 of the 41 plant habitats of Toedokado territory, its density and productivity are quite low. Production of herbage ranges from 3 to 27 kilograms only per hectare in normal years. It achieves greatest densities in the lowlands of Dixie Valley and around the margins of Humboldt salt marsh and the adjacent playa (Figure 52). Simms's (1987:130-132) harvesting experiments found bottlebrush squirreltail yielding the lowest caloric return rate of all plants examined, at 91 calories per hour. However, Simms's processing methods involved parching and winnowing techniques that were inefficient for removing the long awns characteristic of this species. Had the awns been removed by burning, return rates could have doubled (Steve Simms, personal communication, January 1995).

Wildrye

Wildrye (Hickman 1993) is represented in the study area by two species, Great Basin wildrye and creeping or beardless wildrye. The former is a perennial bunchgrass preferring areas along drainages and near springs. Creeping wildrye dwells in moister situations, most commonly in wet, alkaline meadows. Also perennial, it colonizes extensively by its creeping, scaly rhizomes (Chase 1971:253). Both species produce seeds in late summer to early fall. Foliage remains green into the fall, even after seed production.

Ethnographic data attest that numerous species of wildrye were collected and eaten (Steward 1938:24); the Yuki harvested the grains of creeping wildrye in great quantities (Chestnut 1974:312); use of blue wildrye and Canada wildrye is attributed to Gosiute by Chamberlain (1911:368). Steward (1933:244) indicates that the Owens Valley Paiute used seed beaters to harvest Canada wildrye. Muir ([1894] 1961:76) reported a harvest of wild rye by Mono Lake Paiute, and DeQuille (1963:53) observed a reaping and threshing harvest by Northern Paiute, probably within Toedokado territory. Wildrye macrofossils are common in human coprolites of Lovelock Cave, documenting their usage by prehistoric groups just north of Toedokado territory (Napton and Heizer 1970:107).

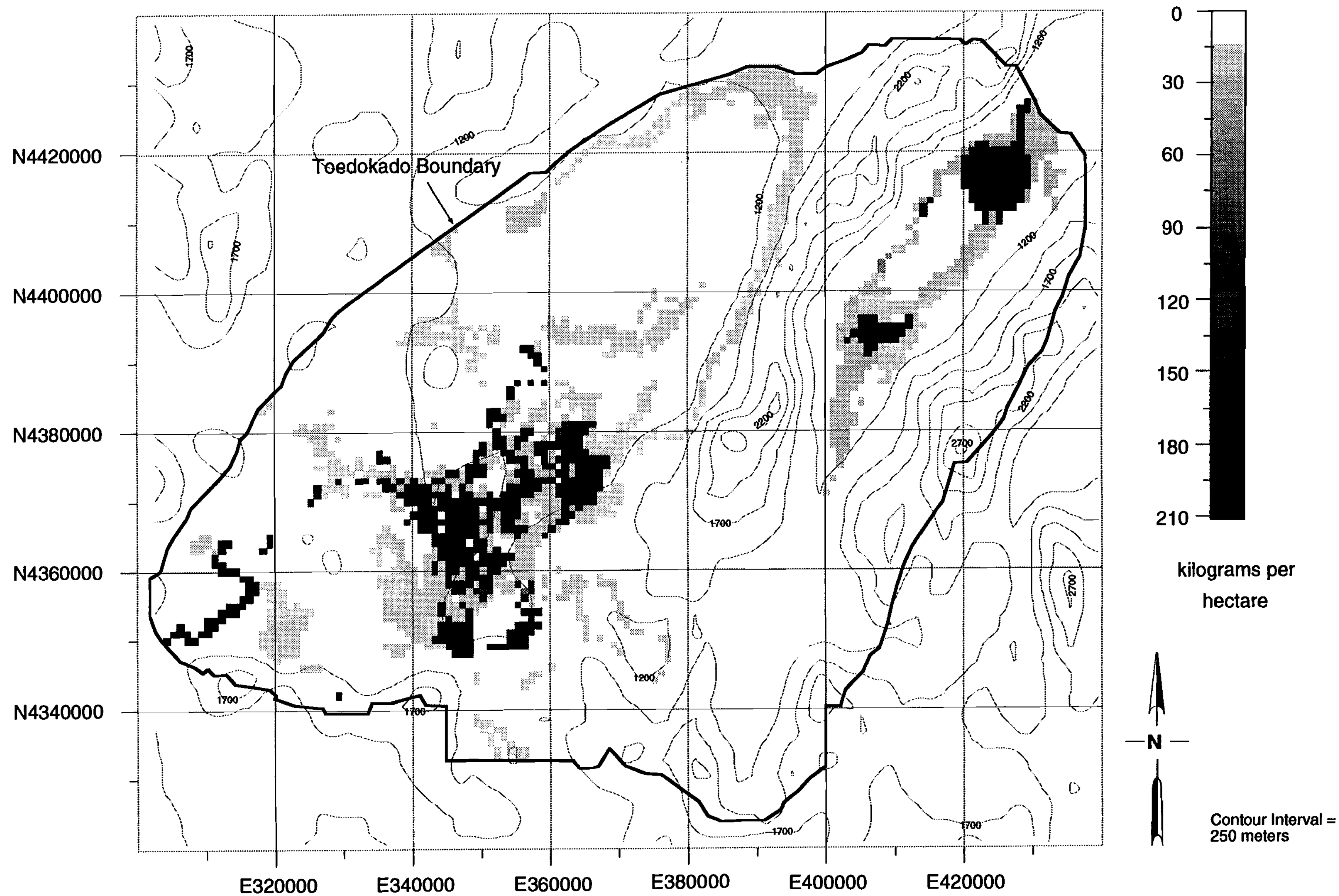

Figure 51. Normal year productivity of inland saltgrass (kg/ha) in Toedokado territory.

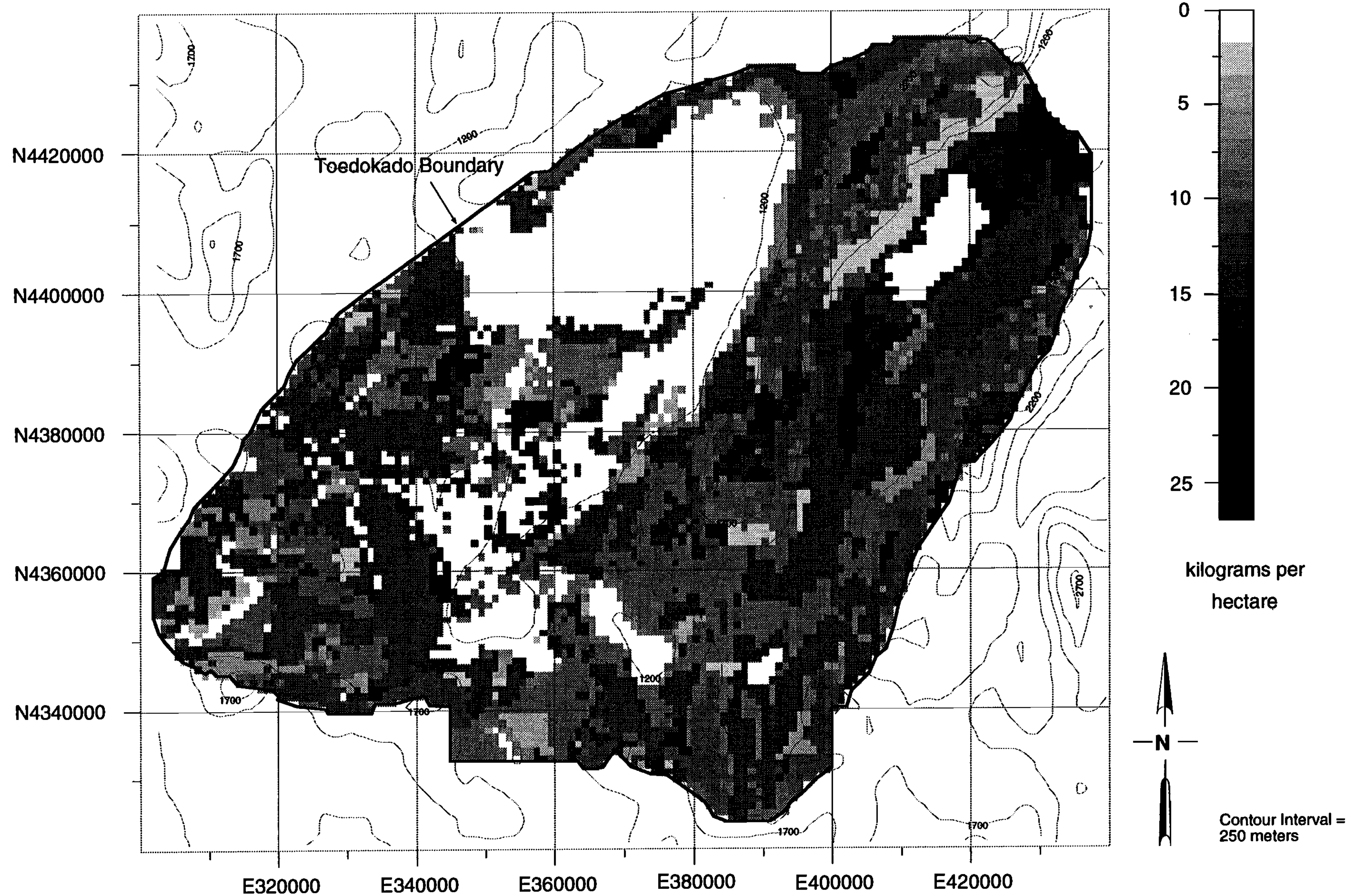

Figure 52. Normal year productivity of bottlebrush squirreltail (kg/ha) in Toedokado territory.

Wildrye is one of the few Lahontan Basin plants that occur on both lowland alkaline soils and well drained upland soils (Lesperance et al. 1978:125). Wildrye probably was much more abundant in Toedokado territory before the introduction of cattle (Young et al. 1976:196-197; Lesperance et al. 1978:125-128). Wildrye currently appears in 23 of the 41 plant habitats, with values ranging from 3 to 974 kilograms per hectare; however, it is most prolific in Habitats 6 (974 kg/ha), 51 (922 kg/ha), 5 (642 kg/ha), 28 (560 kg/ha), and 29 (219 kg/ha). Its ubiquity in three lowland riparian habitats (6, 5, and 28), in one greasewood saltbush habitat (29), and in the upland spring habitat (51) attests to its tolerance for soils both well and poorly drained.

The distribution of wildrye in Toedokado territory is illustrated in Figures 53 and 54. The most extensive and dense patches of wildrye occur in the Carson River lowlands and in the Dixie Valley lowlands north and south of Humboldt Salt Marsh. The two areas, however, maintain unequal representations of the two species; creeping wild rye comprises approximately 70 percent of wildrye in the Carson River lowlands, while over 90 percent in Dixie Valley is Great Basin wildrye.

Simms's (1987:114-115) experimental procurement of Salina wildrye produced high returns of 920 to 1240 calories per hour, but only 260 to 470 calories per hour for Great Basin wildrye. Since Simms harvested stands of Great Basin wildrye that were not yet ripe, Raven and Elston (1989:99) suspected that a more "perfectly timed" harvest of Great Basin wild rye would elevate return rates. However, subsequent experimentation by Bullock (1994) produced return rates consistent with those of Simms—between 280 and 500 calories per hour. Therefore, we accept as reasonable the return rates of Simms and of Bullock.

Other Summer Maturing Perennial Grasses

Wheatgrass is represented in the Cattail Eater model by three native species: thickspike wheatgrass, western wheatgrass, and slender wheatgrass. While all are drought resistant, long-lived sod grasses, thickspike wheatgrass is more drought resistant than western wheatgrass (Hafenrichter et al. 1968:23-27). Slender wheatgrass is a domesticated native bunchgrass adapted to a wide range of soils and climate (Hafenrichter et al. 1968:2). There is no direct ethnographic evidence of the use of the three species native to Toedokado territory, although Steward (1933:243) observed Owens Valley Paiute using grains of related wheatgrass varieties.

In the study area, wheatgrass occurs in 11 of the 41 identified habitats, in densities ranging from 4 to 263 kilograms per hectare. It is most abundant in wetland Habitats 4, 5, 6, 28, and 51. It occurs in one sagebrush habitat (27), and in trace amounts in greasewood/saltbush Habitats 7, 9, 11, 16 and 20. Figure 55 illustrates the distribution of these species in Toedokado territory as predicted by the model. As can be seen, it is distributed throughout the Carson River lowlands, and dense patches appear in Fairview Valley, Salt Wells Basin, and at the base of the Dead Camel Mountains.

No data are available on the economic costs and benefits of consuming wheatgrass but Raven and Elston (1989:101-102) suspect that return rates must be comparable to those of Great Basin wildrye. We continue that assumption in the present study.

Sacaton is represented by two species, both perennial bunchgrasses, in Toedokado territory; sand dropseed tends to ripen slightly earlier than alkali sacaton. Alkali sacaton, a coarse, tough, densely tufted perennial grass, is good forage. Although information on the use of its grains by Paiute of Stillwater Marsh is lacking, there is ethnographic evidence of its use by Owens Valley, Panamint, and Southern Paiute (Fowler 1986:77).

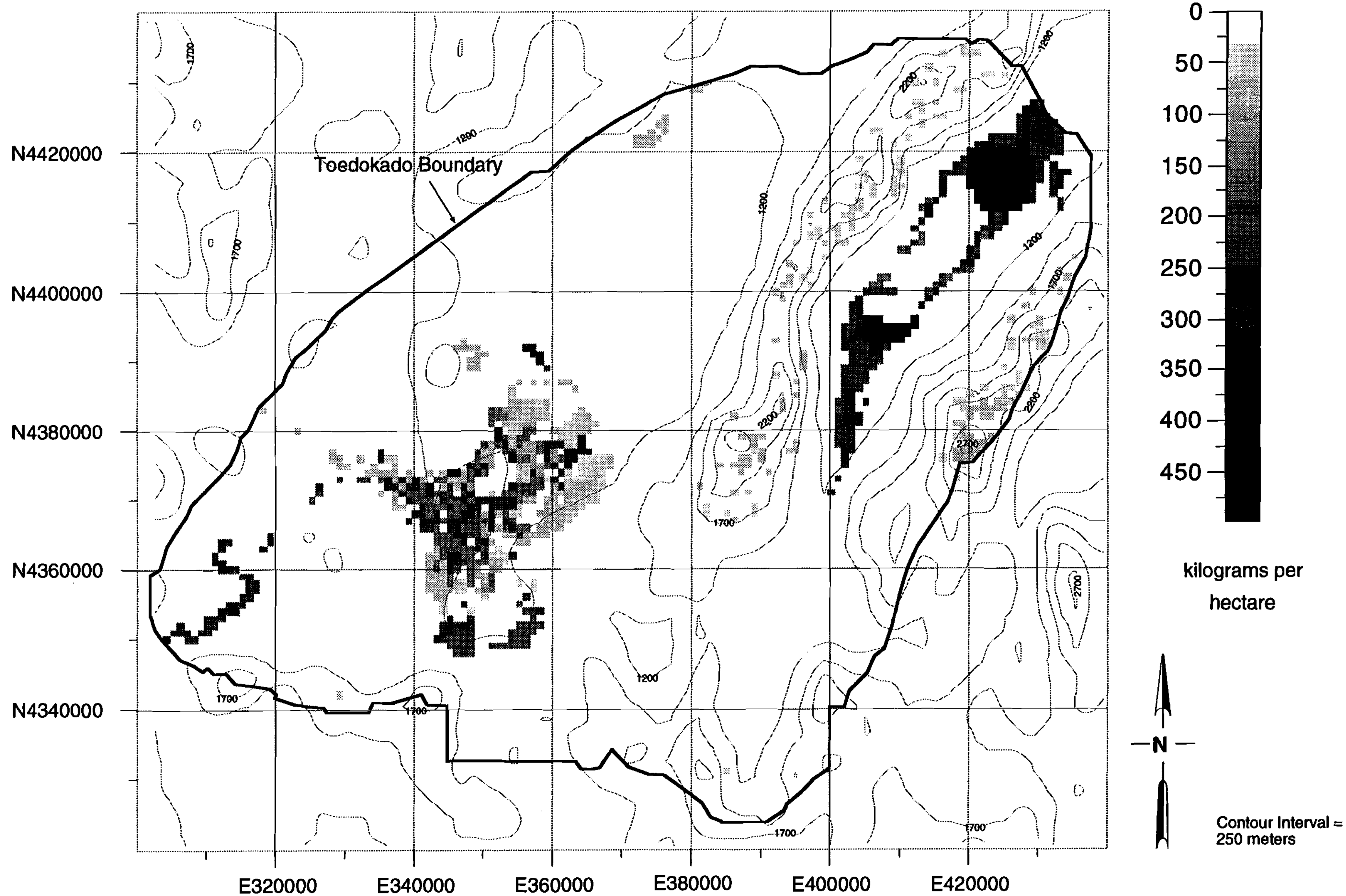

Figure 53. Normal year productivity of Great Basin wildrye (kg/ha) in Toedokado territory.

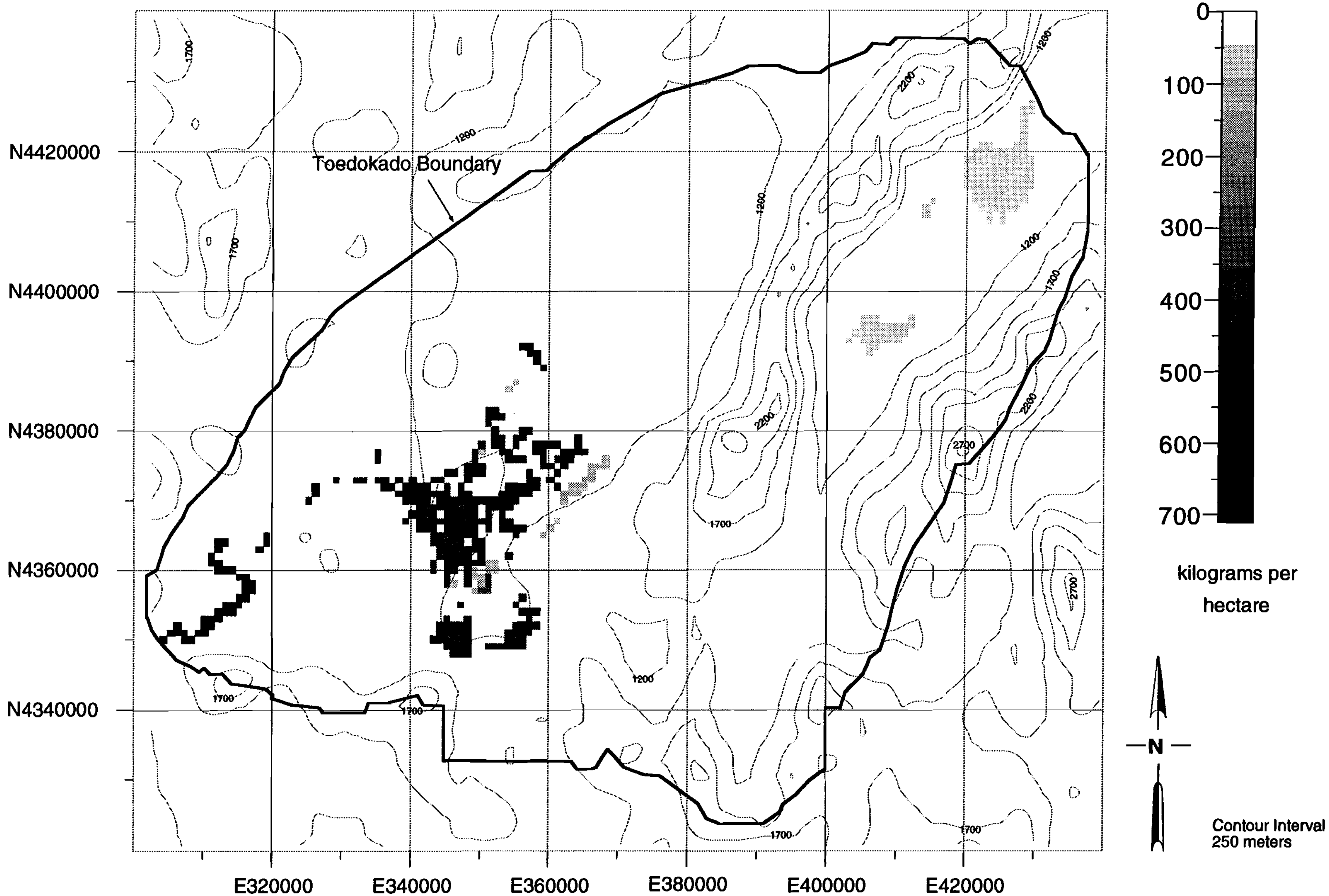

Figure 54. Normal year productivity of creeping wildrye (kg/ha) in Toedokado territory.

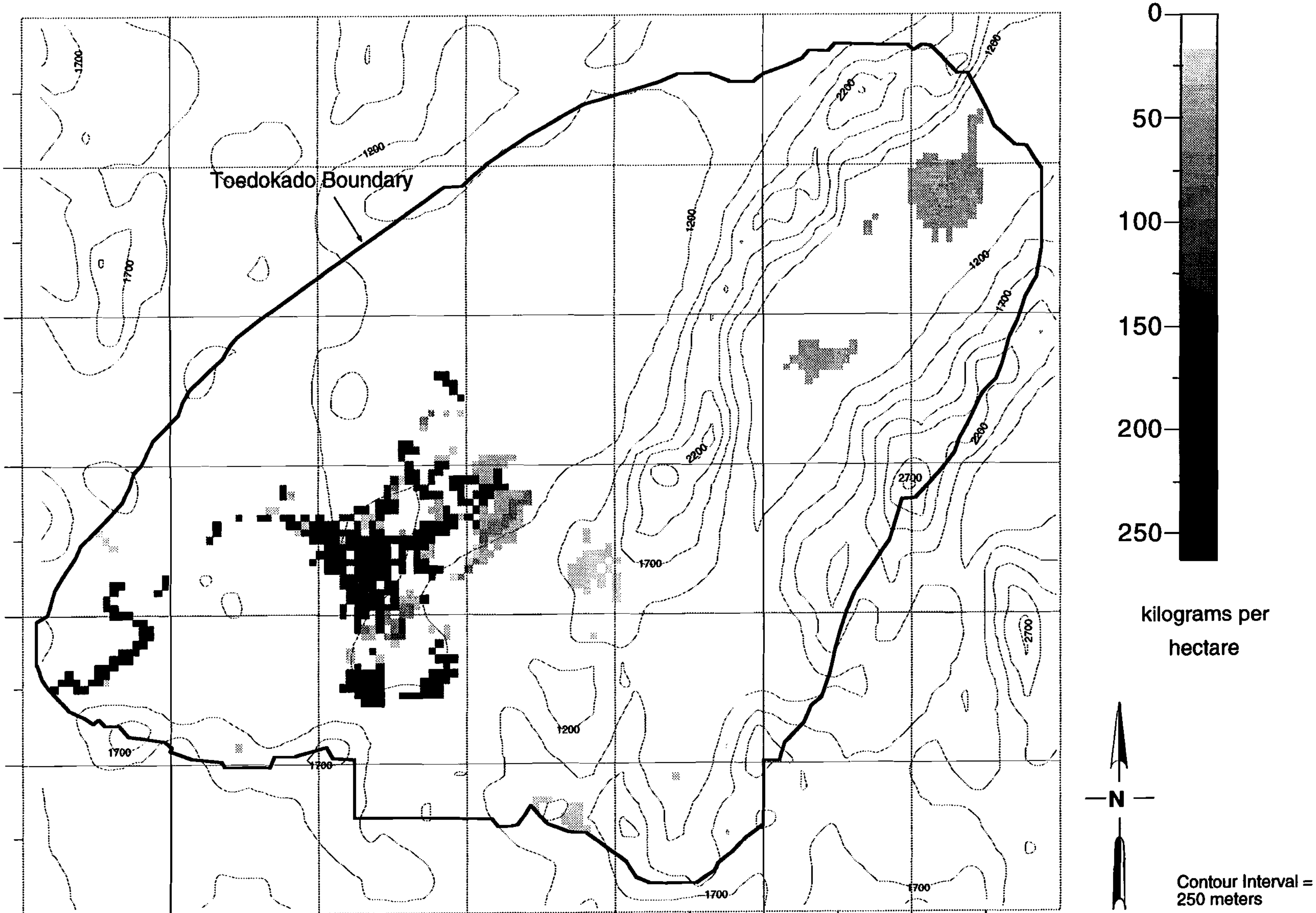

Figure 55. Normal year productivity of wheatgrass (kg/ha) in Toedokado territory.

The two species occur in 28 of 41 habitat types in Toedokado territory, in densities ranging from 1 to 527 kilograms per hectare. Sand dropseed is common in modest proportions in greasewood/saltbush habitats, and to a lesser extent, the sagebrush habitats, whereas alkali sacaton occurs in respectable quantity throughout the wetlands, yielding between 358 and 527 kilograms per hectare in Habitats 4, 5, 6 and 28.

Mat muhly has limited distribution in Toedokado territory, occurring in small proportions only in Habitats 5 and 6 and never exceeding 80 kilograms per hectare. The exceedingly small seed grains ripen in late summer.

Simms (1987:131) tested *Sporobolus asperifolius* and *Muhlenbergia asperifolia*, both known colloquially as scratchgrass and listed interchangeably by botanists (Arnow et al. 1980:447). Simms combined test results from these two species to obtain a return rate of slightly less than 300 calories per hour. Although the species tested by Simms are not present in the Carson Desert, the return rates probably are similar to those available from sand dropseed, alkali sacaton, and mat muhly.

Tufted hairgrass was a food of the Gosiute (Chamberlain 1911:57). In the study area, this taxa occurs only in Habitat 51-upland springs. Here, forage yield for normal years is approximately 20 kilograms per hectare, only 1 percent of total forage yield, rendering it unlikely that this grass ever represented a significant resource in the study area. The grains of tufted hairgrass ripen in late summer (Doebley 1984:52-64).

Idaho fescue is the only fescue species identified in the study area. Fescue is a cool season grass, ripening in early to midsummer. Its grains are relatively small and seed production is scant because individual plants produce few fertile culms (Hafenrichter et al. 1968:46-47). There is neither ethnographic nor archaeological evidence for the use of this fescue in the Carson Desert, although six-weeks fescue was a food of the Gosiute (Bohrer 1972; Chamberlain 1911:369) and the Navajo (Bohrer 1972; Jones 1938:47). Fescue occurs in small proportions in pinyon-juniper woodlands (Habitat 34), and in greater proportions in Habitat 47, where it produces about 24 kilograms per hectare in normal years.

Upland Annual and Perennial Forbs

Numerous forbs were valuable food resources of ethnographic hunter-gatherers, although few appear in range type profiles in quantities sufficient to model production accurately. This is, to a large extent, a consequence of the tendency of forbs to generate foliage, flower, and seed in so short a time span as to make it difficult to record their presence as constituents of range types (see Chapter 2). Thus, the absence of a particular taxa in a range type is more nearly indicative of season of survey than of true plant productivity.

Forbs of notable value include the small seed plants blazing star, sunflower, buckwheat, mule ears, and tansy mustard. Also important were plants with economic roots, rhizomes, tubers, bulbs, and corms, such as biscuitroot, spring beauty, lily, bitterroot, and Cusick's sunflower. Forbs with multiple food parts are onions with their edible bulbs and leaves, goosefoot with seeds and leaves, dock with roots and seeds, and balsamroot with edible seeds, shoots, and tubers.

Fowler (1992) records the ethnographic Toedokado use of onion, blazing star, sunflower, tansy mustard, bitterroot, desert parsley, spring beauty, balsamroot, and mule ears. Archaeological evidence of consumption of these plants is lacking in Toedokado territory, but tansy mustard seeds are common in archaeobotanical samples from Owens Valley, where goosefoot, sunflower, and blazing star also have been observed archaeologically (Basgall and Wohlgemuth 1988:304-324; Bettinger 1989:285-286).

Balsamroot is identified in the Toedokado Habitat model, occurring in montane Habitats 34 and 47, but in densities of only 4 and 6 kilograms per hectare, respectively. Bitterroot appears only in sagebrush Habitat 35, at 4 kilograms per hectare, whereas biscuitroot is restricted to Habitat 47, at 6 kilograms per hectare. Because of the sampling problems associated with forbs, and the way in which we average multiple range types to estimate habitat densities, we must assume that these low production figures do not reflect the true densities of these species. Nevertheless, biscuitroot, bitterroot, and balsamroot should prefer the rocky talus slope environments of the habitats where they are noted, and these should be habitats that also support several perennial forbs not accounted for in the database, such as onion, and spring beauty.

Fowler (1992:39) notes that the Cattail Eaters gathered roots on Table Mountain, which corresponds to the distribution of the three habitats. Couture et al. (1986:158) report relatively high return rates for roots in south central Oregon; two species of biscuitroot returned approximately 1220 to 3800 calories per hour while bitterroot returned 1370 calories. Simms (1989:118) estimates a similar return (i.e., 1240 calories per hour) for bitterroot. We presume that these rates represent feasible returns for the same taxa in Carson Desert habitats.

Our model records the generic abundance of such annual forbs as tobacco, goosefoot, blazing star, sunflower, and tansy mustard. Simms (1987:111) obtained high caloric return rate of 1300 calories per hour for tansey mustard and between 450 and 500 calories per hour for sunflower, which illustrates the range of potential returns for annual seeds.

Annual forbs are recorded in nine habitats in low densities ranging from 4 to 20 kilograms per hectare. Again, these values probably are underrepresenting the true abundance of the forbs, because of sampling bias. Habitat 16 manifests the best potential representation of annual forbs followed by habitats 11, 19, 15, and 20 (at 8-9 kg/ha each). Consequently, we assume that Habitat 16 constitutes the primary habitat for annual forbs, noting, at the same time, that these annual forbs should have occurred temporarily, but in abundance, in almost all other habitats where climax plant communities were disturbed.

Shrubs

Both berry and small seed bearing shrubs occur in the study area. Seed bearing shrubs include shadscale, four-wing saltbush, Torrey quailbush, wada, and iodine bush or iodine bush. Of these, shadscale and wada are potentially the most productive in the study area. Shrubs in the study area that produce fruits or berries include wild rose, serviceberry, currant, chokecherry, silver buffaloberry, and wolfberry.

Shadscale

Shadscale is a prolific perennial shrub on arid and saline soils of the Great Basin (Mozingo 1987). In the Lahontan Basin, it is common on dry, alkaline lake bottoms as well as on adjacent terraces, benches, slopes, and washes (Cronquist et al. [1972] 1986:114; Billings 1945:6-8). Shadscale prefers clay but will grow in sand and gravelly substrate. It is extremely drought tolerant and can survive as little as 10 cm of annual precipitation (USDA Forest Service 1988:609-610; USDA Soil Conservation Service 1990).

Shadscale begins its growth in late spring and seeds mature in late fall. An individual plant may produce between 400 and 600 seeds (Mozingo 1987:56). Simms (1987:109) calculated the return rate of shadscale seeds at 1033 calories per hour. The high return rate of such a late season plant inspires confidence in its value to human foragers of the study area, who could have harvested shadscale seed late in the autumn and in early winter (Simms 1987:109-110) when there would have been few scheduling conflicts with other resources. The Gosiute Shoshone consumed shadscale seeds (Chamberlain 1911:52) and Fowler (1992:74) indicates that the Toedokado did likewise. Archaeological evidence of the consumption of shadscale seeds is rare but small quantities of *Atriplex* sp. seeds in Lovelock Cave coprolites (Roust 1967:57-60) and Stillwater Marsh sites (Budy 1988:349-350) could well be shadscale.

It should be noted that all saltbushes tolerate arid alkaline settings because of their deep taproots and C-4 metabolic pathways, which allow extraction of water from deep within surrounding alkaline soils. As a consequence, toxic levels of selenium can accumulate in the plant, thus limiting the suitability of shadscale as a food plant (Simms 1987:110; USDA Soil Conservation Service 1990).

Shadscale occurs in 31 of the 41 habitats of Toedokado territory, ranging in abundance from 4 to 141 kilograms of herbaceous growth per hectare annually. It is most abundant in Habitats 36 (141 kg/ha), 14 (106 kg/ha), 46 (101 kg/ha), 42 (78 kg/ha), and 10 (62 kg/ha). Figure 56 illustrates the projected spatial distribution of shadscale in Toedokado territory, showing dispersion in low to moderate densities, with high densities occurring only in small isolated pockets of northern Dixie Valley, Fairview Valley, and the Carson Desert.

Wada

Two varieties of wada appear in Toedokado territory: seepweed and desert blite. The ethnographic record for use of seepweed is the most extensive (Chamberlain 1911:383; Kelly 1932:98, Stewart 1941:428; Fowler 1989:47) its use is and best documented for the Toedokado (Fowler 1992:70). While ethnographic use of desert blight is much less well documented, Fowler (1992:70) confirms that it was a food of the Cattail Eaters. Raven and Elston (1989:110) suggest that the meager ethnographic record is a consequence of its confusion with seepweed. Small quantities of carbonized wada seeds were observed in archaeobotanical samples from Stillwater Marsh sites (Budy 1988:349-350).

Seepweed occurs as both annual and short-lived perennial, while desert blight is perennial (Dayton 1960:97). Wada thrives in poorly drained and alkaline mud flats adjacent wetlands (Fowler 1992:70). The salt tolerance of wada is such that it frequently occurs in pure stands on sediments where other shrubs cannot grow (Dayton 1960:97). Wada seeds are produced in summer, remaining on the plant until late fall (Raven and Elston 1989:110; Fowler 1990:70).

Wada occurs in twelve of the Toedokado territory habitats, in densities ranging from 5 to 41 kilograms per hectare. Densities are greatest in Habitats 28 (41 kg/ha), 4 (29 kg/ha), 6 (26 kg/ha), 5 (19 kg/ha), and 3 (20 kg/ha), all lowland riparian habitats. Wada is most widely distributed in the Carson River lowlands, but achieves maximum densities around Humboldt Salt Marsh in Dixie Valley (Figure 57). Fowler (1992:38) notes that ethnographic Toedokado collected seepweed along Old River north of Fallon, a location that corresponds well with areas of predicted high seepweed density in the Carson Desert.

No experimental data on the caloric returns of seepweed or desert blite are available. Raven and Elston (1989:110-111) note that Wada is a prolific producer of seeds that can occur in dense stands and should be harvested easily using a seedbeater. On the basis of on these observations, they suggest, and we concur, that wada should have a caloric return at least as high as that reported by Simms (1987:109-110) for shadscale.

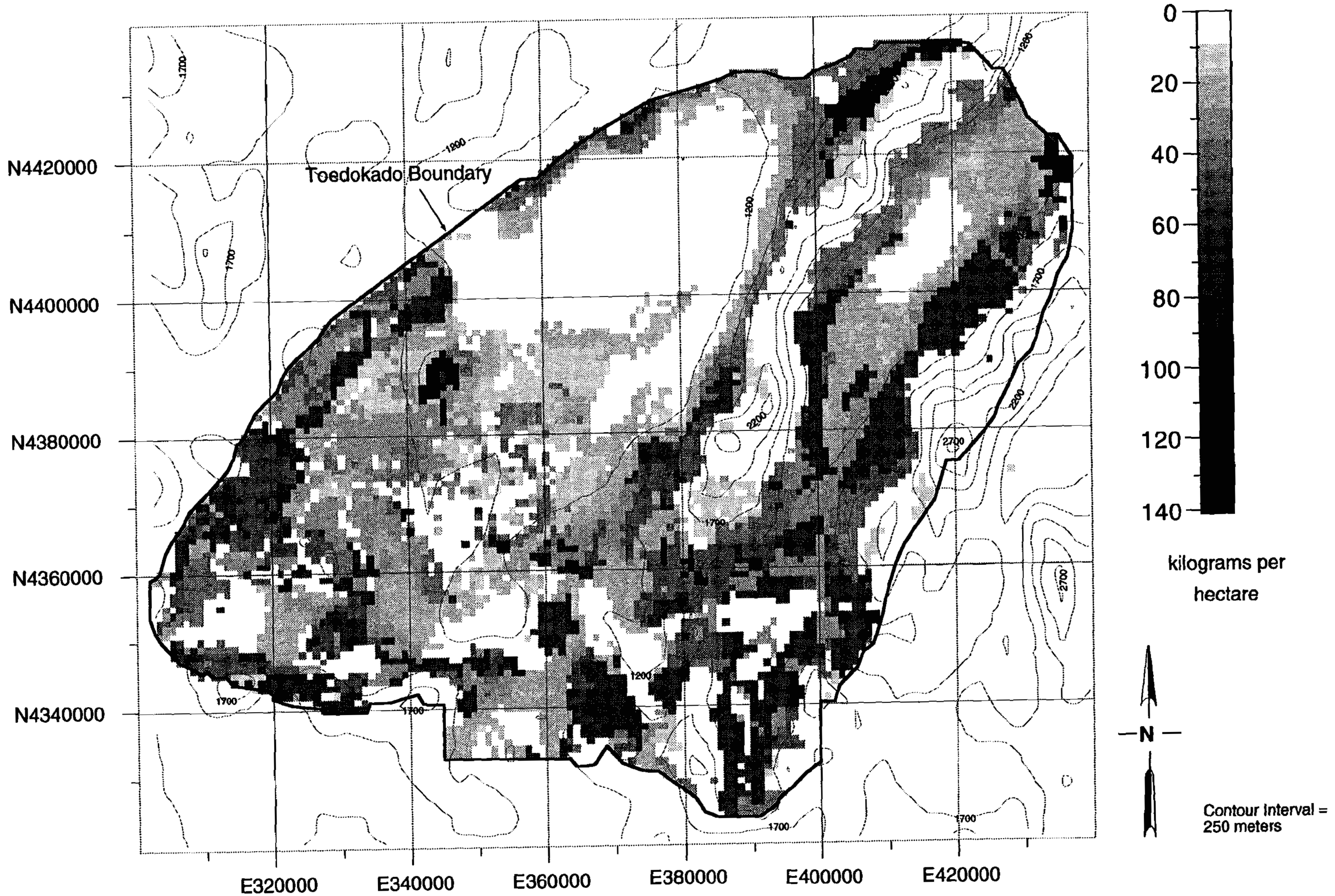

Figure 56. Normal year productivity of shadscale (kg/ha) in Toedokado territory.

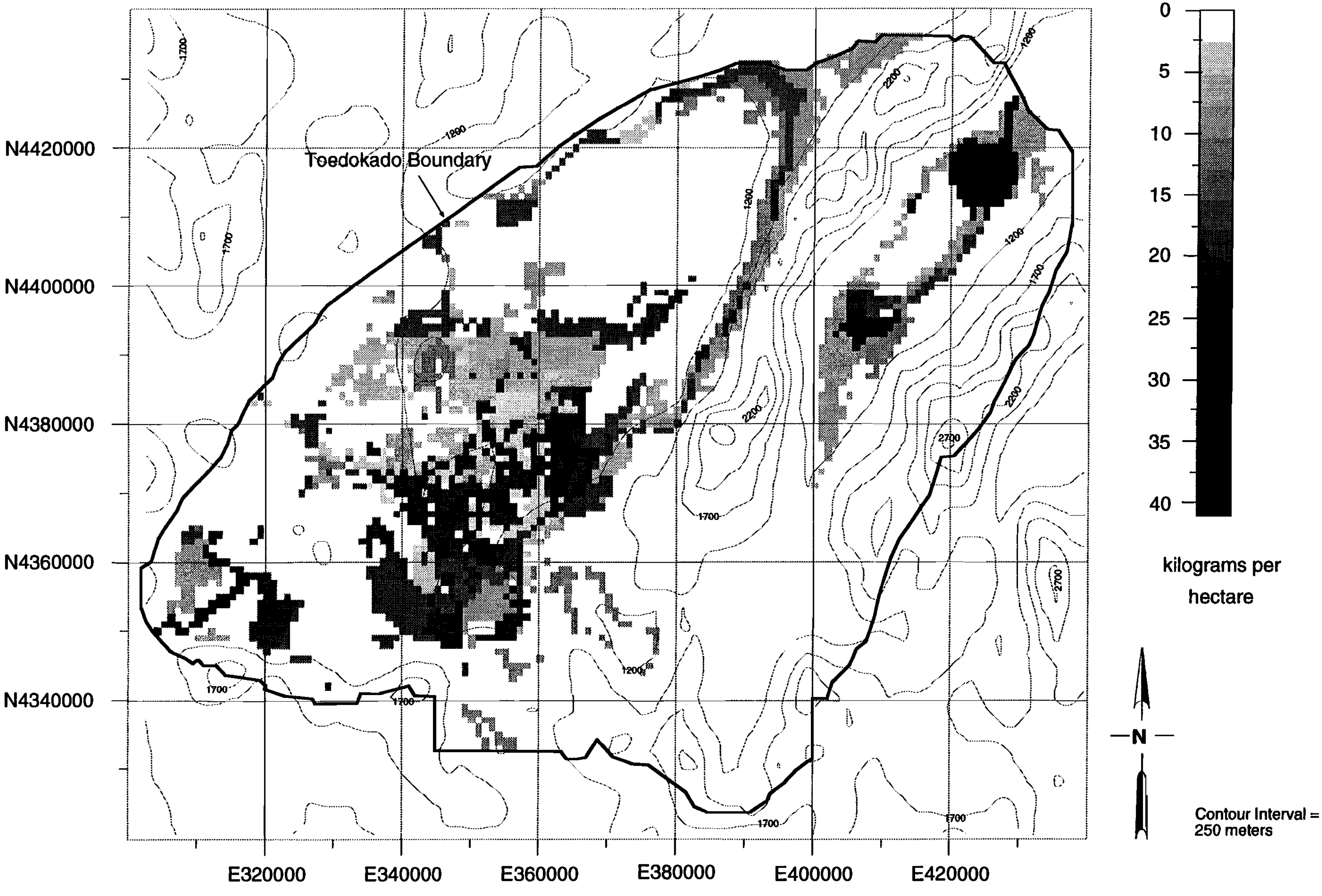

Figure 57. Normal year productivity of seepweed (kg/ha) in Toedokado territory.

Other Seed Producing Shrubs

Fowler (1990:21) notes the consumption of saltbush, four-wing saltbush, and iodine bush by the Toedokado. The seeds of these shrubs ripen quite late in autumn and into early winter. Most are somewhat spiny, collected best with seed beater and basket tray.

Four-wing saltbush begins its growth in late spring or early summer, maturing its seeds three to four months after flower formation (USDA Soil Conservation Service 1990). It prefers sandy soils, particularly those of dunes (Mozingo 1987:46), but adapts to a wide range of soil conditions (USDA Soil Conservation Service 1990). It thrives in moderately saline or alkaline conditions, sometimes occurring in pure stands in suitable settings (USDA Forest Service 1988:608). It appears in 21 of the Toedokado territory habitats, in densities ranging from 1 to 76 kilograms of annual growth per hectare. It is most abundant in Habitats 16 (76 kg/ha), 20 (63 kg/ha), 15 (63 kg/ha), 11 (39 kg/ha) and 7 (27 kg/ha). High density patches occur in Fairview Valley, around the Cocoon and Desert Mountains, and around the southern margins of the Carson Sink (Figure 58).

Chamberlain (1911:52) and Steward (1933:244) report that Gosiute and Owens Valley Paiute used four-wing saltbush as food, although Steward (1938:22) suggests that it probably was not a frequently used food. Fowler (1992:74) lists the seeds of four-wing saltbush as a comestable of the Toedokado, but gives no details. No experimental data are available on the energetic costs and benefits of its use, but Raven and Elston (1989:114) suggest that it should yield returns no greater than those of shadscale.

There is no ethnographic record of the use of Torrey quailbush as a food resource, but Raven and Elston (1989:114) suggest that ethnological observers may have confused Torrey quailbush with other examples of *Atriplex*. It is possible that Fowler (1992:75-76) refers to Torrey quailbush (*Atriplex torreyi*) when she reports use of saltbush (*Atriplex argenta*) by Cattail Eater Paiute. Torrey quailbush grows in heavily saline or alkaline soils with high subsurface water tables (Mozingo 1987:60) and commonly grows with big greasewood (Billings 1945:13). It is particularly common on coarse textured saline mounds common to the margins of abiotic playas (Blank et al. 1992:196). Densities of Torrey quailbush range from 4 to 227 kilograms per hectare in ten Toedokado territory habitats. Unquestionably, it is most prolific in Habitat 29 (227 kg/ha), followed distantly by Habitat 28 (41 kg/ha). It occurs as a minor plant in the Carson River lowlands, but is a dominant shrub around the margins of Humboldt Salt Marsh in Dixie Valley (Figure 59). No data are available on the economics of Torrey quailbush, but Raven and Elston (1989:114-115) suggest that its returns probably are equivalent to those of shadscale.

Iodine bush grows in extremely alkaline or saline, seasonally or intermittently flooded playa clays (Mozingo 1987:43; Hamilton and Auble 1993:15), commonly in saltgrass meadows and alkali flats surrounding wetlands in the Carson Dessert (Fowler 1992:70; Hamilton and Auble 1993:11). It also is common on coarse textured coppice mounds on playa margins, and its establishment as a wind barrier on playa surfaces may lead directly to the formation of such mounds (Blank et al. 1992:196). Iodine bush occurs in only ten habitats of Toedokado territory, in densities ranging from 4 to 12 kilograms per hectare. It is most abundant in Habitats 3 and 38, bearing 11 to 12 kilograms per hectare each. Despite its low densities, it is fairly widespread, occurring throughout the Carson River lowlands and along the margins of Carson Sink and Humboldt Salt Marsh (Figure 60).

Iodine bush seldom is mentioned as a food resource in the Great Basin (Chamberlain 1911:55; Stewart 1941:375); however, Fowler (1992:69,70) suggests that the Toedokado may have collected it because it produces a storable seed late in the fall. Archaeological evidence for its use is absent from Lovelock Cave (Napton and Heizer 1970) and Stillwater Marsh sites (Budy 1988:351), but it was observed in coprolites from Danger and Hogup Caves of the eastern Great Basin (Fry 1970).

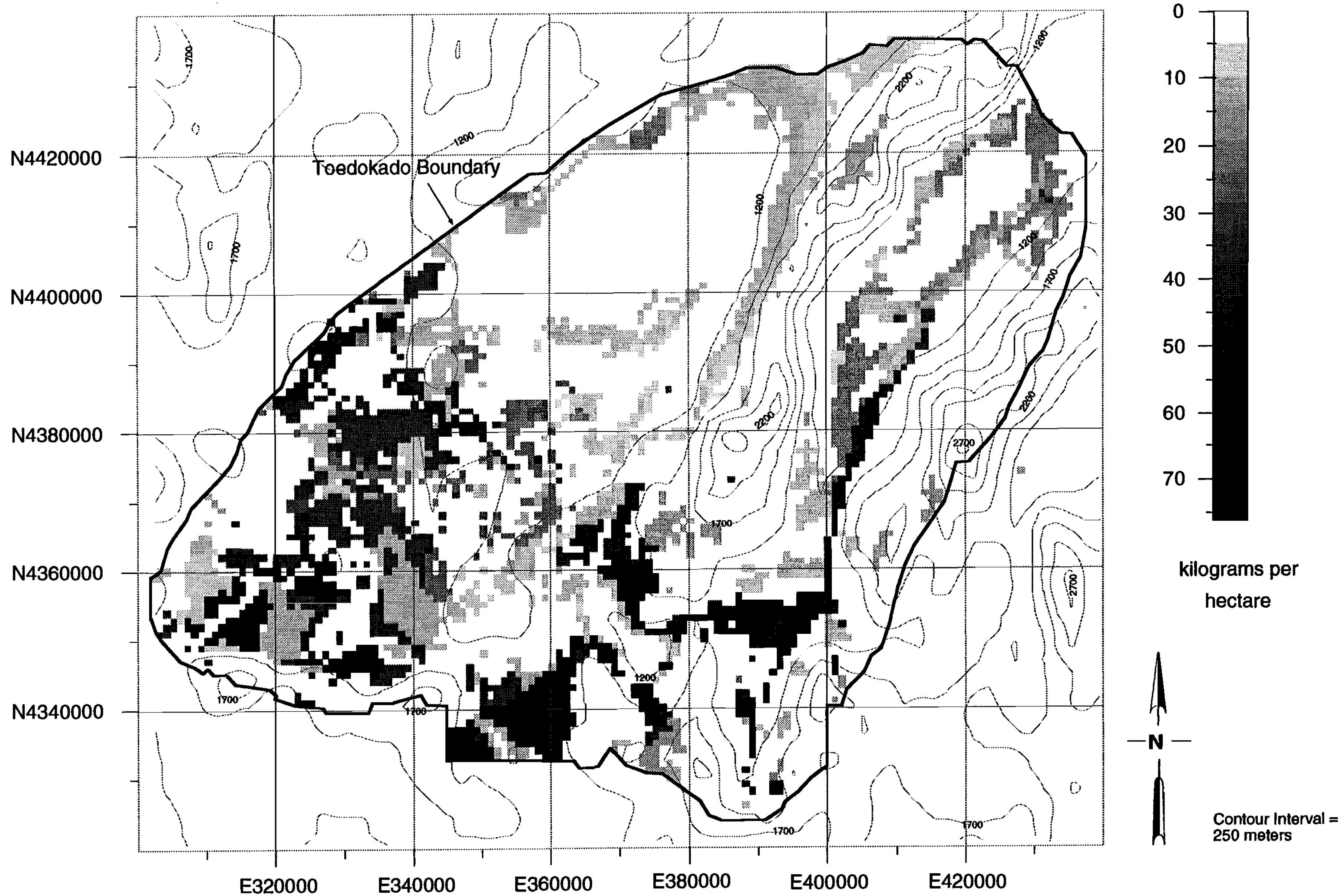

Figure 58. Normal year productivity of four-wing saltbush (kg/ha) in Toedokado territory.

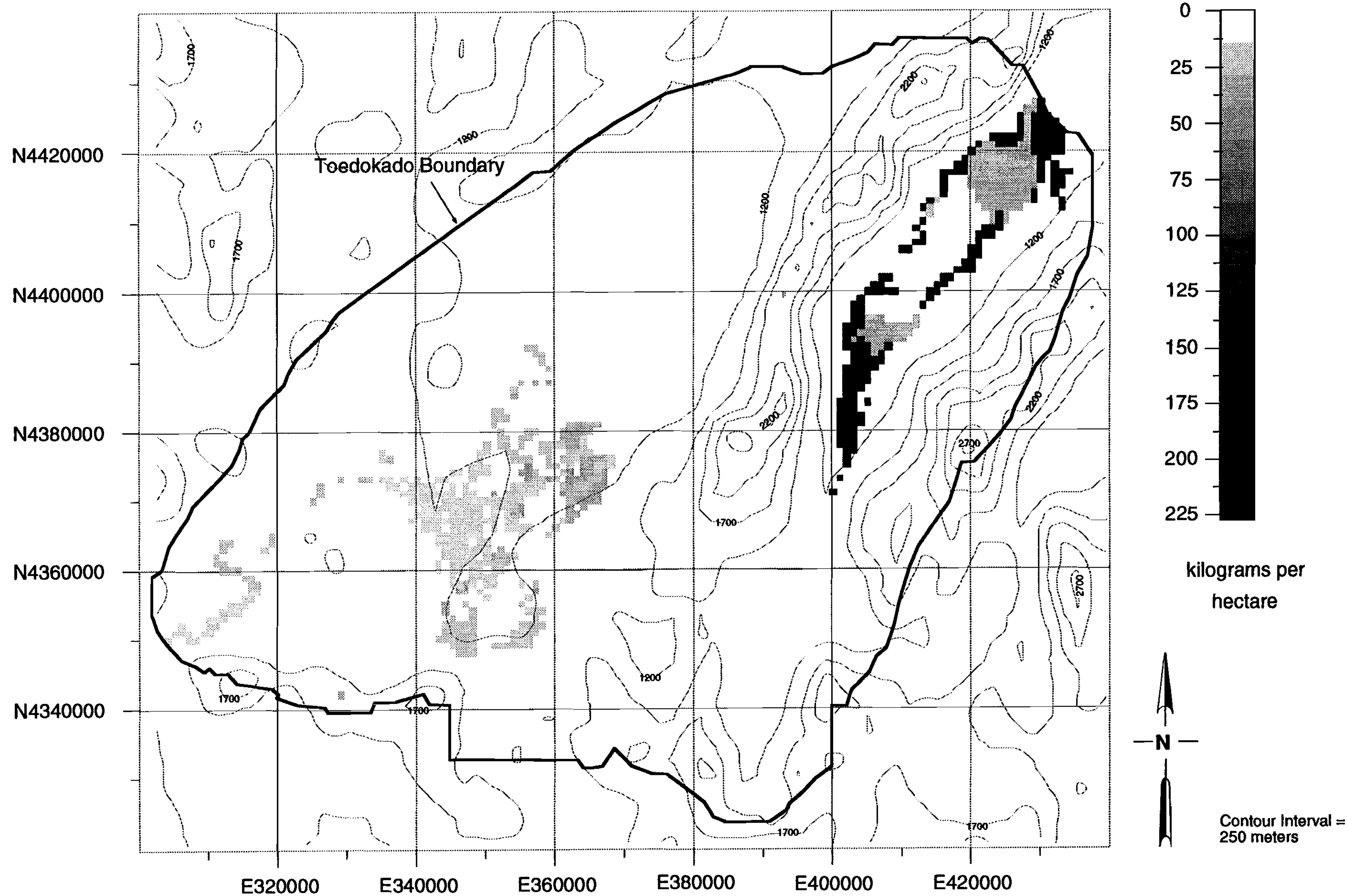

Figure 59. Normal year productivity of Torrey quailbush (kg/ha) in Toedokado territory.

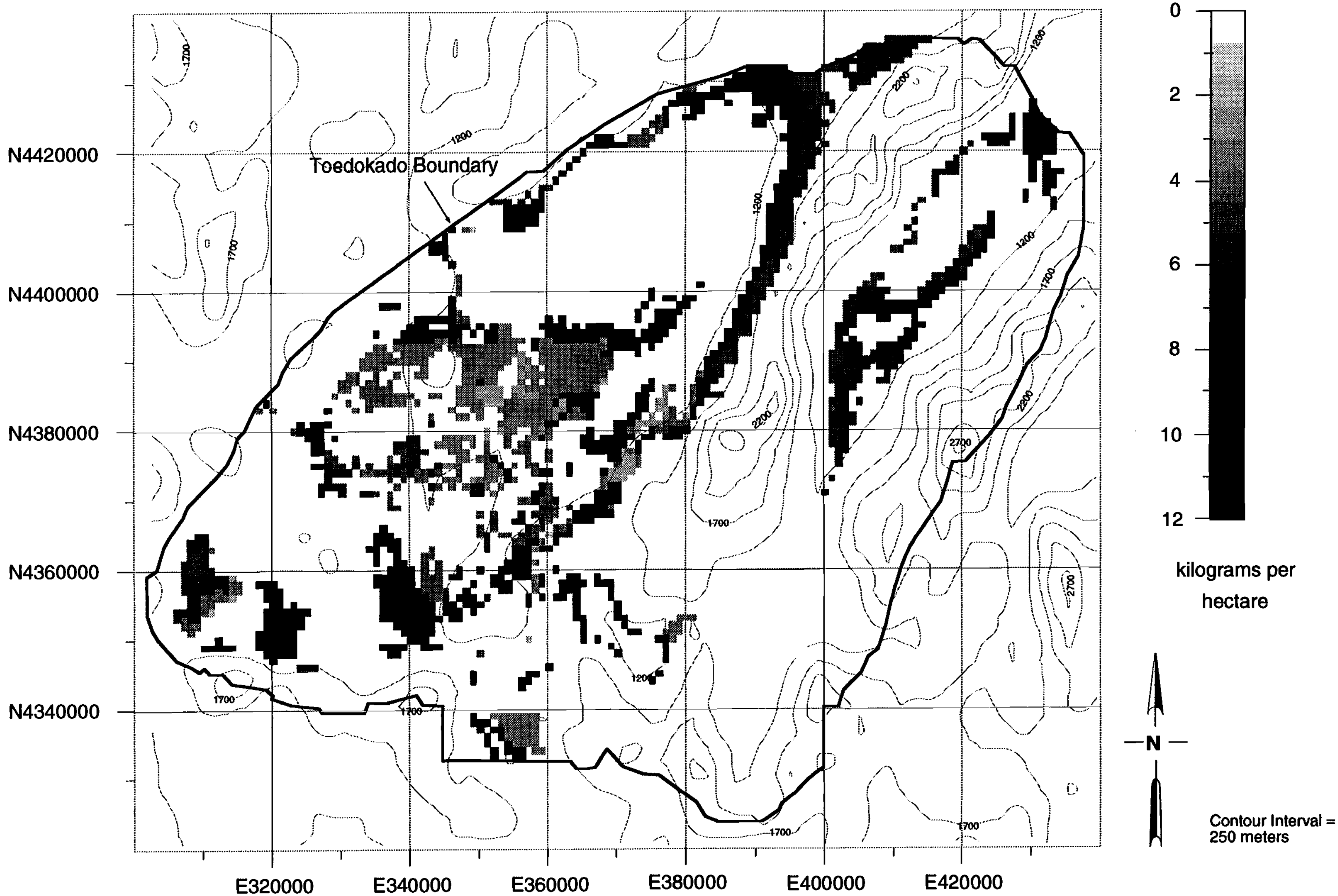

Figure 60. Normal year productivity of iodine bush (kg/ha) in Toedokado territory.

Simms (1987:108-109) found that iodine bush provided particularly low return rates of between 90 and 150 calories per hour because of its small seeds and difficulty in processing, although Barlow and Metcalfe (1994) achieved returns as high as 275 calories per hour. Consequently, we take 90 to 280 calories per hour for a best estimate of the caloric return of iodine bush procurement.

Fruit Producing Shrubs

Shrubs that produce fruits or berries in the study area include wild rose, serviceberry, elderberry, currant, chokecherry, silver buffaloberry, and wolfberry. The Toedokado gathered most of these in late spring and summer (Wheat 1967:10-11; Fowler 1992:83).

Most berry shrubs are most common near springs or in drainages. Wild rose prefers well-watered habitats near seeps, springs, and streams (Mozingo 1987:183; USDA Forest Service Forest Service 1988:768-770). It occurs, in densities of 18 to 39 kilograms per hectare, in only five habitats in the study area: 51 (39 kg/ha), 1 (31 kg/ha), 6 (26 kg/ha), 5 (19 kg/ha), and 53 (18 kg/ha), habitat preferences strongly associated with spring, marsh and riparian water sources. Wild rose is most abundant in the Carson River Lowlands, Indian Lakes, Stillwater Marsh, Carson Lake, and Dixie Valley Hot Springs (Figure 61).

Fowler suggests that use of the fruit of wild rose was widespread in the ethnographic Great Basin (Fowler 1986:78), and has documented its use by Cattail Eater Paiute (1992:75). The latter harvested rose hips early in autumn and frequently dried them for use as a seasoning. Fowler mentions that although wild rose was present in upland canyons, it was most abundant in lowland stream-side areas of the Carson River.

Silver buffaloberry is distributed similarly, preferring well-watered locations that are not too saline (Mozingo 1987:195-197; USDA Forest Service 1988:694). It occurs only in Habitats 6 (53 kg/ha), 5 (38 kg/ha), 4 (29 kg/ha), and 28 (21 kg/ha), all lowland riparian habitats. It is most abundant in the Carson River lowlands, but can be found on playa margins in Dixie Valley (Figure 62). Fowler (1992:75) notes that buffaloberry currently is rare in the study area but previously was most common around Stillwater Slough and the tributaries of Carson River. However, she also notes that buffaloberry was common in perennial stream canyons of the Stillwater range (1992:39, 83), locations not reflected in the Toedokado model. Buffaloberry, used as a food throughout the Great Basin (Chamberlain 1911:75, Kelly 1932:100, Steward 193829-30), was collected by the Cattail Eaters in July.

Wolfberry or desert thorn prefers well drained, gravelly soils of alluvial fans and lower piedmont slopes (Mozingo 1987:229). Fowler (1989:50, 1992:75) notes that wolfberries ripen in June or July, but that the plants produce berries only once every three or four years. Wolfberry is present in low densities (2 to 12 kg per hectare) in 16 habitats. It is most common in Habitats 14 (12 kg/ha), 10 (8 kg/ha), 21 (8 kg ha), 26 (6 kg/ha), and 7 (5 kg/ha). Figure 63 shows that despite low densities it is widespread throughout the lowlands of the Carson Desert, Fairview Valley, and Dixie Valley. Fowler indicates that ethnographic Toedokado found wolfberry abundant "south and east of Stillwater Marsh, including the low foothills of the Stillwater range" (Fowler 1992:75). Wheat's (1967:10) account of desert thorn procurement suggests that the berries were distributed widely but sparsely, requiring considerable mobility to exploit. Both assessments accord well with the distributions illustrated in Figure 63.

Serviceberry thrives in a diversity of habitats ranging from open, dry, rocky slopes to deep, moist soils in coniferous woodlands (USDA Forest Service 1988:587-588). Despite its versatility in the Intermountain West, it occurs, in low densities, in only two habitats of Toedokado territory: 34 (14 kg/ha) and 47 (12 kg/ha). These habitats are most widespread in the Stillwater and Clan Alpine

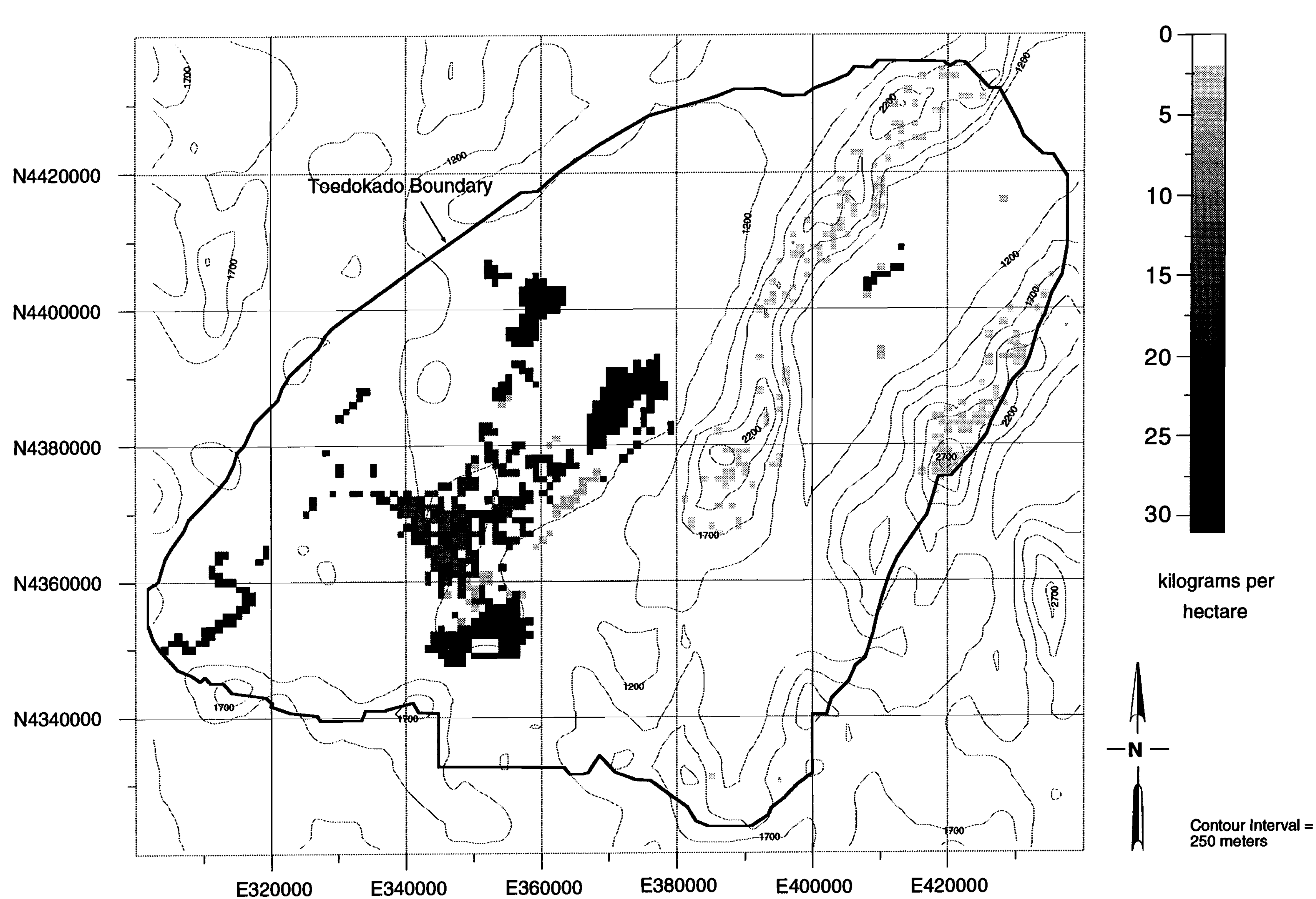

Figure 61. Normal year productivity of wild rose (kg/ha) in Toedokado territory.

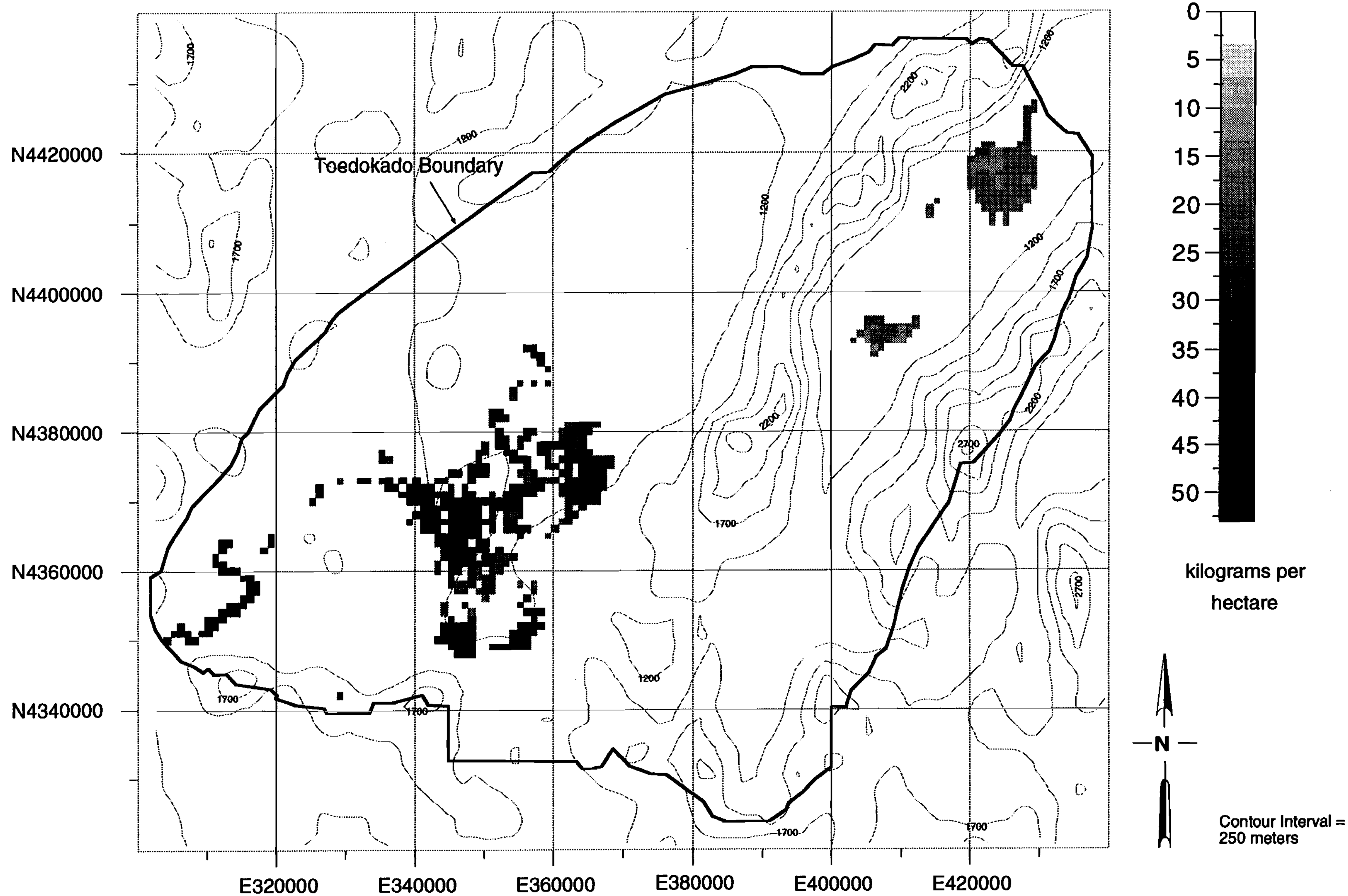

Figure 62. Normal year productivity of silver buffaloberry (kg/ha) in Toedokado territory.

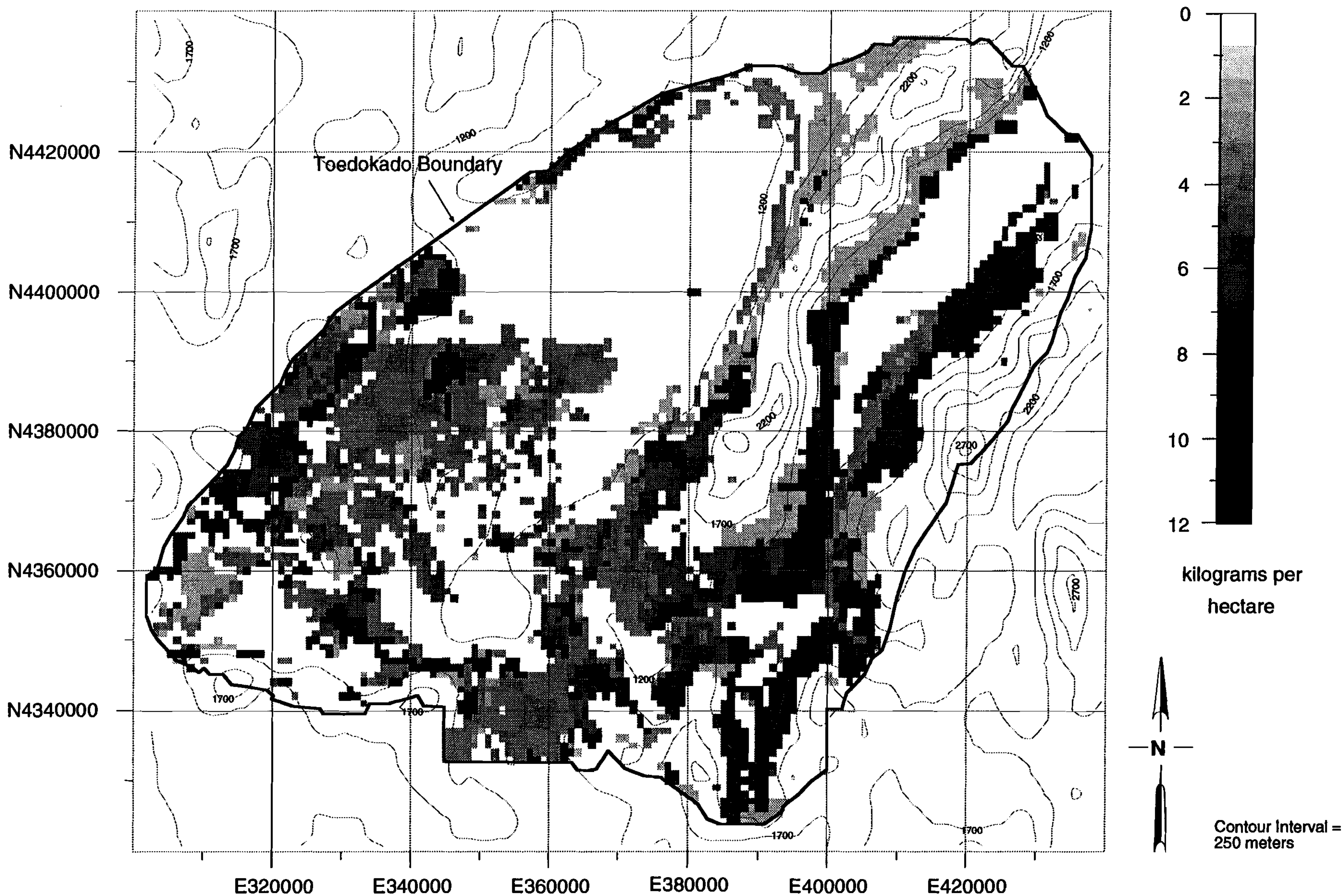

Figure 63. Normal year productivity of wolfberry (kg/ha) in Toedokado territory.

Mountains, with an isolated patch in the Fairview Mountains. Serviceberry flowers in May or June and it berries mature rapidly, by late June (Mozingo 1987:148).

Currant prefers dry, open mountain slopes and the margins of well watered upland watercourses (Mozingo 1987:136). However, in Toedokado territory currant only occurs in Habitat Type 47 (6 kg/ha) and Habitat Type 34 (4 kg/ha). Fowler (1992:82) records chokecherry as a food of Toedokado, but none is recorded in the Carson Desert Habitat model. Anderson peachbrush or desert peach (*Prunus andersonii*), a potential food source, occurs in Habitats 47 (12 kg/ha) and 51 (20 kg/ha), on the lower dry slopes of alluvial fans and mountain piedmonts (Mozingo 1987:169).

Winterhalder (1982:83) found that the Cree of Ontario, Canada, procured 650 calories per hour from blueberry harvest. Absent similar data for berries of the Great Basin, we tentatively accept this as an estimate of the returns obtainable.

Wetland Plant Resources

Wetland plants, most of which are perennial grass-like plants or forbs can be obtained with little effort. These resources are identified easily on the landscape, and typically are readily available in relatively dense patches. Potential wetland plant resources include cattail, bulrush, spikerush, water plantain, sego pondweed and chufa fatsedge.

Cattail

Cattail is a perennial plant with thick underground rootstalks. Two species prevail in the marshes of the Carson Desert: common cattail and southern cattail; narrowleaf cattail may be present as well (Fowler 1992:64, 215). Cattail thrives in lower salinity emergent marsh habitats (Hamilton and Auble 1993:4, 11, 15). New growth begins early in spring and, by early July, abundant pollen forms on the heads of spikes. Seeds mature in late fall. Although roots are present year-round, they achieve highest carbohydrate and nutrient content in late summer and autumn (Sojda and Solberg 1993:4). Experimental harvest of cattail roots in winter indicate that they are depleted of usable starch and therefore unavailable for consumption in that season (Steve Simms, personal communication, January 1995).

As the name "Cattail Eaters" implies, the use of cattail pollen, seed, stalk, and root as food by ethnographic Toedokado is well documented, as is its use as a building material (Fowler 1992:64-66; Wheat 1967:13-16). The Toedokado collected stalks, spikes, and roots in early spring, harvested pollen in early July, and gathered seeds and roots in late autumn. Cattail seeds were common in coprolites from Lovelock Cave (Napton and Heizer 1970:14-118) and in archaeobotanical samples from sites in Stillwater Marsh (Budy 1988:349-350).

Simms' (1987:133) experiments found that harvesting cattail pollen could yield between 2750 and 9390 calorie per hour, making it the highest ranked plant resource that he tested. Simms advises that processing costs are negligible because cattail pollen is edible right off the stalk, although ethnographic evidence indicates that pollen was boiled or shaped into cakes and baked in leaves. Simms also conducted experimental harvests of cattail roots, finding them considerably less profitable at yields of 130 to 270 calories per hour. Seventeen harvest experiments of cattail roots by Jones and Madsen (1991:71-72) produced similar low returns ranging from 40 to 260 calories per hour. Cattail produces as many as 250,000 seeds on one spike (Sojda and Solberg 1993). Neither nutritional information nor return rate values are available for cattail seeds which, according to Wheat (1967:12), were especially useful as a nutritious light-pack food item for traveling. Cattail seed remains on the stalk and so could be harvested as late as early winter (Wheat 1967:15). Raven and Elston (1989:120, 137) estimate that caloric returns for cattail seeds should fall below 300 calories per hour because of the size of seed and the intensive preparation required as indicated in ethnographic accounts.

Cattail occurs in only two habitats of the Toedokado model: marsh (Habitat 1) and marsh edge (Habitat 53). It exhibits annual growth of 879 kilograms per hectare for marshes and 424 kilograms per hectare for marsh edges. Figure 64 illustrates the projected distribution of cattail. Not surprisingly, it is most widespread in Stillwater Marsh, Indian Lakes, Carson Lake, and Humboldt Salt Marsh. However, the extent of this distribution should shift radically in response to irregular inundation. For example, Fowler (1992:45) notes that the acreage of cattail stands in Stillwater Marsh expanded from 1300 acres in 1900 to about 3800 acres in 1952, in response to declining water levels.

Bulrush

Two economically important varieties of bulrush occur in the study area, alkali bulrush or nutgrass and hardstem bulrush. Bulrush occurs only in Habitats 1 (408 kg/ha) and 53 (247 kg/ha), as illustrated in Figure 65. As can be seen, its distribution is similar to that of cattail, occurring in abundance in Stillwater Marsh, Indian Lakes, Carson Lake, and Humboldt Salt Marsh. Only alkali bulrush appears in the range type data used to generate the distribution, but we assume that hardstem bulrush also is represented. Minor variation in the distributions of alkali and hardstem bulrush should occur within these habitats. Alkali bulrush thrives in shallower, higher salinity emergent marshes while hardstem bulrush is more prevalent in deeper water emergent marshes that are less saline (Hamilton and Auble 1993:4, 11, 15).

Like other marsh plants, this distribution should be highly vulnerable to irregular inundation. Fowler (1992:45) notes ethnographic evidence that stands of bulrush were 50 to 100 percent more extensive in Stillwater Marsh in 1900 than they were in 1952 because of declining water levels. Hardstem bulrush stands covered 1600 acres in 1900, but only 800 acres in 1952. Stands of alkali bulrush were affected less severely because of their preference for shallower, more saline water. Its acreage declined from 1900 acres in 1900 to 1200 acres in 1952.

Bulrush seeds were ubiquitous in human coprolites recovered from Lovelock, Humboldt, Hidden, and Granite Point Caves (Heizer 1967:6; Napton and Heizer 1970:108), and bulrush quids were numerous in Lovelock Cave. Too, carbonized specimens of bulrush seed were common in Stillwater Marsh sites (Budy 1988:346-356). Ethnographic Cattail Eaters collected bulrush seeds in fall and early winter, stems in spring, and tubers in autumn (Wheat 1967:15, Fowler 1989, 1992). Fowler (1992:67) and Wheat (1967:15) note a unique harvesting technique for alkali bulrush. As seed heads opened and seeds fell into the water, women rafted out to their locations and strained wind-sorted seed aggregate into winnowing baskets; seeds then were dried and stored for later grinding.

Simms (1987:128) notes that bulrush seeds usually are available for harvest through most of summer and autumn by hand stripping seeds or cutting seed heads from stems. Paiute bands are known to have harvested bulrush seeds by the cutting technique (Fowler 1989:48). Although probably less productive than the technique described by ethnographers among the Toedokado, their long window of availability would have permitted their harvest at times when scheduling conflicts with more profitable resources did not occur (Raven and Elston 1989:121).

Stands of alkali bulrush in southern Oregon produced 459 to 918 kilograms per hectare of seed (O'Neil 1972:652). Simms (1987:126-128) found that the seeds of *Scirpus paludosus*, a bulrush variant,

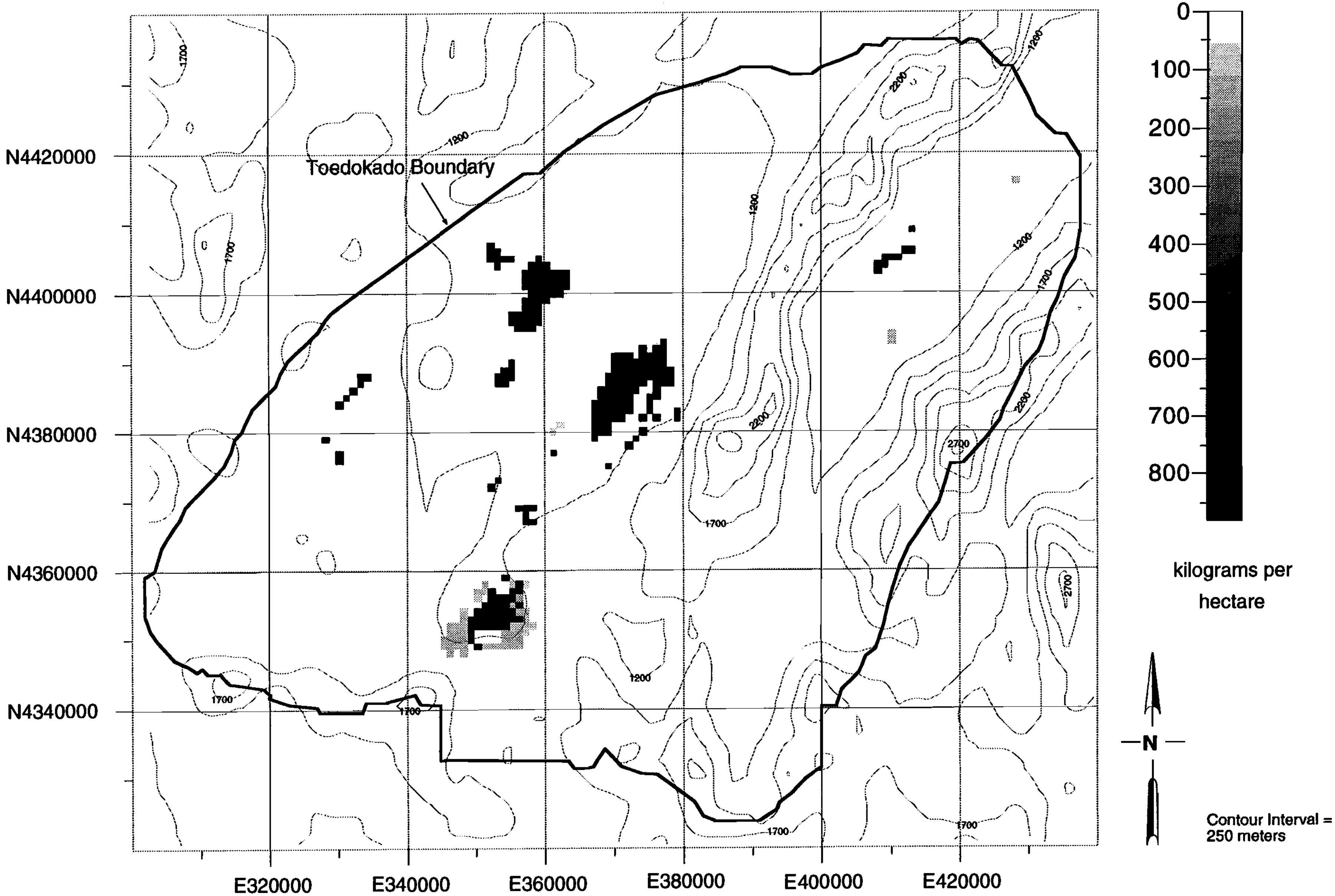

Figure 64. Normal year productivity of cattail (kg/ha) in Toedokado territory.

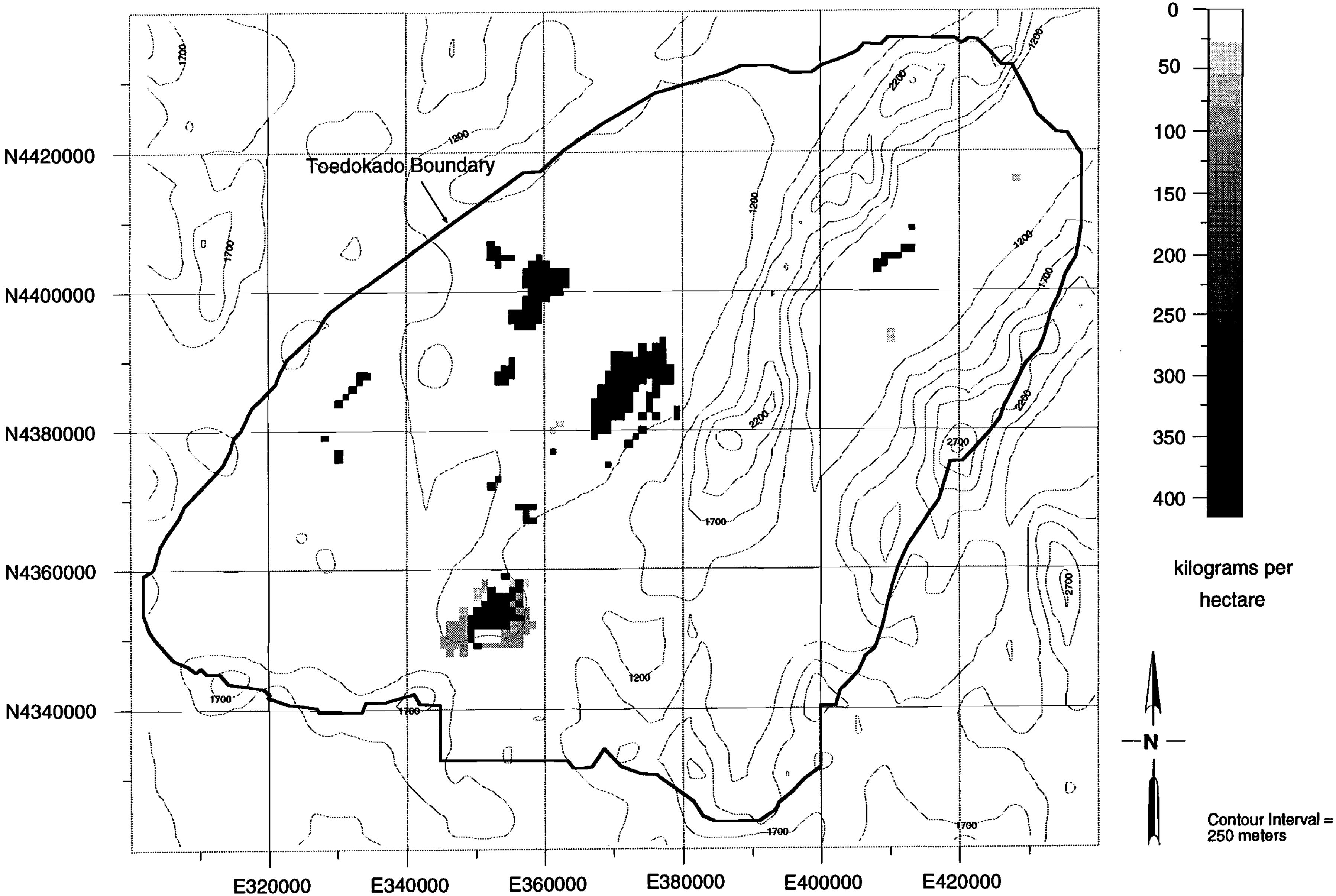

Figure 65. Normal year productivity of bulrush (kg/ha) in Toedokado territory.

returned approximately 470 calories per hour of handling time, whereas those of hardstem bulrush returned about 1700 calories per hour. This range apparently reflects variability in seed size and time of harvest (Steve Simms, personal communication, January 1995). The roots of bulrush yielded only 160 to 260 calories per hour of handling time.

Other Marsh Plants

Other edible marsh plants available in Toedokado territory are spikerush, water plantain, sego pondweed, wapato, sedge, chufa fatsedge, and dock.

Although not true grasses, sedges are grass-like plants whose seeds mature in late summer (USDA Forest Service 1988:107). Sedges occur over a wide range of elevations, soils, and topographic locations but generally prefer moist conditions. Sedge occurs in nine habitats in Toedokado territory in densities ranging from 5 to 336 kilograms per hectare. It is most prolific in Habitats 55 (336 kg/ha), 51 (255 kg/ha), 1 (251 kg/ha), 53 (124 kg/ha), and 6 (105 kg/ha). The ethnographic record for use of sedge as food is meager; Fowler (1986:73) records only the Kawaiisu as having eaten it. Sedge produced low energetic returns of about 200 calories per hour in Simms's (1987:111) harvesting experiments.

Chufa fatsedge is not calculated individually in the Toedokado model but should exhibit a distribution similar to Carex. The tubers of chufa fatsedge were consumed by Cattail Eaters (Fowler 1992:69) and dock seeds were collected from moist alkali flats along the periphery of Stillwater Marsh (Fowler 1992:69). Dock appears in Habitats 4, 5, 6, and 28 in Toedokado territory, in densities between 19 and 43 kilograms per hectare.

Spikerush, water plantain, and sago pondweed are perennial forbs that occur in low to moderately saline submergent and deeper emergent marsh habitats (Hamilton and Auble 1993:4, 11, 14). Consequently, they are exclusive to marsh Habitats 1 and 53. Spikerush is most abundant, occurring in densities of 628 kilograms per hectare in Habitat 1 and 318 kilograms per hectare in Habitat 53. The remaining species occur in quantities of 94 kilograms per hectare each in Habitat 1, 53 kilograms per hectare in Habitat 53, and 20 kilograms per hectare in Habitat 51.

Sago pondweed is favored by waterfowl, and the Toedokado collected its corms by observing and wading to the feeding locations of the birds (Fowler 1992:68). Small quantities of carbonized sago pondweed seeds were present at habitation sites in Stillwater Marsh (Budy 1988:349, 354). Owens Valley Paiute may have used the seeds of spikerush (Steward 1933:245), but other Northern Paiute claim to have used only its sap to make a beverage (Fowler 1989:49, 1992:68). The Cattail Eaters sieved the seeds of water plantain from open water (Fowler 1992:69).

No data are available on the energetic returns of harvesting any of these plants, with the exception of sedge. Raven and Elston (1989:122) estimated the return for spikerush at less than 300 calories per hour, based on comparison with the returns of sedge. We also make this assumption and expand it to the remaining marsh resources.

Pinyon

Ethnographic use of pinyon nuts by the Toedokado (Fowler 1992:83-84) and by neighboring Paiute bands (Fowler 1989:50-52) is well documented. Wheat's (1967:29-39) description of pinyon procurement and processing techniques employed by the Cattail Eaters is one of the most detailed in the Great Basin ethnographic literature. Fowler (1992:83) suggests that pinenuts were the most important food produced by the uplands, noting that productive pinyon harvests might prompt the Toedokado to overwinter in the pinyon zone (but see also Wheat 1967:15; Thomas 1985:157; and Raven and Elston 1989:157). Yet, despite the extensive ethnographic record for pinyon utilization, archaeological evidence for prehistoric pinyon use in Toedokado territory is meager; one pinyon hull was identified in a coprolite from Hidden Cave (Roust 1967:68). Whether the paucity of archaeological evidence is due to sampling bias, temporal subsistence variability, or paleoenvironmental change remains unclear and controversial (Raven and Elston 1991:49, 80).

Single-leaf pinyon is a coniferous, evergreen tree that is unique among pines for its one-needle leaf (Lanner 1981:3-4; 1983:30). It is widely distributed in montane habitats across the Great Basin (Beeson 1974:3-8). In the Stillwater and Clan Alpine Mountains it grows at elevations between 1830 and 2900 meters (6004 to 9515 ft amsl) above sea level (USDA Soil Conservation Service 1992): its lower limit is defined by its need for more than 25 cm per year of precipitation (Beeson 1974:10). Pinyon grows in a range of topographic positions and soil conditions (Beeson 1974:6-9); in the Stillwater and Clan Alpine Mountains, on mountain sideslopes ranging from 30 to 50 percent gradient (USDA Soil Conservation Service 1992).

Pinyon "nuts" are actually large, cone-borne seeds (Lanner 1981:50). Pinyon cones develop over a twenty-six month period spanning three growing seasons (Lanner 1981:77). However, the size of a pinyon crop is yearly erratic with large and small crops alternating on one to two year intervals. For example, Lanner (1983) inventoried a 1/5 acre study plot in Raft River Mountains of northwestern Utah for five years. In two of those years the crop exceeded 2000 cones per acre. In another two only 500 to 800 cones per acre were produced, and one year saw no cone production in the study plot.

Pinyon cones mature in late summer and early autumn. After the first frost, the cones open and release their nuts, which are sought by a variety of small mammals and birds that usually collect the crop within a few weeks (Lanner 1981:52, 78).

In the Toedokado territory, mature pinyon occurs only in Habitat 34, although saplings may also occur in Habitat 47. Pinyon sapling growth is estimated at 25 kilograms per hectare for Habitat 34 and 6 kilograms per hectare for Habitat 47. Tree density in mature woodlands of Habitat 34 range from twelve to twenty trees per hectare. Pinenut production in Toedokado territory range from 130 to 450 kilograms per hectare in favorable years (USDA Soil Conservation Service 1992). Pine nut production is restricted to woodlands in Habitat 34.

Figure 66 shows the distribution of pinyon as projected from yearly understory growth. The map indicates that most extensive pinyon patches occur in the Stillwater and Clan Alpine Mountains, while a small patch occurs in the Fairview Mountains. Fowler (1992:39-40) records that ethnographic Toedokado collected pinyon near Jobs Peak and Silver Hill in the Stillwater Mountains and in the southern portion of the Clan Alpine Mountains, corresponding fairly well to the projected pinyon distribution of Figure 66. Notably, Fowler (1992:83) also suggests that pinyon woodlands were more extensive in the Stillwater Mountains before they were lumbered for fence posts and firewood in the modern period.

Because of the prominent role that pinyon played in many ethnographic Great Basin subsistence-settlement patterns (Steward 1938:27-28, 233), more intensive economic analyses have been conducted on pinyon than other Great Basin plants. Pinenuts are rich in carbohydrates but low in protein and fat (Farris 1980). Simms's (1987) experimental tests for harvesting pinyon nuts returned 840 to 1410 calories per hour of handling time. Repeated experiments by Barlow and Metcalfe (1994) produced returns between 1000 and 1700 calories per hour. Thus, pinyon is a relatively high ranked plant food in the Great Basin.

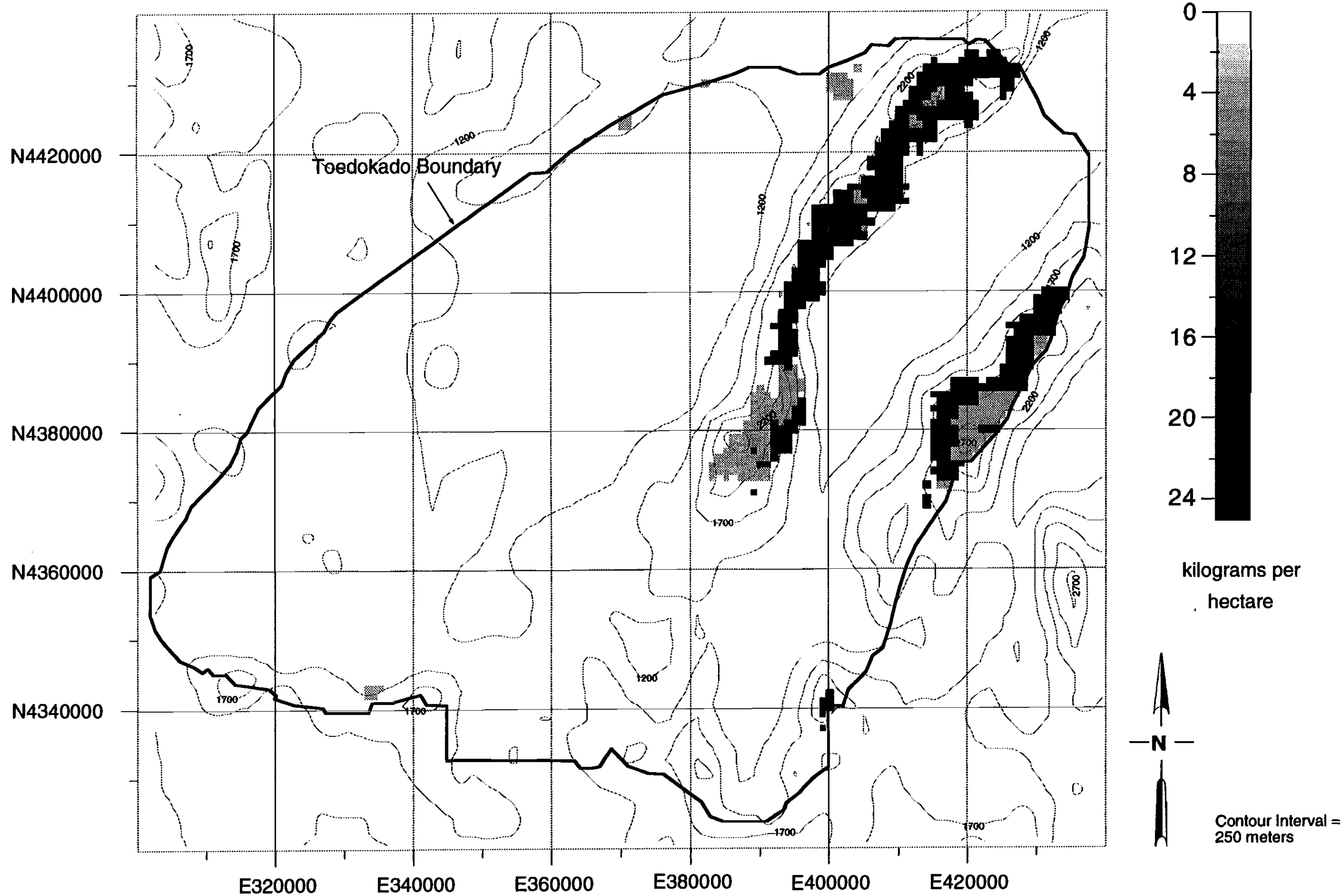

Figure 66. Normal year productivity of pinyon (kg/ha) in Toedokado territory.

Hunter-gatherers who monitored cone development should have been able to predict the size and location of pinyon crops as much as 18 months before the harvest date (Thomas 1983:62), irregular seed production notwithstanding. Such predictability allowed Great Basin hunter-gatherers to plan the logistics of their intensive procurement exercises. Ethnographic accounts consistently indicate that a family of Great Basin hunter-gatherers could procure between 540 and 680 kilograms of unhulled pinyon nuts in a good year (Steward 1938:27; Price 1967:62; Cook 1941:54; Voegelin 1938:20), a winter food supply sufficient to last at least four months (Steward 1938:27). However, pinyon harvests could net a family as little as 45 kilograms in a poor year and 270 kilograms in a normal year (Cook 1941:54). The overall size of the pinyon crop probably determines the lower end of these harvest estimates (Cook 1941:54). Since nut production can achieve 450 kilograms per hectare in the Stillwater Mountains in a good year, hunter-gatherers should be able to exceed a 680 kilogram pinyon harvest simply by collecting nuts from more than 1.5 hectares.

The maximum size of a pinyon harvest probably reflects constraints on the time available for gathering the nuts. For example, the prime pinyon collection time is limited to a two to four week window by competition with birds and other animals, and by the tendency for uncollected nuts to rot quickly after release from the cones (Lanner 1981:50-51). This suggests that 540-680 kilograms represents the outside limit of nuts that can be collected in the available time, an assessment that accords with estimates of the handling time necessary to harvest and process pinyon (Simms 1987:123). Great Basin hunter-gatherers may have been able to exceed this limit by knocking immature green cones from trees and roasting them to release the seeds. However, the extra handling costs associated with "green cone procurement" have yet to be determined (Bettinger and Baumhoff 1983; Simms 1987).

Animals

A predictive model of hunter-gatherer foraging decisions based on optimal foraging theory must consider animal resources, simply because most edible mammals, birds, invertebrates, and fish offer higher foraging returns than do most plants (Simms 1987; Layton et al. 1991:256; cf. Chapter 5, this report). Thus, fauna must be included in the Toedokado territory model. While soil and range data offer no direct mechanism for modeling the spatial distribution or abundance of fauna, they do permit observation of the distributions of many forage plants of those fauna. Too, variability in water and soil structures wildlife habitat as well as plant habitat (Cooperrider et al. 1986). Therefore, we can use the Carson Desert habitat model to assess the suitability of plant habitat types for animal habitat based on the production of forage and on physiographic requirements of particular game animals. However, such data cannot permit direct estimation of species abundance. For purposes of the present exercise, estimates of animal resource abundance and productivity must be derived from the literature of ethnography, history, and wildlife biology. The following discussions review this literature and discuss the habitat suitability for selected game species.

Large Mammals

Three classes of large mammal are potentially important food sources of the ethnographic Toedokado (Fowler 1992:87): pronghorn antelope, mule deer, and bighorn sheep. Ethnographic sources also mention black bear as food (Fowler 1992:87), but we assume that bear must have been rare in Toedokado territory and, thus, unimportant in the Cattail Eater diet (Fowler 1989:19).

Pronghorn Antelope

Although pronghorn were important prey of most Northern Paiute hunters (Fowler 1989:14-19), their role in ethnographic Toedokado diets is less certain because antelope presently are rare in Toedokado territory. It is unclear whether ethnographic accounts of Cattail Eater antelope hunts refer to logistic forays outside our defined study area or to local hunting episodes (Fowler 1992:76-77). Antelope bones are rare in Stillwater Marsh sites (Dansie 1987:262; Schmitt and Sharp 1990:84), and only a small quantity was recovered from Hidden Cave (Grayson 1985:155). However, the importance of pronghorn in Great Basin subsistence strategies (cf. Thomas 1983) suggests that the Toedokado would have hunted antelope in Toedokado territory whenever they appeared there.

Typical pronghorn habitat is low, open, gently rolling terrain in sagebrush and greasewood-saltbush plant communities. Antelope generally shun steeper slopes (Kindschy et al. 1982; Yoakum 1980). The preference for open, gentle terrain is attributable to a strategy of using keen eyesight and high running speeds to flee predators in such landscapes (Frison 1978:251).

Antelope occur over a wide elevational range throughout the American West but are most abundant between 900 and 1800 meters (2953 to 5906 ft amsl) above sea level. Precipitation and snowfall impose this elevational window on antelope habitat; antelope have difficulty foraging in areas with snow deeper than 25 cm, or rainfall lower than 25 cm annually (Kindschy et al. 1982; Yoakum 1980). These climatic conditions compel antelope herds to migrate between winter and summer ranges as much as 100 km apart. Population densities generally are low in areas with too much snow or too little rainfall to qualify as good winter or summer range (Kindschy et al. 1982).

Handy drinking water is extremely important for antelope habitat (Kindschy et al. 1982; Yoakum 1980). Although antelope occasionally may forage as far as 8 km from water, pronghorn populations are strongly tethered to their water sources, as demonstrated by wildlife inventories in Wyoming which have documented that 95 percent of a population of 12,000 pronghorns remained within 5 to 6.5 km of water (Yoakum 1980:15).

Pronghorn generally are browsers and shrubs are their major food source. Typically, low sagebrush dominates the best summer ranges of antelope, whereas winter ranges maintain saltbush, greasewood, and winterfat; the animals also consume grasses and forbs. Rangelands maintaining a desirable mixture of these plant classes represent best antelope habitat (Kindschy et al. 1982); Yoakum (1980) estimates that mixtures of 30-40 percent grasses, 10-30 percent forbs, and 5-30 percent shrubs are optimum. Table 13 lists forage plants of pronghorn antelope (Gullion 1964; Kindschy et al. 1982; Yoakum 1980:16; USDI Fish and Wildlife 1978:67) that are considered by the Toedokado model, where antelope forage occurs in all but five habitats. Densities range from 34 to 493 kilograms per hectare. Yoakum (1980:28) suggests that habitats producing more than 900 kilograms of antelope forage per hectare are ideal, while those with less than 450 kilogram per hectare are poor.

The data on forage species associated with the climate and slope constraints on antelope habitat may explain why antelope were uncommon in Toedokado territory in the late nineteenth and early twentieth centuries. On the basis of on forage abundance alone, almost all the study area is poor antelope range. Nearly all the study area sees less than 25 cm of rainfall per year (USDA Soil Conservation Service 1981:21). Some montane habitats in the Clan Alpine and Stillwater Mountains receive more than 25 cm precipitation per year, but as winter snowfall in these typically steep areas. Such factors would have limited the suitability of the Toedokado territory as summer or winter pronghorn habitat.

Table 13. Forage Plants of Pronghorn Antelope.

Common Name	Genus/species	Forage Quality
alpine timothy	*Phleum alpinum*	Poor
Anderson peachbrush	*Prunus andersonii*	Excellent
antelope bitterbrush	*Purshia tridentata*	Excellent
arrowleaf balsamroot	*Balsamorhiza sagittata*	Excellent
bluegrass	*Poa* sp.	Poor
bottlebrush squirreltail	*Sitanion hystrix*	Poor
clover	*Trifolium* sp.	Good
eriogonum	*Eriogonum* sp.	Excellent
evening primrose	*Oenothera* sp.	Good
four-winged saltbush	*Atriplex canescens*	Excellent
gilia	*Gilia* sp.	Poor
groundsel	*Senecio* sp.	Poor
hawksbeard	*Crepis* sp.	Poor
hopsage	*Grayia spinosa*	Good
Idaho fescue	*Festuca idahoensis*	Good
Indian ricegrass	*Oryzopsis hymenoides*	Good
lupine	*Lupinus* sp.	Excellent
meadow barley	*Hordeum brachyantherum*	Poor
milkvetch	*Astragalus* sp.	Good
needlegrass	*Stipa* sp.	Poor
penstemon	*Penstemon* sp.	Poor
phlox	*Phlox* sp.	Excellent
povertyweed	*Iva axillaris*	Excellent
rabbitbrush	*Chrysothamnus* sp.	Good
rush	*Juncus* sp.	Poor
sagebrush	*Artemisia* sp.	Excellent
sedge	*Carex* sp.	Poor
serviceberry	*Amelanchier* sp.	Poor
shadscale	*Atriplex confertifolia*	Poor
tapertip hawksbeard	*Crepis acuminata*	Poor
western dock	*Rumex occidentalis*	Good
wheatgrass	*Agropyron* sp.	Good
wild rose	*Rosa* sp.	Poor
willow	*Salix* sp.	Poor
winterfat	*Eurotia lanata*	Excellent

Despite the overall limitations of Toedokado territory as antelope habitat, we attempted to determine the best antelope habitats in the study area based on slope, water, and forage. To accomplish this, we devised a "habitat rating key," patterned after published keys for antelope (Kindschy et al. 1982; Yoakum 1980) but modified for concordance with variables encoded our territorial model.

The pronghorn antelope key considers three variables identified in wildlife literature as critical to pronghorn antelope: forage abundance, slope, and association with water (we ignore the precipitation variable since almost all the study area is suboptimal for pronghorn). Variability in each of the three categories is divided into ordinal classes that are assigned a relative score, as in Table 14.

Table 14. Pronghorn Antelope Productivity Rating Score.

Score	Forage Quantity	Slope	Distance to Water
0	0 kg/ha	>18 percent	>10 km
1	1-165 kg/ha	10-18 percent	6 to 10 km
2	166-330 kg/ha	3-9 percent	3 to 6 km
3	> 330 kg/ha	<3 percent	<3 km

A total score for any square kilometer quadrat in the study area then is calculated by multiplying each of the scores for the three environmental variables. For example, a score for a quadrat with 250 kilograms per hectare of antelope forage, 7 percent slope, and 6 km from water would be 4 (2 X 2 X 1 = 4). The individual scores are multiplied rather than added together to prevent quadrats that are completely unsuitable for antelope in one variable (for example having no forage, being too remote from water, or excessively steep) from achieving relatively high scores on the basis of the other two variables. In order words, we assume that any quadrat scoring zero in one variable is totally unsuitable as antelope habitat no matter how favorable the quadrat may score in the remaining two variables.

Figure 67 illustrates the distribution of ranked antelope habitat. As can be seen, the most extensive clusters of high score quadrats occur in the western area, near the Carson River and Churchill Butte. Suitable habitat also occurs south of the Stillwater range, and in Dixie Valley. These areas correspond well to riparian Habitats 4, 5, 6, 28, and 55 and to greasewood-saltbush Habitats 3, 7, 9, 11, 16, and 29. We consider these the best habitats for antelope in Toedokado territory, which generally accords well with Fowler's (1992:76) statement that any antelope hunts conducted within Cattail Eater territory most likely would have occurred in the area "south and east of Stillwater Marsh and ... west ... of the Indian Lakes District".

Northern Paiute usually hunted pronghorn by communal drives, although individual hunting was occasional (Fowler 1992:76). Simms (1987:65-67) estimates that communal hunts could have procured between 15,000 and 32,000 calories per hour. However, antelope herds depleted by communal drives may have required 10-12 years to become reestablished (Egan 1917:241).

Mule Deer

The modern ubiquity of mule deer is a consequence of modern alterations to Great Basin plant communities initiated by the arrival of Euro-Americans (Thomas 1983; Berger and Wehausen 1991; Grayson 1993; Tausch 1973); the abundance and distribution of mule deer in the prehistoric Great Basin are uncertain. Fowler (1992:84) mentions that mule deer may never have been abundant in either the Stillwater or Clan Alpine Ranges in ethnographic times. Even today, a wilderness assessment of the Clan Alpine Range mentions that deer hunting ranks only fair-to-good because deer populations are relatively small (USDI Bureau of Land Management 1991). However, ethnographic Toedokado record that they hunted mule deer in Cattail Eater territory (Fowler 1992:84). A small quantity of mule deer bones was recovered at Hidden Cave (Grayson 1985:155), but they are absent or rare in Stillwater Marsh sites (Dansie 1987; Schmitt and Sharp 1990). The paucity of deer remains in lowland sites may reflect ethnographic Toedokado preference not to hunt deer logistically from lowland camps, as well as the rarity of mule deer in the study area (Fowler 1992:85).

Mule deer generally prefer steep, rough, or broken terrain offering elevational relief. This kind of topography offers effective escape from predators and easy access to a variety of potential feeding habitats within a small area (Kerr 1979; Grady 1980). Mule deer frequently migrate between winter and summer ranges, taking advantage of topographic relief to obtain good forage and escape extensive snow cover (Kerr 1979; Grady 1980).

Proximity of drinking water seems less important to mule deer habitat than to antelope habitat (Grady 1980). However, mule deer are likely to remain within 6.5 km of a water source (Kerr 1979). Severity of winter snowfall greatly effects mule deer population size and can induce marked population fluctuations (Kelly 1985; Osborne 1992). Deer attempt to cope with winter by using tall brush, trees, and rock outcrops as cover from adverse weather as well as hiding terrain from predators (Leckenby et al. 1982; Kerr 1979). In the Great Basin, mule deer make heavy use of habitats maintaining stands of big sagebrush, pinyon-juniper woodland, antelope bitterbrush, and mountain mahogany because of the

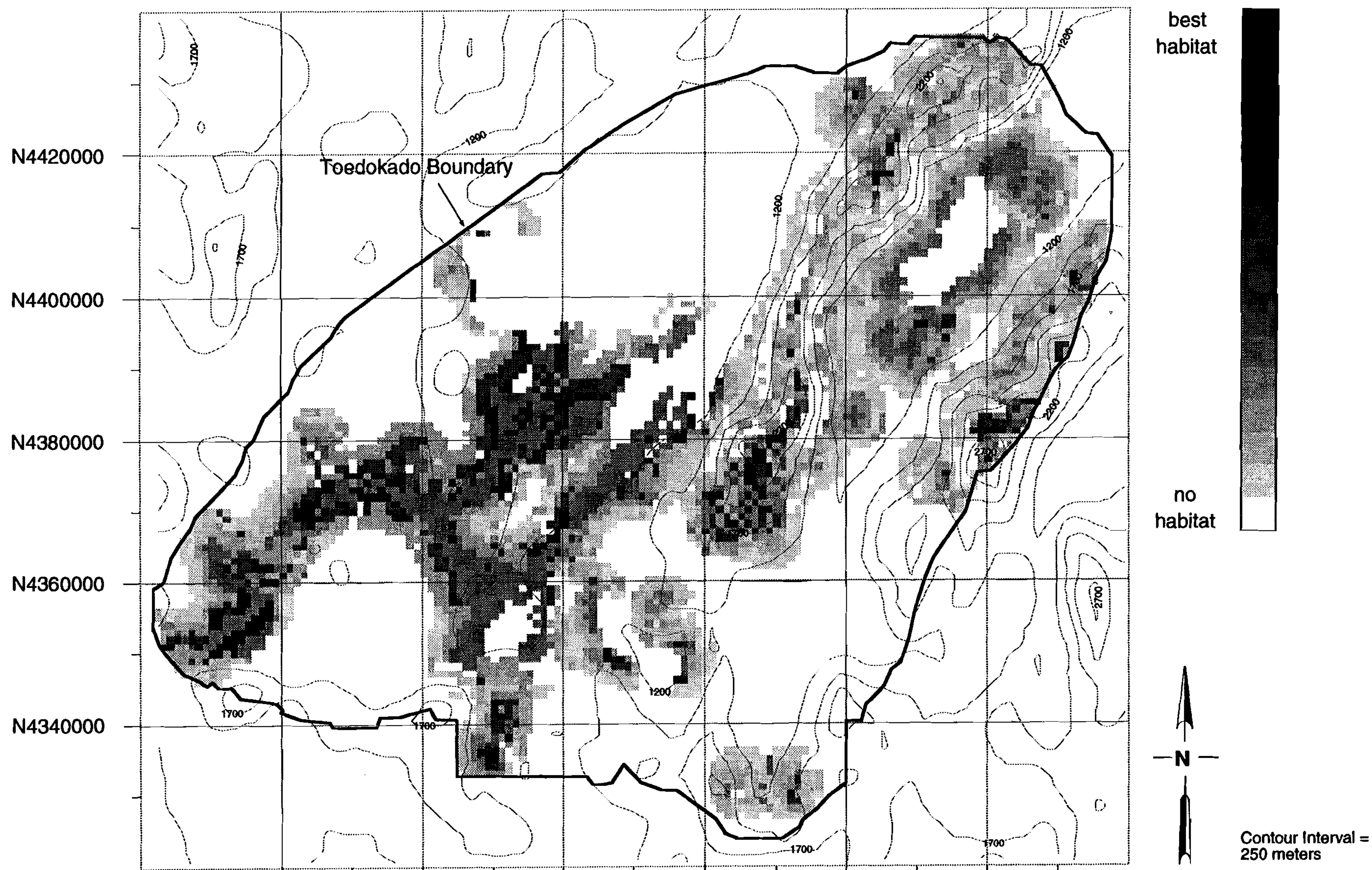

Figure 67. Antelope habitat productivity rankings in Toedokado territory.

effective cover and high quality forage in these areas. Deer use riparian zones as fawning areas because they are good migration corridors between winter and summer foraging ranges, and provide good forage, cover, and access to water (Leckenby et al. 1982).

Mule deer are browsers relying heavily on shrub vegetation in late summer, fall, and winter. Mountain mahogany and antelope bitterbrush are particularly attractive to mule deer. Succulent grasses and forbs take up a greater portion of mule deer diet in spring and early summer. Table 15 summarizes known mule deer forage plants that appear in the Toedokado model (Gullion, 1964; Kufeld et al. 1973; USDI Fish and Wildlife Service 1978:71).

Table 15. Forage Plants of Mule Deer.

Genus/species	Common name	Forage Quality
4-winged saltbush	*Atriplex canescens*	Good
alpine timothy	*Phleum alpinum*	Poor
Anderson peachbrush	*Prunus andersonii*	Poor
antelope bitterbrush	*Purshia tridentata*	Excellent
arrowleaf balsamroot	*Balsamorhiza sagittata*	Good
basin big sagebrush	*Artemisia tridentata tridentata*	Excellent
big/tall sagebrush	*Artemisia tridentata*	Excellent
black sagebrush	*Artemisia arbuscula nova*	Good
bluegrass	*Poa* sp.	Good
bottlebrush squirreltail	*Sitanion hystrix*	Good
bud sagebrush	*Artemisia spinescens*	Excellent
clover	*Trifolium* sp.	Excellent
creeping wildrye	*Elymus triticoides*	Poor
currant	*Ribes* sp.	Good
desertbroom	*Baccharis sarothroides*	Good
eriogonum	*Eriogonum* sp.	Good
Fremont cottonwood	*Populus fremontii*	Good
Great Basin wildrye	*Elymus cinereus*	Good
green ephedra	*Ephedra viridis*	Good
groundsel	*Senecio* sp.	Good
horsebrush	*Tetradymia* sp.	Poor
Idaho fescue	*Festuca idahoensis*	Good
Indian ricegrass	*Oryzopsis hymenoides*	Good
inland saltgrass	*Distichlis spicata stricta*	Poor
low sagebrush	*Artemisia arbuscula*	Poor
lupine	*Lupinus* sp.	Good
milkvetch	*Astragalus* sp.	Poor
mountain big sagebrush	*Artemisia vesayana*	Excellent
mountain mahogany	*Cercocarpus ledifolius*	Excellent
needlegrass	*Stipa* sp.	Good
Nevada ephedra	*Ephedra nevadensis*	Poor
oceanspray	*Holodiscus* sp.	Good
penstemon	*Penstemon* sp.	Good
phlox	*Phlox* sp.	Poor
pinyon	*Pinus monophylla*	Good
pricklygilia	*Leptodactylon* sp.	Excellent
rabbitbrush	*Chrysothamnus*	Poor
rush	*Juncus* sp.	Poor
sedge	*Carex* sp.	Poor
serviceberry	*Amelanchier* sp.	Excellent
silver sagebrush	*Artemisia cana*	Poor
slender wheatgrass	*Agropyron trachycaulum*	Good
snowberry	*Symphoricarpos*	Excellent
tapertip hawksbeard	*Crepis acuminata*	Good
thickspike wheatgrass	*Agropyron dasystachyum*	Good
Utah juniper	*Juniperus osteosperma*	Good
western wheatgrass	*Agropyron smithii*	Poor
wild rose	*Rosa* sp.	Excellent
willow	*Salix* sp.	Excellent
Wyoming big sagebrush	*Artemisia tridentata wyomingensis*	Poor
yarrow	*Achillea* sp.	Good

Abundant forage is scattered in the Carson River lowlands, Dixie Valley, Fairview Valley, the Stillwater Range, and the Dead Camel and Desert Mountains. Forage abundance ranges from none to 1235 kilograms per hectare, with most values falling below 600 kilograms per hectare. Habitats with the highest quantities of mule deer forage are 51 (1235 kg/ha), 47 (597 kg/ha), 6 (606 kg/ha), 28 (518 kg/ha), 16 (464 kg/ha). Of these, 51 and 47 are montane, 6 and 26 are lowland riparian, and 16 is a greasewood-saltbush association.

To refine our resolution of deer habitat we modified the antelope habitat rating key to reflect published keys for mule deer habitat (Kerr 1979:55-56), as in Table 16.

Table 16. Mule Deer Productivity Rating Score.

Score	Forage Quantity	Slope	Distance to Water
0	0 kg/ha	<3 percent	>10 km
1	1-250 kg/ha	3-9 percent	6 to 10 km
2	251-500 kg/ha	>18 percent	3 to 6 km
3	> 500 kg/ha	10-18 percent	<3 km

We use the same scores for distance to water, but modify those for forage quantity in order to account for the different range of forage values for deer, and change the scoring for slope values to reflect deer preference for steep slopes and rugged relief. We made no attempt to model cover since none of the variables used to construct the Toedokado habitat type model directly reflect cover.

The distribution of combined mule deer habitat scores is reflected in Figure 68. The habitat rating key focuses on suitable mule deer habitat in the Stillwater and Clan Alpine Ranges with isolated patches occurring in the Fairview, Sand Springs, and Dead Camel Mountains. This assessment accords well with ethnographic accounts of Mule Deer hunting by the Cattail Eaters, wherein Fowler (1992:40) mentions Silver Hill, Sheep Canyon, and Coyote Canyon of the Stillwater Range as favored deer hunting locations.

The areas identified as mule deer habitat generally correspond well to the distributions of montane Habitats 47 and 51. Habitat types 31, 34, and 44, fostering only moderate quantities of mule deer forage (319 kg/ha, 309 kg/ha, and 272 kg/ha respectively), tend to score high as mule deer habitat owing to slope and proximity to water. In particular, pinyon-juniper woodlands of the Stillwater and Clan Alpine ranges (Habitat 34) are notably hospitable to mule deer because of the thermal cover the trees provide (USDA Soil Conservation Service 1992). Thus, we rank Habitats 31, 34, 44, 47, and 51 as prime deer habitat. Despite the abundance of forage maintained by Habitats 6, 16, and 28, these do not qualify as suitable mule deer habitat given their remoteness from the preferred slopes of montane areas.

Simms (1987:46) estimates deer hunting return rates at 18,000 to 32,000 calories per hour. Fowler (1989:13) reports that eight Northern Paiute hunters were able to procure about three deer a day for two weeks on a cooperative hunt in the Gerlach Mountains. Using Simms's estimate of handling time at five hours per day for eight hunters, a yield of 50,000 calories per hour can be expected (Steve Simms, personal communication, January 1995). Although, this probably is not representative of hunting success possible in deer-poor Toedokado territory, it is suggestive of feasible deer hunting returns.

Mountain Sheep

Ethnographic accounts report that the Cattail Eaters hunted mountain sheep in the study area, although indigenous sheep populations were extinct by modern times (Fowler 1992:84). Small quantities

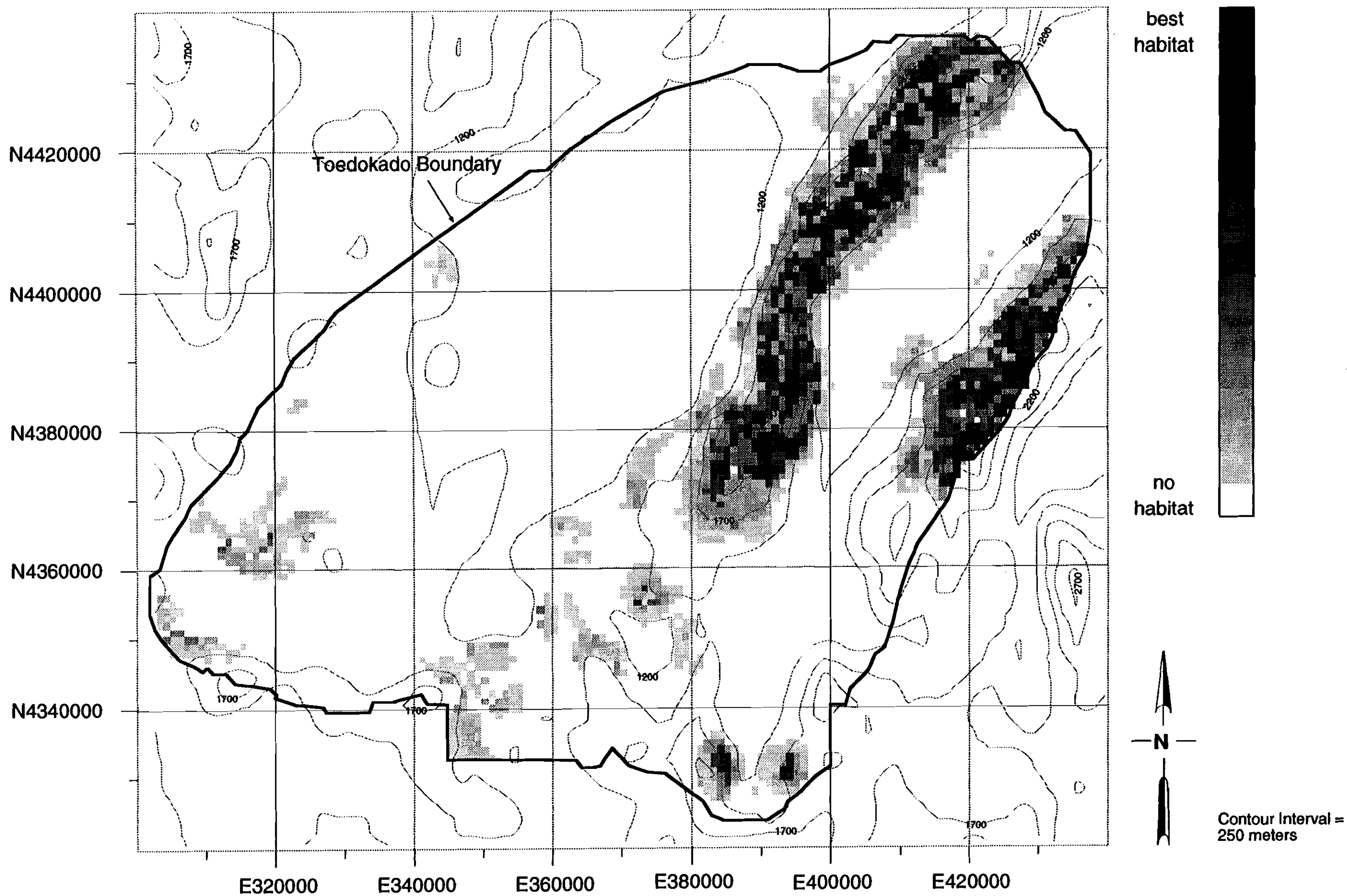

Figure 68. Mule deer habitat productivity rankings in Toedokado territory.

of sheep bone were present in Stillwater Marsh archaeological assemblages (Dansie 1987; Schmitt and Sharp 1990) and at Hidden Cave (Grayson 1985). Complexes of stone hunting features observed in the Clan Alpine Range probably attest to prehistoric drives and intercept hunting of mountain sheep (McGuire and Hatoff 1991).

The defining characteristic of mountain sheep habitat is precipitous, remote topography. Mountain sheep use steep bluffs, cliffs, rock rims, and outcrops as escape terrain. Similarly, bedding and lambing areas are restricted to steeper slopes. Although adult rams occasionally venture as far as 3 km from steep relief, mountain sheep usually remain within 0.8 km of escape terrain even when rich, well watered foraging patches lie not much further away (Boyd et al. 1986; Van Dyke et al. 1983; Wehausen 1983; Lothson 1989).

Proximity of drinking water is also important to mountain sheep habitat; populations generally cluster within 1.6 to 3.2 km of water sources, especially in summer months (Van Dyke et al. 1983). Winter snow accumulations force mountain sheep to forage at lower elevations; in the Intermountain West, winter ranges typically are between 1220 and 1830 meters (4002 to 6004 ft amsl) above sea level, while summer ranges exceed 2290 meters (7513 ft amsl) (Van Dyke et al. 1983:13-14; Wehausen 1983). Mountain sheep populations fluctuate in response to severe winters and to drought (Kelly 1985; Osborne 1992).

Mountain sheep are primarily grazers, subsisting on grasses augmented by browse and forbs in spring and summer (Van Dyke et al. 1983:8; Wehausen 1983). Table 17 indicates known food plants of bighorn sheep which are calculated in the Toedokado model (Gullion 1964; USDI Fish and Wildlife Service 1978; Van Dyke et al. 1983:13; Wehausen 1983).

Table 17. Forage Plants of Mountain Sheep.

Common name	Genus/species	Forage Quality
alkali sacaton	*Sporobolus airoides*	Excellent
alpine timothy	*Phleum alpinum*	Poor
Anderson peachbrush	*Prunus andersonii*	Poor
antelope bitterbrush	*Purshia tridentata*	Excellent
arrowleaf balsamroot	*Balsamorhiza sagittata*	Good
basin big sagebrush	*Artemisia tridentata tridentata*	Good
big/tall sagebrush	*Artemisia tridentata*	Good
bitterroot	*Lewisia rediviva*	Poor
black sagebrush	*Artemisia arbuscula nova*	Good
bottlebrush squirreltail	*Sitanion hystrix*	Good
bud sagebrush	*Artemisia spinescens*	Good
burrobrush	*Hymenoclea* sp.	Good
Canby bluegrass	*Poa canbyi*	Good
clover	*Trifolium* sp.	Excellent
creeping wildrye	*Elymus triticoides*	Good
currant	*Ribes* sp.	Good
Cusick bluegrass	*Poa cusickii*	Good
dalea	*Dalea* sp.	Poor
desert needlegrass	*Stipa speciosa*	Good
desertbroom	*Baccharis sarothroides*	Good
eriogonum	*Eriogonum* sp.	Good
evening primrose	*Oenothera* sp.	Good
four-winged saltbush	*Atriplex canescens*	Poor
Fremont cottonwood	*Populus fremontii*	Good
galleta	*Hilaria jamesii*	Excellent
Great Basin wildrye	*Elymus cinereus*	Good
green ephedra	*Ephedra viridis*	Good
groundsel	*Senecio* sp.	Good
Idaho fescue	*Festuca idahoensis*	Excellent
Indian ricegrass	*Oryzopsis hymenoides*	Good
inland saltgrass	*Distichlis spicata stricta*	Poor

Table 17, continued.

Common name	Genus/species	Forage Quality
low sagebrush	*Artemisia arbuscula*	Poor
lupine	*Lupinus* sp.	Good
mat muhly	*Muhlenbergia richardsonis*	Good
milkvetch	*Astragalus* sp.	Good
mountain big sagebrush	*Artemisia vesayana*	Poor
muttongrass	*Poa fendlerana*	Excellent
needleandthread	*Stipa comata*	Good
Nevada bluegrass	*Poa nevadensis*	Good
Nevada ephedra	*Ephedra nevadensis*	Poor
oceanspray	*Holodiscus* sp.	Excellent
penstemon	*Penstemon* sp.	Poor
phlox	*Phlox* sp.	Poor
pinyon	*Pinus monophylla*	Poor
pricklygilia	*Leptodactylon* sp.	Good
rabbitbrush	*Chrysothamnus* sp.	Poor
rush	*Juncus* sp.	Poor
Sandberg's bluegrass	*Poa secunda*	Good
sedge	*Carex* sp.	Poor
serviceberry	*Amelanchier* sp.	Excellent
shadscale	*Atriplex confertifolia*	Poor
silver sagebrush	*Artemisia cana*	Good
slender wheatgrass	*Agropyron trachycaulum*	Excellent
snowberry	*Symphoricarpos* sp.	Good
tapertip hawksbeard	*Crepis acuminata*	Excellent
thickspike wheatgrass	*Agropyron dasystachyum*	Good
Thurber needlegrass	*Stipa thurberiana*	Good
tufted hairgrass	*Deschampsia cespitosa*	Poor
Utah juniper	*Juniperus osteosperma*	Poor
Webber ricegrass	*Stipa webberi*	Good
western needlegrass	*Stipa occidentalis*	Excellent
western wheatgrass	*Agropyron smithii*	Poor
wild rose	*Rosa* sp.	Good
willow	*Salix* sp.	Good
Wyoming big sagebrush	*Artemisia tridentata wyomingensis*	Poor
yarrow	*Achillea* sp.	Poor

Sheep forage occurs in all but two habitats of Toedokado territory in abundances ranging from 47 to 1949 kilograms per hectare, with most values falling below 600 kilograms per hectare. Habitats with the highest quantities of sheep forage are 6 (1949 kg/ha), 51 (1353 kg/ha), 5 (1226 kg/ha), 28 (1099 kg/ha), and 47 (530 kg/ha). Of these, 51 and 47 are in montane habitats, and 5, 6 and 28 are lowland riparian habitats. Unexpectedly high quantities of forage occur in the Carson River lowlands and in Dixie Valley, enriched by patches of Great Basin wildrye and creeping wildrye.

We used the mule deer habitat rating key to refine our assessment of mountain sheep habitat, as in Table 18; forage levels have been altered to reflect the distribution of sheep forage in Toedokado territory and slope scores have been altered to reflect sheep preferences for the most precipitous.

Table 18. Sheep Productivity Rating Score.

Score	Forage Quantity	Slope	Distance to Water
0	0 kg/ha	<3 percent	>10 km
1	1-250 kg/ha	3-9 percent	6 to 10 km
2	251-500 kg/ha	10-18 percent	3 to 6 km
3	> 500 kg/ha	>18 percent	<3 km

Not surprisingly, the four prime sheep habitats are the same as those identified for deer: 34, 44, 47, and 51. This assessment accords well with ethnographic accounts of sheep hunting by the Cattail Eaters, that identify identical locations for mule deer and mountain sheep hunting. Fowler (1992:40) mentions Silver Hill, Sheep Canyon, and Coyote Canyon of the Stillwater Range as sheep hunting locations. The distribution of combined mountain sheep habitat scores is reflected in Figure 69.

Although indigenous sheep populations were eradicated by the early twentieth century as a result of overhunting and disease, herds were reintroduced into the Stillwater and Clan Alpine Ranges in the early 1980s (USDI Bureau of Land Management 1991). By the late 1980s, approximately 100 sheep inhabited the Stillwaters and 30 more were in the Clan Alpine Mountains. The two ranges are capable of supporting populations of 350 and 125 sheep respectively (USDI Bureau of Land Management 1991:37). Ethnographic accounts indicate that the Northern Paiute hunted sheep through a variety of encounter, intercept, and drive tactics (Fowler 1989:19; 1992:84). Simms estimates that caloric returns for hunting sheep could range between 17,000 and 32,000 calories per hour.

Medium and Small Mammals

The Toedokado and surrounding bands of Northern Paiute consumed a variety of small and medium sized mammals (Fowler 1992, 1989). Here, we consider four categories of small to medium sized mammals for which there is sufficient wildlife behavior literature to model their habitats in Toedokado territory: muskrats, jackrabbits/hares, ground squirrels, and woodrats/marmots, and a set of small mammals including white-tailed antelope squirrel, kangaroo rat, vole, grasshopper mouse, deer mouse, pinyon mouse, least chipmunk, and pocket gopher are considered collectively. We assume that other small to medium sized mammals ethnographically consumed by the Cattail Eaters such as porcupine, beaver, badger, and bobcat were too rare in Toedokado territory to contribute significantly to the diet and make no attempt to model their distributions.

Muskrat

Ethnographic Northern Paiute informants in and around Toedokado territory agree that they procured muskrat but imply that muskrat were not an important *dietary* item (Fowler 1989:26; 1992:70-71). Muskrat remains are abundant in archaeological contexts in Stillwater Marsh (Dansie 1987; Schmitt and Sharp 1990) and are present at Hidden Cave (Grayson 1985:151), suggesting that these animals may have been frequent targets of prehistoric hunters.

Muskrat are widespread throughout the Great Basin, occurring in any wetland environment with water sufficiently deep to allow muskrat to escape predators, and with aquatic vegetation suitable for food and nest construction (Zeveloff 1988; Call 1986; Hall 1946). Muskrat may eat a variety of small animals including mussels, crayfish, fish, and turtles, but they are primarily vegetarian, thriving on emergent vegetation during the growing season and tubers during winter. Gullion (1964) records willow, bulrush, and cattail as forage plants of muskrat, whereas Thompson and Hallock (1988:63) note that cattail is favored over all others. The distribution of all these plants in Toedokado territory is plotted in Figure 70. Not surprisingly, muskrat forage is most abundant and widespread in Carson Lake, Stillwater Marsh, and Indian Lakes, with smaller patches along Carson River and around Dixie Hot Springs. These fall into only four habitats: 1 (894 kg/ha), 53 (691 kg/ha), 6 (69 kg/ha), and 5 (47 kg/ha); all are marsh or riparian wetland communities and represent suitable muskrat habitat.

Muskrats currently inhabiting Stillwater Marsh are descended from eastern United States stock introduced into the Stillwater Wildlife Management Area in the late 1940s to replace the extinct indigenous population (Thompson and Hallock 1988:137; Fowler 1992:71). Stillwater muskrats feed in

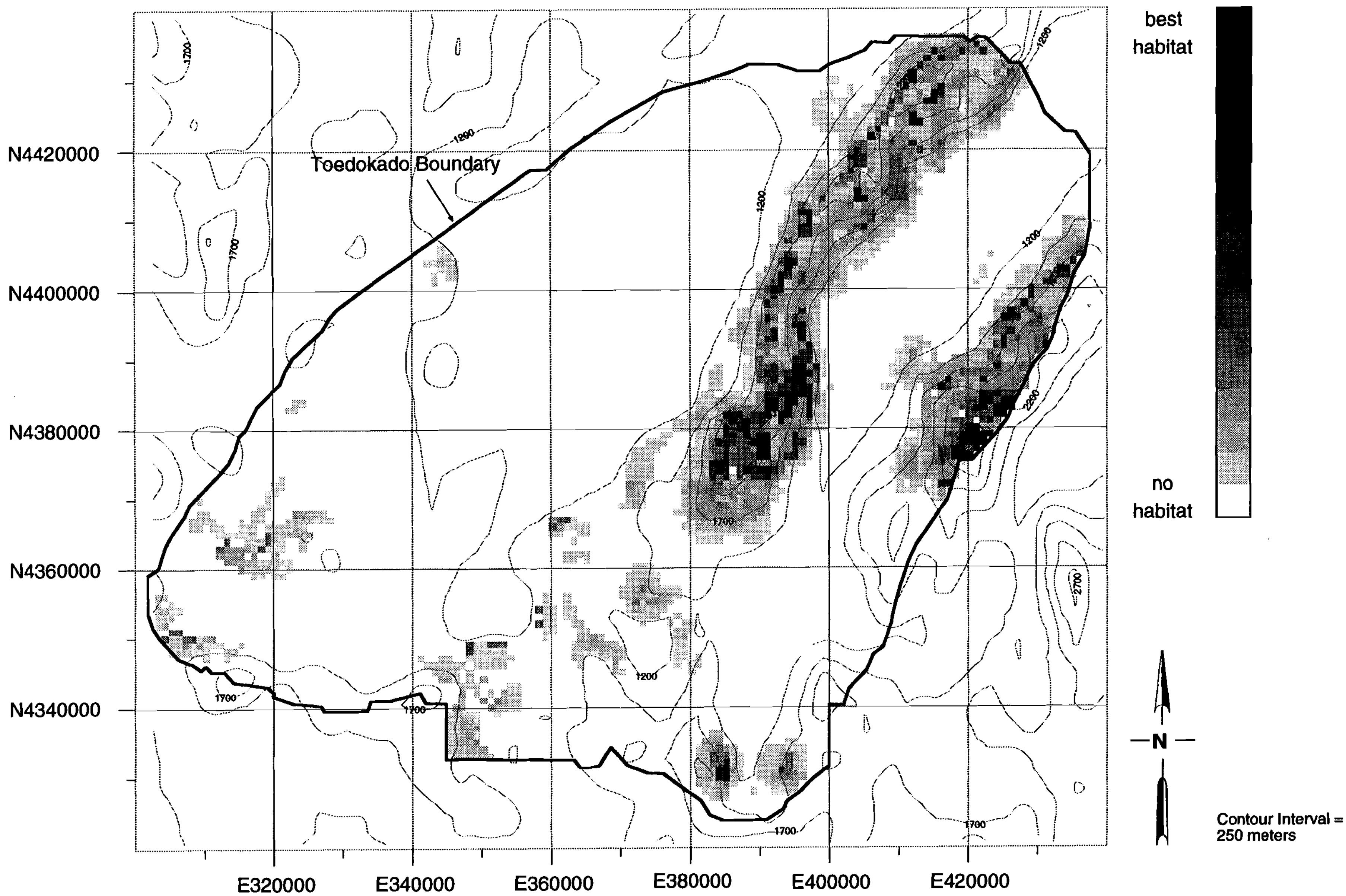

Figure 69. Mountain sheep habitat productivity rankings in Toedokado territory.

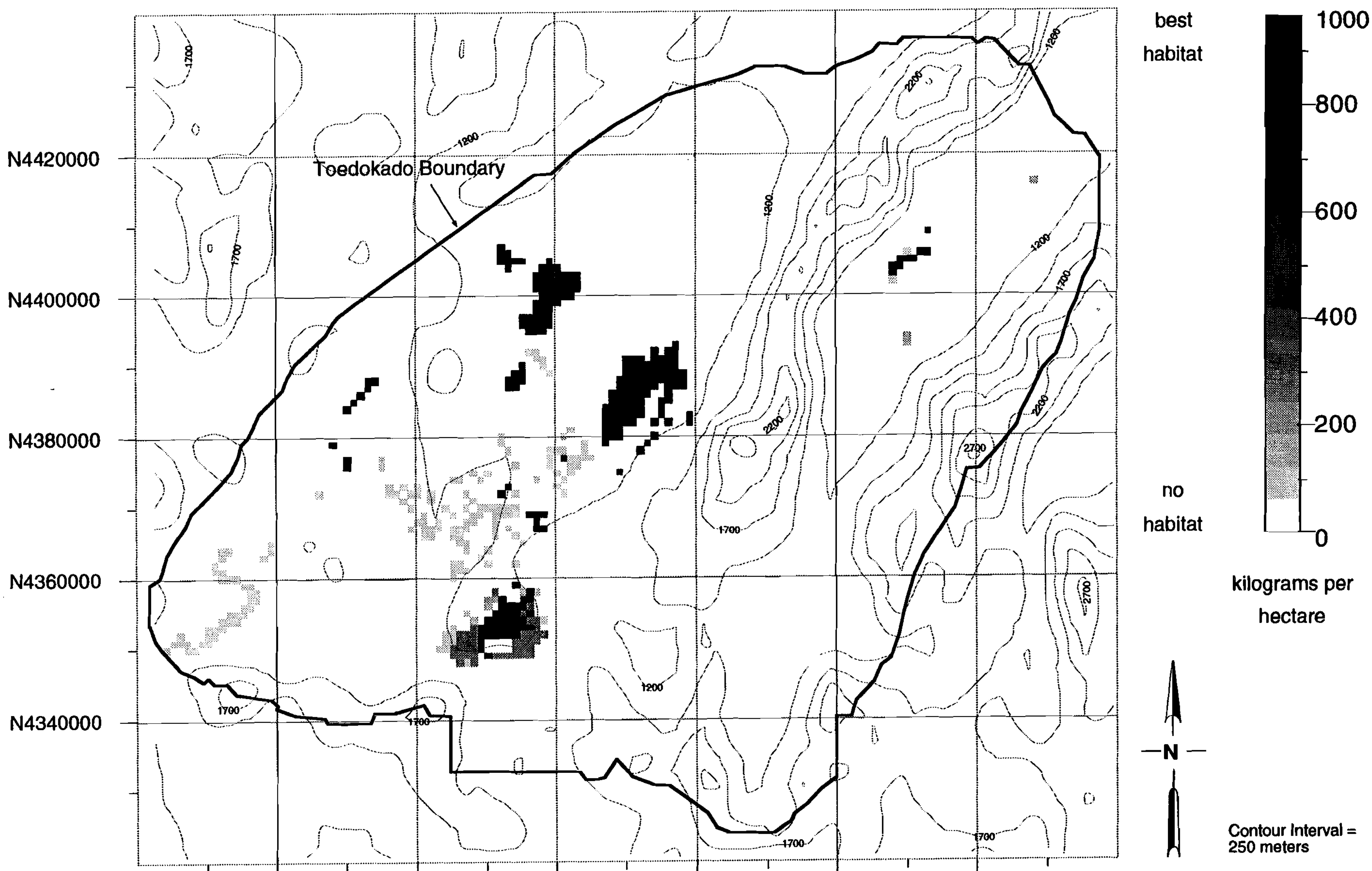

Figure 70. Normal year productivity of muskrat forage plants (kg/ha) in Toedokado territory.

saltgrass meadows, as well as in emergent and submergent marsh habitats (Hamilton and Auble 1993:13) where they build lodges. Fowler (1992:71) suggests that native muskrats nested in burrows dug into banks adjacent the marsh; Zeveloff (1988:233) notes both types of nest for muskrats inhabiting the Intermountain West.

Toedokado territory is capable of supporting huge numbers of muskrat but populations are subject to rapid fluctuations that occur in approximate ten year cycles. For example, the Stillwater Wildlife Management Area received an introduced population of 440 in 1949, and in 1957 more than 14,000 of the animals were trapped. Catastrophic collapse of the muskrat population occurred in the late 1950s, early 1960s, mid-1970s, and mid-1980s in response to overpopulation, drought, and flooding (Thompson and Hallock 1988:137-138). Muskrats can deplete emergent marsh vegetation, prompting their own decimation. For example, ten muskrats per acre can eliminate stands of cattail in as little as two years (Sojda and Solberg 1993:5). Using ethnographic data, Reidhead (1976:122-123) estimates that Cree hunters could procure only about 350 calories per hour trapping muskrats, a return much smaller than for many Great Basin plants. However, Reidheads' data originate in an area where muskrat populations were artificially depressed by heavy commercial trapping. It is unlikely that this figure represents feasible return rates when populations are at peak levels. Winterhalder (1981:83) observes that the Cree could obtain 4700 to 6300 calories per hour trapping muskrat in more amenable harvest conditions. For present purposes, we assume that return rates for harvesting muskrat in Stillwater Marsh fall in this latter range.

Jackrabbit/Hare

Fowler (1989:27-29, 1992:77, 85) indicates that ethnographic Toedokado procured Nuttall's cottontail, black-tailed jackrabbit, and white-tailed jackrabbit utilizing communal drives, encounter hunting, and snares. All three lagomorphs appear in the archaeological record of Stillwater Marsh (Dansie 1987; Schmitt and Sharp 1990) and of Hidden Cave (Grayson 1985).

Although the habitats of the three rabbits differ, there are considerable similarities. Generally, white-tailed jackrabbit and cottontail share a propensity to occur in sagebrush and montane plant communities at higher elevations than black-tailed jackrabbit. The latter occur in all plant communities identified in Toedokado territory (Maser et al. 1984; USDI Fish and Wildlife Service 1978:105).

Rabbits and hares are eclectic as regards habitat diversity, but they prefer areas of low growing shrubs and trees for the escape cover they provide. Although rabbits will feed in open grasslands and meadows where they are vulnerable to predation, they usually remain within 300 m of protective brush cover (Hall 1946; USDI Fish and Wildlife Service 1978:105; Chapman and Willner 1986). Unlike many other animals considered herein, proximity of water is not critical to rabbit habitat; rabbits may drink but usually satisfy their water requirements by eating succulent plants. Nevertheless, population densities may parallel closely the distribution of water sources because of the greater densities of succulent plants they support (Chapman and Willner 1986).

Rabbits and hares prefer succulent forbs and grasses, especially in the summer when moisture requirements are highest. They are nevertheless quite eclectic diners, feeding on shrub vegetation when succulents are unavailable (USDI Fish and Wildlife Service 1978:105). Known food plants of rabbits and hares that are calculated in the Toedokado model are listed in Table 19, compiled from government documents (U.S. Fish and Wildlife Service 1978) and relevant wildlife biology literature (Gullion 1964; Chapman and Willner 1986). No data on the relative forage quality (for lagomorphs) of these species was available.

Table 19. Forage Plants of Rabbits and Hares.

Common name	Genus/species
alkali bluegrass	*Poa juncifolia*
alkali sacaton	*Sporobolus airoides*
Anderson peachbrush	*Prunus andersonii*
antelope bitterbrush	*Purshia tridentata*
Bailey's greasewood	*Sarcobatus vermiculatus Baileyii*
Baltic rush	*Juncus balticus*
basin big sagebrush	*Artemisia tridentata tridentata*
big/tall sagebrush	*Artemisia tridentata*
black greasewood	*Sarcobatus vermiculatus*
black sagebrush	*Artemisia arbuscula nova*
bluegrass	*Poa* sp.
bottlebrush squirreltail	*Sitanion hystrix*
bud sagebrush	*Artemisia spinescens*
burrobrush	*Hymenoclea* sp.
Canby bluegrass	*Poa canbyi*
Cusick bluegrass	*Poa cusickii*
Douglas rabbitbrush	*Chrysothamnus vicidiflorus*
four-winged saltbush	*Atriplex canescens*
galleta	*Hilaria jamesii*
gilia	*Gilia* sp.
globemallow	*Sphaeralcea* sp.
gray molly kochia	*Kochia americana vestita*
green ephedra	*Ephedra viridis*
green molly kochia	*Kochia americana*
hopsage	*Grayia spinosa*
horsebrush	*Tetradymia* sp.
Idaho fescue	*Festuca idahoensis*
Indian ricegrass	*Oryzopsis hymenoides*
inland saltgrass	*Distichlis spicata stricta*
kochia	*Kochia* sp.
little horsebrush	*Tetradymia glabrata*
low sagebrush	*Artemisia arbuscula*
lupine	*Lupinus* sp.
meadow barley	*Hordeum brachyantherum*
milkvetch	*Astragalus* sp.
Mormon tea	*Ephedra* sp.
mountain big sagebrush	*Artemisia vesayana*
muttongrass	*Poa fendlerana*
needleandthread	*Stipa comata*
Nevada bluegrass	*Poa nevadensis*
Nevada ephedra	*Ephedra nevadensis*
rabbitbrush	*Chrysothamnus* sp.
rubber rabbitbrush	*Chrysothamnus nauseosus*
sagebrush	*Artemisia* sp.
sand dropseed	*Sporobolus cryptandrus*
Sandberg's bluegrass	*Poa secunda*
sedge	*Carex* sp.
shadscale	*Atriplex confertifolia*
silver sagebrush	*Artemisia cana*
spikerush	*Eleocharis* sp.
thickspike wheatgrass	*Agropyron dasystachyum*
Thurber needlegrass	*Stipa thurberiana*
western wheatgrass	*Agropyron smithii*
wheatgrass	*Agropyron* sp.
winterfat; bluegum eucalyptus	*Eurotia lanata*
wolfberry	*Lycium* sp.
Woods rose	*Rosa woodsii*
Wyoming big sagebrush	*Artemisia tridentata wyomingensis*

The distribution of these species in Toedokado territory is plotted in Figure 71. Low to moderate densities of lagomorph forage are widespread throughout the study area. Rich patches occur in the

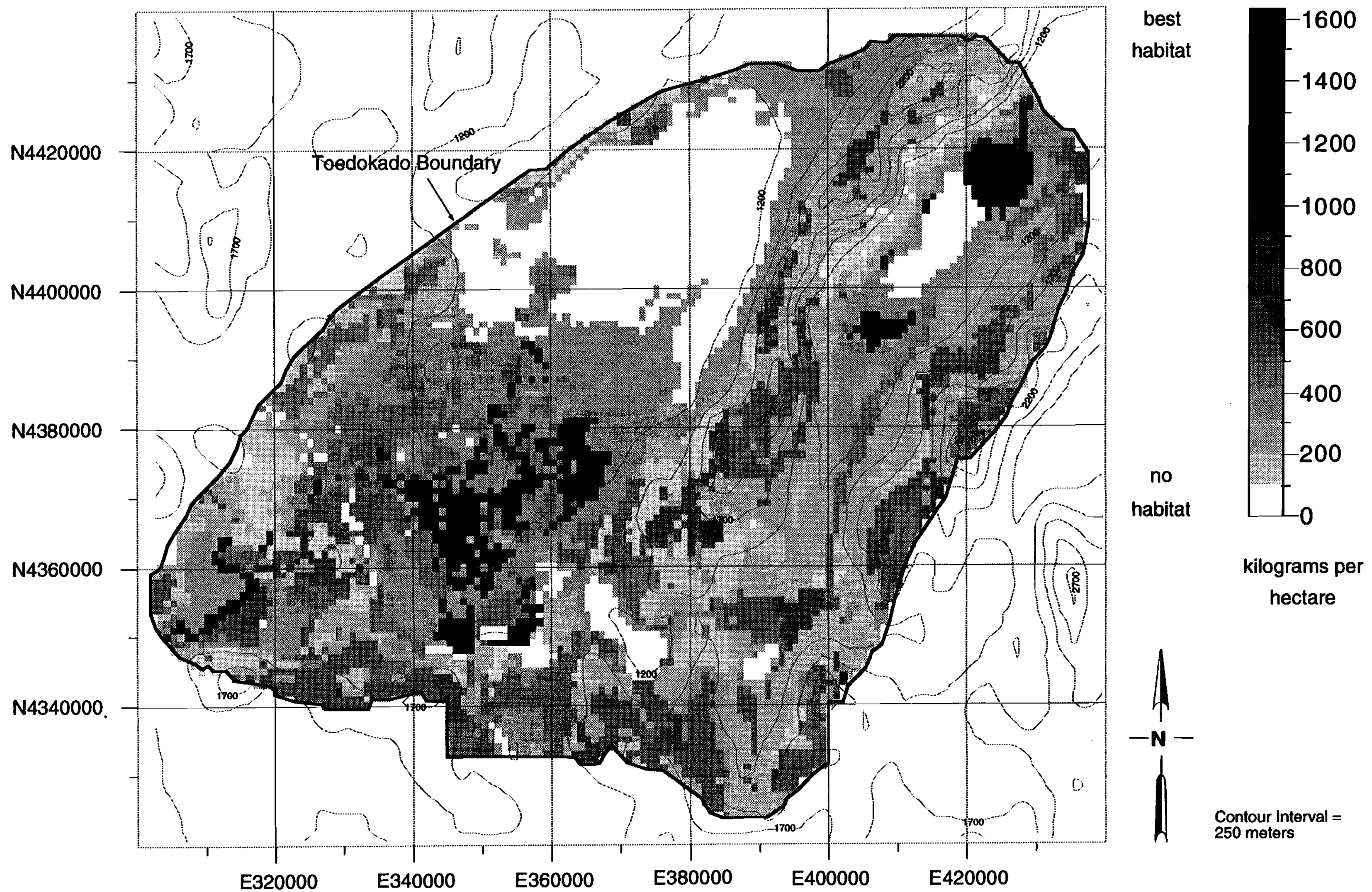

Figure 71. Normal year productivity of jackrabbit and hare forage plants (kg/ha) in Toedokado territory.

Carson River lowlands and on the northern and southern margins of Humboldt Salt Marsh in Dixie Valley. Smaller moderate to high density "hotspots" are dispersed throughout the Stillwater and Clan Alpine Mountains. Quantities of jackrabbit and hare forage range from absent to 1792 kilograms per hectare, with the greatest amounts in habitats 55 (1792 kg/ha), 6 (1626 kg/ha), 5 (1216 kg/ha), 28 (1196 kg/ha), and 4 (1073 kg/ha). All these, which we rank as primary rabbit/hare habitat, are wetland riparian or lowland spring community habitats. The next richest habitats are 51 (870 kg/ha), 31 (642 kg/ha), 36 (569 kg/ha), 16 (592 kg/ha), and 47 (558 kg/ha). Habitat 51 represents upland springs, 31 is sagebrush, 47 is montane, and 16 and 36 are greasewood-saltbush communities. The values illustrate the range habitable by rabbits and hares, but clearly suggest a bias for lowland riparian and spring vegetation communities.

Fowler (1992:34, 41) notes that Cattail Eater Paiute occasionally hunted rabbits in the area between the Hot Spring Mountains and Fallon, and conducted rabbit drives in the area between the South Branch of the Carson River and Old River. Fowler (1992:77) also observes that, at the turn of the century, rabbits were particularly common around Fallon, between Stillwater Marsh and Old River, and east of Carson Lake, observations that accord well with the high densities of rabbit forage in the riparian lowlands of Carson River.

Densities of up to 260 jackrabbits per square mile have been reported in some areas of the Intermountain West (Zeveloff 1988:97-98) and densities around Fallon may have approached this level (Fowler 1992:77). However, high rabbit fertility rates and the susceptibility of rabbits to epidemics of tularemia induce rapid short term fluctuations in rabbit population densities. Simms (1987:45) estimates return rates of between 9000 and 10000 calories per hour and 12000 and 16000 calories per hour for hunting, respectively, cottontails and jackrabbits. Winterhalder (1981:82) observes that the ethnographic Cree can procure more than 8000 calories per hour snaring hares when hare population densities are low; he estimates returns as high as 15000 calories per hour in more favorable conditions.

Ground Squirrels

Ethnographic informants have identified golden mantled ground squirrel, Belding's ground squirrel, and Townsend's ground squirrel as prey of the Toedokado and neighboring Northern Paiute bands (Fowler 1989:24; 1992:77, 85; Wheat 1967:9), with Townsend's ground squirrel was a particular favorite (Fowler 1992:79, 86). Most of the following discussion emphasizes the latter because wildlife literature is more extensive for this ethnographically preferred species. Ground squirrel remains have not been observed in Stillwater Marsh assemblages (Dansie 1987; Schmitt and Sharp 1990) as they have been at Hidden Cave (Grayson 1985:143).

Ground squirrel thrive in a variety of habitats in greasewood-saltbush, sagebrush, and montane plant communities and are particularly fond of deep, well drained soils which permit burrowing (USDI Fish and Wildlife Service 1978; Maser et al. 1988; Rickart 1987). However, Townsend's ground squirrel occurs in highest densities in communities containing winterfat (Smith and Johnson 1984; Nyedegger and Smith 1986). Zeveloff (1988:122) and Rickart (1987) record that Townsend's ground squirrel populations are particularly large at desert springs, and reproduction frequently occurs near wet meadow, riparian, palustrine, and lacustrine habitats (Masser 1984:84).

Ground squirrels eat seeds as well as succulent green vegetation from forbs, grasses, and shrubs, as well as a few insects. Generally, squirrels eat green forbs after emerging from hibernation in January or February and gradually shift reliance to grass seed before reentering hibernation in June or July (Yensen and Quinney 1992). In particular, winterfat, Sandberg's bluegrass, and various forbs are favored foods of ground squirrels (Johnson 1977; Yensen et al. 1992; Rogers and Gano 1980). Table 20 lists known foods of ground squirrel (Gullion 1964, USDI Fish and Wildlife Service 1978, Johnson 1977, Yensen et al. 1992, Rogers and Gano 1980), but we evaluate habitat types as ground squirrel habitat based only on favored annual and perennial forbs, Sandberg's bluegrass, and winterfat. Density and abundance values for these four resources range from none to 91 kilograms per hectare. Highest ranking habitats are 36 (91 kg/ha), 27 (90 kg/ha), 16 (63 kg/ha), 31 (62 kg/ha), 37 (50 kg/ha), and 11 (48 kg/ha). Of these, 27, 31, and 37 are sagebrush community habitats, while 36, 16, and 11 are greasewood-shadscale habitats. We assign these to highest ranking ground squirrel habitat, and consider as well wetland habitats 5, 6, 51 and 55 in light of ground squirrel preference for proximity to water. Habitats 5 and 6 are riparian, whereas 51 and 55 represent spring meadows; all four maintain high densities of perennial forbs and bluegrass (although not Sandberg's bluegrass) attractive to ground squirrel.

Table 20. Forage Plants of Ground Squirrels.

Common name	Genus/species	Forage Quality*
wheatgrass	*Agropyron* sp.	
serviceberry	*Amelanchier* sp.	
sagebrush	*Artemisia* sp.	Poor
milkvetch	*Astragalus* sp.	
saltbush	*Atriplex* sp.	Poor
arrowleaf balsamroot	*Balsamorhiza sagittata*	
Mormon tea	*Ephedra* sp.	
winterfat	*Eurotia lanata*	Excellent
gilia	*Gilia* sp.	
lupine	*Lupinus* sp.	
Indian ricegrass	*Oryzopsis hymenoides*	
penstemon	*Penstemon* sp.	
phlox	*Phlox* sp.	
pinyon	*Pinus monophylla*	
bluegrass	*Poa* sp.	Excellent
cinquefoil	*Potentilla* sp.	
antelope bitterbrush	*Purshia tridentata*	
currant	*Ribes* sp.	
bottlebrush squirreltail	*Sitanion hystrix*	
globemallow	*Sphaeralcea* sp.	
needlegrass	*Stipa* sp.	Good

*Forage quality is indicated as known.

Like many small-medium mammals, ground squirrels can achieve high population densities but are subject to rapid fluctuation in population size (Alcorn 1940; Yensen et al. 1992). Townsend's ground squirrels are particularly vulnerable to drought conditions affecting the distribution of succulent grasses and forbs in winter and early spring. In years with insufficient succulent vegetation, many ground squirrels will fail to reproduce, eating instead to build sufficient fat reserves to reenter torpor. Repeated drought years can threaten local populations with extinction (Smith and Johnson 1985; Yensen et al. 1992).

The northern Paiute procured ground squirrels through trapping and by flooding burrows. Simms (1987:45) estimates that encounter hunting of ground squirrels can provide between 5000 and 6500 calories per hour.

Woodrats/Marmots

Fowler lists desert woodrat, bushy-tailed woodrat, and yellow-bellied marmot in the diets of Toedokado and neighboring Paiute bands (Fowler 1989:24; 1992:77, 85). Remains of woodrats and marmots are elements of the archaeological faunal assemblage from Hidden Cave (Grayson 1985:142, 148-149), but were not present in Stillwater Marsh sites (Dansie 1987; Schmitt and Sharp 1990).

Distributions of the three species overlap: bushy-tailed woodrats occur in sagebrush, pinyon-juniper, and mountain brush vegetation communities; desert woodrats are common in greasewood-shadscale, and sagebrush communities; and marmots are most common in montane communities and wet meadows (USDI Fish and Wildlife Service 1978; Maser et 1984). However, all three species live in diverse habitats.

Woodrats and marmots favor forbs (Johnson and Hansen 1979), but woodrats will eat the succulent parts of shrubs and grasses, as well as seeds (Zeveloff 1988:216-217). Table 21 lists known food plants of woodrats that are in the Toedokado model. No data are available on the relative quality or preference of these species.

Table 21. Forage Plants of Woodrats and Marmots.

Common name	Genus/species
currant	*Ribes* sp.
globemallow	*Sphaeralcea* sp.
greasewood	*Sarcobatus*sp.
milkvetch	*Astragalus* sp.
Mormon tea	*Ephedra* sp.
pinyon	*Pinus monophylla*
sagebrush	*Artemisia* sp.
serviceberry	*Amelanchier* sp.
Utah juniper	*Juniperus osteosperma*
willow	*Salix* sp.

Rock outcrops, which provide protection from predators and weather, are a critical element of woodrat and marmot habitat strongly affecting population densities (Llewellyn 1981). The soil and vegetation databases used to construct the Toedokado model records the association of rock outcrops with soil and range mapping units.

Of the 41 plant habitats in the model, only 22 are associated with rock outcrops; the quantity of marmot and woodrat forage associated with each is listed in Table 22. Forage values range from 15 to 272 kilograms per hectare. The five habitats with the greatest amounts of suitable forage are 47, 31, 37, 13, and 34. Of these 47 and 34 are montane, 31 and 37 are sagebrush, and 13 is greasewood-saltbush communities. We designate these five as primary woodrat and marmot habitat.

Table 22. Quantity of Woodrat and Marmot Forage for Habitat Types in Rock Outcrops.

Habitat Type	Woodrat/Marmot Forage (kg/ha)
10	112
11	100
13	190
18	15
19	169
20	78
21	73
26	65
31	216
34	172
35	161
36	143
37	199
40	64
42	156
44	131
46	77
47	272
48	132
49	87
52	169
56	97

The Toedokado hunted woodrats and marmots individually or trapped them in rock traps (Fowler 1992:78-79, 86). Fowler specifically mentions Hazen Buttes, Rattlesnake Hill, and low mountains along the southern boundaries of Toedokado territory as productive marmot and woodrat hunting habitat. Marmots were also hunted on Table Mountain (Fowler 1992:79, 86), and deQuille (1963:71 cited in Thomas 1985:23) observed that logistic groups from Carson Sink procured woodrats in the Clan Alpine Range. No data are available on the energetics of hunting woodrats or marmots, but Simms (1987) estimates the return for large ground squirrels at 5000 and 65000 calories per hour, which we take as feasible return rates for woodrats and marmots.

Other Small Mammals

Fowler notes that Cattail Eater procured a variety of small and medium sized mammals, besides the categories already discussed. These include white-tailed antelope squirrel, kangaroo rat, porcupine, vole, grasshopper mice, deer mice, pinyon mice, least chipmunk, and pocket gopher. The procurement of these animals by historic Toedokado invited frequent comment by historical observers (Simpson 1876: entry for June 3, 1859; Dequille 1963:88; Alcorn 1940:160-170). Small mammal remains were abundant at Hidden Cave (Grayson 1985) and at Stillwater Marsh sites (Dansie 1987; Schmitt and Sharp 1990). Taphonomic indicators in the Stillwater assemblages strongly suggested that many of those specimens represented subsistence remains rather than natural fossil fauna. The frequent predominance of small mammal remains in marsh assemblages, as well as the abundance of small mammals living in marsh environments, has encouraged a perception that small mammals were a particularly attractive food resource in wetlands (Raven and Elston 1989:124), a view which we, too, hold. Wildlife studies consistently indicate that wetlands maintain higher densities of small mammals than drier terrestrial habitats (Feldhammer 1979; Clary and Medin 1992). Consequently, marsh (Habitats 1 and 53) and riparian (Habitats 3, 4, 5, 6, 28) communities generally should represent rich habitat for small mammals.

However, the regional perspective offered by the Toedokado model suggests that a diversity of rich small mammal habitats should occur in the Toedokado environment. Many small mammals are specialized inhabitants of non-wetland habitats and consequently should occur in greatest abundance in drier terrestrial settings. For example, wildlife studies (Feldhammer 1979:210) at Malheur National Wildlife Refuge in the northern Great Basin obtained highest capture rates in marsh environments (3.8 small mammals per 1.1 hectare plot per night), but obtained high capture rates in greasewood and sagebrush environments as well (3.1 small mammals per 1.1 hectare plot per night). Different assemblages of small mammals characterized each plant community; vole in the bulk of marsh community assemblages, deer mouse and least chipmunk in greasewood, and deer mouse, least chipmunk and Great Basin pocket mouse in sagebrush communities. The densities of non-wetland small mammals corresponded significantly to soil depth and soil texture. Clearly, multiple habitats are capable of supporting high densities of mammals that are specialized to microenvironmental characteristics of those habitats.

Gopher, porcupine, deer mouse, vole, and chipmunk require drinking water to survive. In arid settings this means that the distributions of these mammals are tethered to water sources to the extent required by their mobility and moisture requirements. Therefore, population densities of these mammals may strongly correlate with marshes solely because of proximity to water. However, they also occur in abundance near other water sources such as upland springs. For example, pinyon stands of Habitat 34 maintain high densities of least chipmunk and pinyon mouse (USDA Soil Conservation Service 1992); therefore, Habitats 34 and 51 (upland spring meadow) should also maintain high densities of small mammals.

Many small mammals can metabolize moisture from succulent plants and consequently do not require drinking water. These include white-tailed antelope squirrel, kangaroo rat, grasshopper mouse, and deer mouse. The densities of these mammals should coincide with wetland plant communities only if (as was the case with rabbits) the distribution of forage species or other critical habitat variables such as soil depth and texture happen to correlate with proximity to water. Indeed, these mammals should occur in greatest proportion in forage patches too remote from water for competing mammals to rely on (Brown 1973; Brown and Liebermann 1973).

Trapping experiments conducted in the northern Carson Desert (McAdoo et al. 1983) indicate the potential abundance of small mammals in arid terrestrial environments. Twenty-five traps were dispersed on a transect 225 m long on a productive stand of Indian ricegrass. The traps captured 850 rodents (mostly kangaroo rats) from a single study site over 27 days, with an average capture rate of 31 rodents per day. Similarly, Brown (1973) trapped 181 small rodents at four sand dunes in the Carson Desert, with an average capture rate of 26 rodents per day.

These data suggest that seed stands in desiccated settings of Toedokado territory can maintain high densities of small mammals (see also Billings 1945:11). In particular, Habitats 11, 15, 16 and 20 produce large stands of Indian ricegrass seeds on deep sandy eolian soils that frequently are more than 10 km from any perennial water source. These habitats should be particularly productive for white-tailed antelope squirrel, kangaroo rat, grasshopper mouse, and deer mouse. Therefore, we rank Habitats 11, 15, 16, and 20 highly as small mammal habitat.

Although we see marsh and riparian habitats as most productive for small mammals, clearly productive resource patches are likely to occur in desert and montane settings. Perhaps the critical difference between wetland and dryland small mammal habitats should be in their susceptibility to environmental change. Zeveloff (1988:225) notes that vole populations in marsh habitats are stable compared to voles living in drier habitats. He suggests that this may be due to greater reliability of the food supplies in palustrine environments. Common sense would suggest that these mammals would be most sensitive to flooding which can wash out marsh and marsh edge vegetation communities. As was the case with muskrat, floods should dramatically affect population levels. In contrast, populations of terrestrial mammals that do not live near marsh environments should be most susceptible to drought (Yentzen and Quinney 1992). These rodents depend heavily on succulent vegetation for providing water as well as provisioning for reproduction and hibernation. Drought years can dramatically reduce the productivity of vegetation, leading to dramatic population declines of small mammals (Smith and Johnson 1985).

Fowler (1992:79) documents that the Toedokado procured small and medium sized mammals by trapping and by flooding burrows. Notably, ethnographic informants chronicle kangaroo rat taken in desert settings while deer mouse, pinyon mouse, and chipmunk were taken in pinyon pine forests (Fowler 1992:79, 86). Simms (1987:47) estimates caloric return rates for hunting gophers at 9000 to 11000 calories per hour. He did not derive estimates for the smaller rodents considered here, but we assume that his estimate for thirteen-lined ground squirrel, of 2800 to 3600 calories per hour, is representative.

Birds

Ethnographic Cattail Eaters and neighboring bands of Northern Paiute hunted a variety of birds (Fowler 1989:54-58; 1992:51, 80, 85). For purposes of description, we emphasize two categories of avifauna: waterfowl and shorebirds, and upland game birds.

Waterfowl and Shorebirds

The Toedokado fully exploited the diversity of waterfowl and shorebirds found near Stillwater Marsh and Carson Lake (Fowler 1992:51), specifically canvasback, redhead, mallard, tundra swan, snow goose, white fronted goose, Canada goose, and American coot. A variety of water and shore bird remains were observed in archaeological deposits in Stillwater Marsh (Dansie 1987; Livingston 1988) and Hidden Cave (Grayson 1985), coots and ducks most abundantly in all assemblages.

Waterfowl and shorebirds inhabit a variety of feeding and nesting habitats in the wetlands of Toedokado territory. Tundra swan prefer upland nesting sites, adjacent water sources where they feed on submergent and emergent vegetation. Tundra Swan may also feed on upland vegetation when marshes freeze (Eng 1986b:372). Canada Geese typically nest in a variety of habitats in emergent vegetation, preferring islands as nesting sites (Eng 1986b:373). They feed on terrestrial and aquatic vegetation in saltgrass meadows and emergent marshes. Canvasback and redhead prefer nesting in protected emergent vegetation closely juxtaposed with open water, uplands, and islands (Eng 1986b:375; Thompson and Hallock 1988:63). They feed in emergent and submergent settings (Hamilton and Auble 1993:11-13). Mallards nest in upland settings near wetlands, feeding in saltgrass meadows and emergent vegetation (Eng 1986b:372, 375; Hamilton and Auble 1993:11-13). Coots nest in saltgrass meadows or in emergent vegetation and feed in meadow, emergent, or submergent settings (Hamilton and Auble 1993:11-13).

The waterfowl and shorebirds discussed here rely heavily on aquatic invertebrates to provide protein for molting, egg formation, and hatchling growth (Hamilton and Auble 1993:11-13). Adults subsist on a variety of aquatic vegetation, but sago pondweed is a major food (Eng 1986b; Gullion 1964:7; Thompson and Hallock 1988:63). Table 23 lists plant foods of waterfowl and shorebirds (Gullion 1964; Thompson and Hallock 1988) that are calculated in the Toedokado model.

Table 23. Forage Plants of Waterfowl and Shorebirds.

Common name	Genus/species	Forage Quality*	Waterfowl
alkaligrass	*Puccinellia* sp.		Canada Goose
arrowgrass	*Triglochin* sp.		Ducks
arrowhead	*Sagittaria latifolia*		Canada Goose
bulrush	*Scirpus* sp.	Excellent	Canada Goose, Snow Goose, Mallard, Redhead, American Coot
cattail	*Typha* sp.	Poor	Canada Goose, American Coot
inland saltgrass	*Distichlis spicata stricta*		Canada Goose, Snow Goose, Mallard, Redhead
rabbitfootgrass	*Polypogon* sp.		Canada Goose
sedge	*Carex* sp.		Mallard, Canvasback, Redhead
sego pondweed	*Potamogeton* sp.	Excellent	Canada Goose, Mallard, Redhead, Canvasback, American Coot
willow	*Salix* sp.		Ducks, American Coot

*Forage quality is given as known.

Figure 72 plots the distribution and abundance of these forage species in Toedokado territory. Not surprisingly, the highest densities of waterfowl forage occur in marshlands of Indian Lakes, Carson River, Carson Lake, and Stillwater Marsh. Waterfowl forage occurs in seventeen habitats of Toedokado territory in densities ranging from 4 to 1317 kilograms per hectare. Highest densities are in Habitats 1 (1317 kg/ha), 53 (914 kg/ha), 55 (560 kg/ha), 6 (486 kg/ha), and 5 (334 kg/ha), which we designate as prime waterfowl habitats.

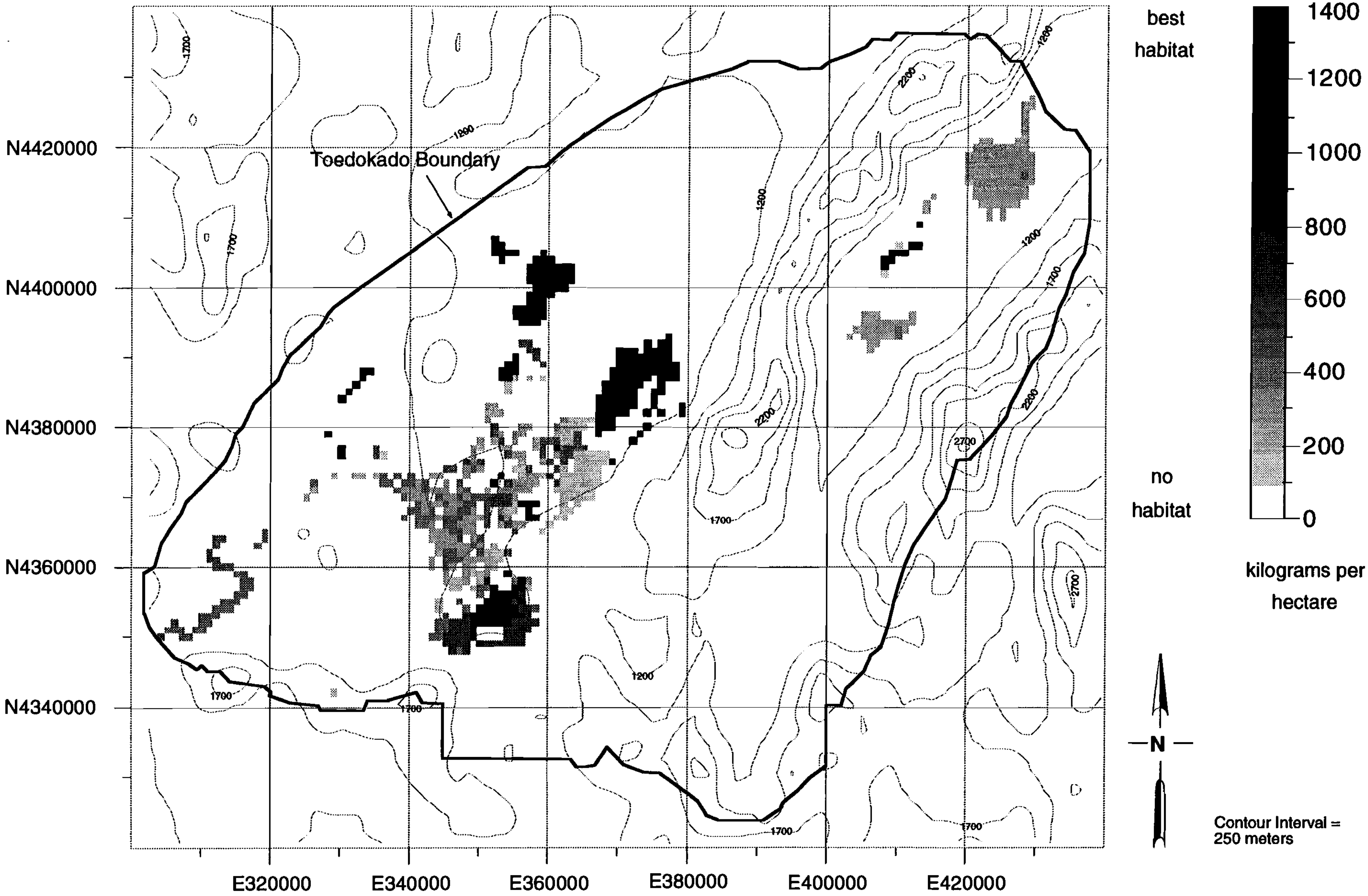

Figure 72. Normal year productivity of waterfowl forage plants (kg/ha) in Toedokado territory.

Fowler (1992:30-40) notes that the Cattail Eaters hunted waterfowl and gathered eggs near Tule Lake, Dutch Bill Lake, Millens Lake, Lead Lake, Nutgrass Lake, Stillwater Slough, Old River, and Carson Lake. Eggs and fledglings of waterfowl and shorebirds were gathered in spring and early summer. Northern Paiute hunted adult waterfowl by employing decoys, snares, nets, and diving techniques. The migratory birds of the Pacific flyway were most available in two peak seasons, from February to March and September to November. American coots or mudhens were taken in drives during their late summer molt (Fowler 1992:48-54).

Waterfowl populations in Stillwater Marsh can range as high as 25,000 birds in years when conditions are best, but populations can fluctuate dramatically (Thompson and Hallock 1988). Simms (1987:47) estimates that return rates for procuring ducks can range from 2000 to 2700 calories per hour. Reidhead (1976:176-181) estimates a similar caloric return rate of about 1300 calories per hour for prehistoric duck hunters in the eastern United States, while Winterhalder (1981:83) observes that ethnographic Cree can obtain 3000 calories per hour hunting ducks in Canada.

Upland Game Birds

Fowler (1992:87) lists sage grouse, blue grouse, and mountain quail as highland species that the Toedokado used as food, with sage grouse preferred. However, blue grouse and mountain quail typify high altitude, coniferous forests (USDI Fish and Wildlife Service 1978; Maser et al. 1984) and are unlikely ever to have been abundant in Toedokado territory. The present discussion emphasizes sage grouse over other species.

One specimen of sage grouse appeared in the Hidden Cave faunal assemblage (Grayson 1985:133), none in the Stillwater Marsh collections (Dansie 1987; Livingston 1988). The low representation of sage grouse in the Toedokado archaeological record may reflect the lack of excavated sites in sagebrush communities.

Sagebrush is critical to sage grouse habitat because it provides protective cover from weather and predators and represents the major overwinter food source for sage grouse (Eng 1986a; Call 1979; Call and Masser 1985; Roberson 1984). Sage grouse may occasionally forage in greasewood-shadscale vegetation communities in winters where deep snows prevent effective foraging in sagebrush. Similarly, in dry summers sage grouse may migrate to montane pinyon-juniper or mountain brush where water and succulent vegetation are available. However, greasewood-saltbush and montane communities are marginal areas for sage grouse and they reproduce almost exclusively in sagebrush communities (Masser et al. 1984; Call and Masser 1985; Roberson 1984).

Drinking water is a necessary component of sage grouse habitat: in summer months the birds may venture no farther than 1.5 to 3.5 km from a stream, spring, or seep (Eng 1986b; Call 1979), but in winter may use snow as a water source (Call and Masser 1985). Sage grouse generally prefer flat or gently rolling terrain over steeper slopes. Sage grouse use open meadows closely juxtaposed with patches of dense sagebrush as strutting grounds or leks while mating in the spring, and use meadows as foraging patches to provision hatchlings and fledglings with insects and succulent vegetation (Call 1979; Call and Masser 1979).

In sum, sage grouse subsist on three categories of food: insects vital to the young, succulent grasses and forbs in summer, and sagebrush leaves for overwintering. Table 24 lists sage grouse forage species, taken from Gullion (1964:122-136), calculated in Toedokado model.

Table 24. Forage Plants of Sage Grouse.

Common name	Genus/species	Forage Quality
Baltic rush	*Juncus balticus*	Good
Basin big sagebrush	*Artemisia tridentata tridentata*	Excellent
big/tall sagebrush	*Artemisia tridentata*	Excellent
black sagebrush	*Artemisia arbuscula nova*	Good
bud sagebrush	*Artemisia spinescens*	Excellent
clover	*Trifolium* sp	Excellent
currant	*Ribes* sp.	Poor
Douglas rabbitbrush	*Chrysothamnus vicidiflorus*	Poor
eriogonum	*Eriogonum* sp.	Poor
evening primrose	*Oenothera* sp.	Poor
low sagebrush	*Artemisia arbuscula*	Good
lupine	*Lupinus* sp.	Poor
meadow barley	*Hordeum brachyantherum*	Poor
milkvetch, locoweed	*Astragalus* sp.	Poor
mountain big sagebrush	*Artemisia vesayana*	Excellent
phlox	*Phlox* sp.	Poor
povertyweed	*Iva axillaris*	Poor
rabbitbrush	*Chrysothamnus* sp.	Poor
rubber rabbitbrush	*Chrysothamnus nauseosus*	Poor
rush	*Juncus* sp	Good
sagebrush	*Artemisia* sp.	Excellent
sedge	*Carex* sp	Poor
serviceberry	*Amelanchier* sp	Poor
silver sagebrush	*Artemisia cana*	Excellent
snowberry	*Symphoricarpos* sp.	Poor
spiny horsebrush	*Tetradymia spinosa*	Poor
western dock	*Rumex occidentalis*	Poor
wild rose	*Rosa* sp.	Poor
Woods rose	*Rosa woodsii*	Poor
Wyoming big sagebrush	*Artemisia. tridentata wyomingensis*	Excellent
yarrow	*Achillea* sp.	Poor

To predict which habitat types of the model represent best sage grouse habitat, we arbitrarily assumed that at least 80 kilograms per hectare of sagebrush was required to satisfy sage grouse preference for sagebrush as cover. This limited consideration to eleven habitats, including seven sagebrush community habitats, both montane habitats, one greasewood-saltbush habitat, and one wetland habitat. The quantity of sage grouse forage, abundance of sagebrush, and community affiliation of each habitat is listed in Table 25.

Table 25. Sage Grouse Forage Habitat Types With At Least 80 kg/ha Sagebrush.

Habitat Type	Forage (kg/ha)	Sagebrush (kg/ha)	Community
27	103	80	Sagebrush
36	117	101	Greasewood-Saltbush
48	126	96	Sagebrush
34	133	118	Montane
44	135	111	Sagebrush
35	159	134	Sagebrush
52	168	138	Sagebrush
37	196	168	Sagebrush
31	207	157	Sagebrush
47	313	253	Montane
51	694	112	Wetland

As can be seen, upland springs habitat type 51 has by far the greatest abundance of sage grouse forage, at 694 kilograms per hectare. The abundance of forage as well as the published preference of sage grouse for upland meadows near water prompt us to rank Habitat 51 as the best sage grouse habitat in the study area. Montane Habitat 47 also has high quantities (313 kg/ha) of sage grouse food, representing, we suspect, good summer sage grouse habitat. Next in productivity are sagebrush Habitats 31 (207 kg/ha), 37 (196 kg/ha), and 35 (168 kg/ha). These habitats are likely to be good summer foraging areas for sage grouse in Toedokado territory. They occur in greatest abundance in the Stillwater and Clan Alpine Mountains, with isolated occurrences in the Cocoon, Sand Springs, and Fairview Mountains.

Fowler (1989:58) reports that Northern Paiute stalked the birds on spring strutting grounds, dispatching them with bow and arrow. Winterhalder (1981:83) notes that ethnographic Cree obtain 1200 to 1800 calories per hour capturing grouse, which we take to be a reasonable estimate of the caloric return feasible for hunting sage grouse in Toedokado territory.

Fish

Fish native to Toedokado territory and eaten by its ethnographic inhabitants (Fowler 1992:60) include tui chub, Tahoe sucker, redside shiner, and speckled dace. Of these, tui chub and Tahoe sucker remains were common in archaeological assemblages from Stillwater Marsh (Greenspan 1988). Tui chub dominated fish assemblages at Hidden Cave, but Tahoe sucker and redside shiner were present, as were minor quantities of Lahontan cutthroat trout and cui-ui (Smith 1985). The following discussion emphasizes tui chub because its ubiquity in archaeological deposits and because data on tui chub are most extensive.

Tui chub occur in lacustrine, palustrine, and riparian habitats widely distributed in the western Great Basin. In lakes and marshes, chub are most abundant in shallow waters from late spring until winter (Sigler and Sigler 1987). In Stillwater Marsh, they characterize submergent and deeper emergent marsh habitats where they feed on invertebrates, vascular plants, algae, and other fish (Sigler and Sigler 1987; Hamilton and Auble 1993:12-14). Tui chub may spawn from April until August (Sigler and Sigler 1987), but not typically in runs (Fowler 1992:60). Tui chub populations can fluctuate rapidly in response to flooding and drought, and can occur in the millions under favorable conditions (Raymond and Sobel 1990).

Cattail Eaters procured fish through various techniques including weirs, baskets, gill netting, seining, harpooning, and hook and line (Fowler 1992:60). Experimental collection of tui chub by gill netting produced caloric return rates raging from 750 to 7500 calories per hour (Raymond and Sobel 1990). The experiments suggested that younger, smaller chub may have been energetically more profitable because they could be netted in large numbers and required lower handling times. The distributions of tui chub cannot be inferred any more precisely than by noting that they should occur in submergent and deeper emergent waters of Carson River, Carson Lake, Indian Lakes, Stillwater Marsh, and Stillwater Slough (Hamilton and Auble 1987:13). Fowler (1992:36, 39, 61-62) records narrow channels separating Nutgrass, Tule, and Dutch Bill Lakes in Stillwater Marsh, as well as Stillwater Slough as ethnographic fishing locations of the Toedokado.

Invertebrates

Invertebrates eaten by Toedokado Paiute include insects and freshwater mollusks. The Cattail Eaters (Fowler 1992:72, 80, 87) and neighboring Northern Paiute bands (Fowler 1989:60-62) harvested a variety of insects, of which two were sufficiently important to warrant discussion herein. Brine fly larvae were collected from Soda Lake early in summer when larvae are washed ashore in windrows. Experimental harvest of grasshopper windrows along Great Salt Lake (Madsen and Kirkman 1988:602) produced phenomenally high caloric returns at 27,000 calories per hour; windrows of brine fly should be comparatively profitable. Mormon cricket also were gathered by the Cattail-Eaters, during years when the insects swarm in the upland canyons and alluvial fans. Experimental harvesting of Mormon cricket returned approximately 9000 calories per hour (Jones and Madsen 1991:69-71).

The ethnographic record for the utilization of freshwater mollusks by the Toedokado is scant (Fowler 1992:72; see also Steward 1933:255), although mollusk shells are significant components of some archaeological sites in Stillwater Marsh. The latter suggests that mussels were a staple food in some marsh settings (Drews 1990). Bivalve shells from Stillwater archaeological sites are all *Anadonta* (spp.), which thrives in lakes and slow moving streams. They prefer vegetation-free, muddy substrates (Drews 1990; 66). At least two populations of *Anadonta* are known to exist in Stillwater Marsh. Densities of bivalves in these populations approach two individuals per square meter (Steve Thompson personal communication to Mike Drews, in Drews 1990:66). Several species of snail are also elements of archaeological invertebrate assemblages at Stillwater. Snails usually live on emergent vegetation in lakes (Drews 1990; Thompson and Hallock 1988).

Although both bivalves and snails occur in Stillwater assemblages, only bivalves are accepted as food remains (Drews 1990; cf. Fowler 1992:72), inasmuch as gastropods can occur naturally in archaeological deposits. However, Drews (1990:71) cautions that gastropods cannot be discounted as dietary item, based on the archaeological or ethnographic evidence. The energetics of mussel utilization in Stillwater Marsh are poorly understood, although Drews (1990:66) cites evidence that two people can gather a bucketful of bivalves by hand in 15 minutes (Steve Thompson personal communication to Mike Drews in Drews 1990:66). Summarizing literature from the eastern United States, Reidhead (1976:124-131) estimates that harvesting bivalves by hand can provide an energetic return rate of around 1600 calories per hour. Cumbaa (1976:49-59) reports that hand collection of gastropods from shallow marsh environments in Florida can return around 2000 calories per hour. Adding additional processing costs estimated by Reidhead lowers this return rate to between 1000 and 1300 calories per hour, a relatively high value that underscores gastropods as a potential food resource for Cattail Eaters.

Exact distributions of insects and mussels are difficult to estimate in the Toedokado model. Ethnographic data assign brine fly to the alkaline waters of Soda Lake, but Mormon cricket are impossible to assign to specific quadrats. Because of their habitat requirements, shellfish, of course, can be assumed to occur in Stillwater Marsh, Stillwater Slough, Indian Lakes, the Carson River delta, and Carson Lake.

Chapter 5. BEHAVIORAL AND ARCHAEOLOGICAL IMPLICATIONS OF RESOURCE DISTRIBUTIONS

David W. Zeanah and Robert G. Elston

The two previous chapters present our best understanding of the distribution, abundance, and economic costs and benefits of biotic resources in Toedokado territory. Here, we use the habitat model to rank habitats according to their human foraging potential and to make predictions about the archaeological record of those habitats. So doing requires us to acknowledge that hunter-gatherers value resources unequally, and that resources are distributed unevenly in space and time. We assume that hunter-gatherers decide where and what to forage based on consideration of the relative value of resources simultaneously available at alternative locations. We subscribe to the working assumption of optimal foraging theory that, given a particular technological repertoire and environmental context, net energy capture rates serve to model the relative value of resources, and hence to predict foraging decisions.

However, in order to use optimal foraging models to understand the foraging decisions of Toedokado, we must also incorporate two constraints into the model that structured ethnographic Toedokado subsistence and settlement strategies: seasonality and sexual division of labor. Seasonality determines intra-annual fluctuation in the availability of resources, whereas the sexual division of labor is a fundamental tactic of hunter-gatherers for scheduling procurement of simultaneously available but spatially dispersed resources. Introduction of these parameters into the model improves the realism and accuracy of its predictions.

Thus, the present chapter considers a set of subsistence resources that we can spatially map through the habitat model. We first rank the relative values of these resources according to caloric costs and benefits. Next, we divide the resources into men's and women's prey, based on the ethnographic record. Then, we further classify the resources according to seasonal availability. We project these sets of resources against the habitat model and ethnographic record to predict which habitats would have been seasonally most productive foraging patches for each sex. This consideration serves as the basis for generating predictions about the archaeological record.

Variable Returns of Major Resources in Toedokado Territory

The diet breadth model calculates the returns of exploiting food species in a given environment based on the time required to procure and process items of each species, and the number of calories thereby obtained per unit of handling time. Net returns are thus expressed as calories per hour and this figure can be used to rank the caloric costs and benefits of different resources. However, estimates of handling cost only calculate the time necessary to extract energy from a resource after it is encountered, excluding the search time necessary to find the resource. Thus, for any specific environment, the relative rank of a resource in a diet breadth model is independent of its abundance (i.e., the encounter rate), and the net caloric return rate of a single resource is different from the average return rate for searching and foraging all dietary items in that environment. A forager should only take a particular resource if the return after collecting and processing that resource (i.e., its net return) is greater than the return for seeking, collecting, and processing all higher ranked resources (i.e., the average return). This means that optimal diet breadth expands or contracts in response to fluctuating resource abundance.

The diet breadth model makes three specific predictions: 1) Hunter-gatherers always will take highest ranked resources when encountered. 2) Whether a forager takes a lower ranked resource depends on the comparative abundance of higher ranked resources and not on the abundance of lower ranked resource. 3) Foragers include or drop particular resources from optimal diets, because of fluctuations in the abundance of higher ranked resources; if high ranked resources increase in abundance then low ranked resources may fall from the diet, but foragers may add new resources to the diet if the abundance of higher ranked resources declines (Schoener 1971).

To conceptualize the principles and predictions of the diet breadth model, imagine that a Toedokado gatherer forages in an environment where ground squirrel (at 5900 cal/hr), shadscale seed (at 1200 cal/hr), and iodine bush seed (at 180 cal/hr) are available. If ground squirrel are sufficiently abundant that the gatherer can achieve average foraging returns greater than 1200 calories per hour for seeking, collecting, and processing only squirrel, she will not harvest the seed of shadscale or iodine bush no matter how often she encounters them. If the overall return rate for squirrel falls below 1200 calories per hour (perhaps because of overhunting or an environmental change), the gatherer will add shadscale seed to her diet. However, note that she will continue to take squirrel no matter how rare they may be, but as long as the average foraging returns for seeking and harvesting squirrel and shadscale remain greater than 180 calories per hour, she will never harvest iodine bush seed no matter how abundant they may be.

Using these principles, we can predict which resources the Toedokado should prefer and model situations when the Toedokado should take or bypass any specific resource. However, to do so, we must first estimate the net return rates of food items in Toedokado territory and thereby rank the resources. Major resources known from ethnographic accounts to be in the diet of the Toedokado Paiute (Wheat 1967; Fowler 1992) and for which caloric return rates have been experimentally determined or qualitatively estimated, as discussed in Chapter 4, are listed in Table 26. Tabled data include the rank order of the resource in the year-round diet, post-encounter returns (range, mean, standard deviation), and source of experimental return data.

Table 26. Rank Order of Toedokado Foods by Calories per Hour.

Rank	Resource	Caloric Range	Caloric Mean	Standard Deviation	Number of Experiments	Data Source
1	Winter-killed fish	--	--	--	--	Raven and Elston 1989
2	Grasshopper/ brine fly larvae	4160-71441	27265	27366	4	Jones and Madsen 1991
3	Deer	17971-31450	24711	-	-	Simms 1987
4	Bighorn sheep	17971-31450	24711			Simms 1987
5	Antelope	15725-31450	23588			Simms 1987
6	Jackrabbit	13475-15400	14438			Simms 1987, Winterhalder 1981
7	Gopher	8983-10780	9882			Simms 1987
8	Cottontail rabbit	8983-9800	9392			Simms 1987, Winterhalder 1981
9	Mormon cricket	618-33156	9229	11497	8	Jones and Madsen 1991
10	Ground squirrel (large)	5390-6341	5866			Simms 1987
11	Woodrat	--	--	--	--	Chapter 4, this report
12	Marmot	--	--	--	--	Chapter 4, this report
13	Cattail pollen	2750-9360	5739	-	2	Simms 1987
14	Muskrat	4200-6200	--	--	--	Winterhalder 1981
15	Ground squirrel (small)	2837-3593	3215			Simms 1987
16	Biscuitroot	3831-1219	2525	-	2	Couture et al. 1986
17	Tui chub (lake)	892-3757	2460	1182	6	Raymond and Sobel 1990
18	Duck	1975-2709	2342			Simms 1987
19	Duck eggs & fledglings	--	--	--	--	Chapter 4, this report
20	Tui chub (pond)	750-2784	1925	828	6	Raymond and Sobel 1990
21	Hardstem bulrush seed	1699	1699	-	1	Simms 1987
22	Sage grouse	1200-1800	--	--	--	Winterhalder 1981

Table 26, continued.

Rank	Resource	Caloric Range	Caloric Mean	Standard Deviation	Number of Experiments	Data Source
23	Tansymustard seed	1307	1307	-	1	Simms 1987
24	Bitterroot root	1374	1374	-	1	Couture et al. 1986)
25	Pinyon pine nut	1003-1702	1296	305	7	Simms 1987; Barlow and Metcalf 1994
26	Shellfish	--	--	--	--	Chapter 4, this report
27	Arrowleaf balsamroot	--	--	--	--	Chapter 4, this report
28	Shadscale seed	1200	1200	-	1	Simms 1987
29	Onion root	--	--	--	--	Chapter 4, this report
30	Peppergrass seed	537	684	-	2	Simms 1987
31	Currant	--	--	--	--	Chapter 4, this report
32	Wolfberry	--	--	--	--	Chapter 4, this report
33	Anderson peachbrush	--	--	--	--	Chapter 4, this report
34	Silver buffaloberry	--	--	--	--	Chapter 4, this report
35	Wild rose	--	--	--	--	Chapter 4, this report
36	Serviceberry	--	--	--	--	Chapter 4, this report
37	Four-wing saltbush	--	--	--	--	Raven and Elston 1989
38	Torrey quailbush	--	--	--	--	Raven and Elston 1989
39	Seepweed	--	--	--	--	Raven and Elston 1989
40	Sunflower seed	467-504	486	-	2	Simms 1987
41	Salt marsh bulrush seed	470	470	-	1	Simms 1987
42	Bluegrass (*Poa* sp.)	419-418	456	-	1	Simms 1987
43	Great Basin wildrye seed	266-492	379	103	6	Simms 1987; Bullock 1994
44	Indian ricegrass seed	301-392	345	34	5	Simms 1987, Jones and Madsen 1991
45	Small bulrush seed	302	302	-	1	Simms 1987
46	Creeping wildrye	--	--	--	--	Raven and Elston 1989
47	Western wheatgrass	--	--	--	--	Raven and Elston 1989
48	Slender wheatgrass	--	--	--	--	Raven and Elston 1989
49	Cattail seed	--	--	--	--	Raven and Elston 1989
50	Scratchgrass seed	162-294	249	-	3	Simms 1987
51	Dropseed seed	162-294	249	-	3	Simms 1987
52	Alkali sacaton seed	--	--	--	--	Raven and Elston 1989
53	Sago pondweed seed	--	--	--	--	Chapter 4, this report
54	Annual Forbs	--	--	--	--	Raven and Elston 1989
55	Foxtail barley seed	138-273	206	-	2	Simms 1987
56	Meadow barley seed	--	--	--	--	Chapter 4, this report
56	Sedge seed	202	202	-	1	Simms 1987
58	Western dock seed	--	--	--	--	Chapter 4, this report
59	Spikerush seed	--	--	--	--	Raven and Elston 1989
60	Bulrush root	160-257	200	3		Simms 1987
61	Pickleweed seed	87-272	184	82	6	Simms 1987; Barlow and Metcalf 1994
62	Kochia seed	--	--	--	--	Chapter 4, this report
63	Mariposa lily root	--	--	--	--	Chapter 4, this report
64	Cattail root	42-267	161	68	19	Jones and Madsen 1991; Simms 1987
65	Needlegrass seed	--	--	--	--	Raven and Elston 1989
66	Prince's plume	--	150	--	--	Hooper 1994
67	Saltgrass seed	146-160	153	-	2	Simms 1987
68	Squirreltail grass seed	91	91	-	1	Simms 1987

The procedures used to rank resources here differ somewhat from that of Raven and Elston (1989:135; Table 13). Although the present study area includes the previous one (Stillwater Wildlife Management Area), it is much larger and more environmentally varied. Too, experimental caloric return data for more species are now at hand than were available during development of the original Stillwater model (Larralde and Chandler 1980:102-108; Couture et al. 1986; Simms 1987; Raymond and Sobel 1990; Jones and Madsen 1991; Bullock 1994; Barlow and Metcalfe 1994; Hooper 1994).

Raven and Elston (1989:135; Table 13) rank resources by the lowest return rate experimentally obtained from each. While such a conservative approach helps insure against inflating the rank of any particular resource, the lowest possible returns probably are not representative of those obtained when prehistoric hunter-gatherers chose to harvest that resource (Simms 1987:82). Moreover, data from multiple experiments on several resources now are available, allowing better assessment of their mean resource return rates. Using the lowest return rate from multiple experiments probably tends to undervalue the rank of those resources relative to others for which data from only one experiment are available. Since we wish to estimate accurately the relative rank of these resources, rather than to determine precisely their true return rates, this could represent a serious bias. Consequently, we have averaged returns for multiple resources to calculate a mean return that probably is closer to the value attained aboriginally than either the upper or lower extreme.

In some cases where no experimental return were data available, Raven and Elston (1989:135, Table 13) ranked resources qualitatively. We follow their lead here, although ranks of several unquantified resources differ slightly from those previously assigned by Raven and Elston (1989:135, Table 13). Rationales for caloric return estimates are explicated in Chapter 4.

When compiling the data for Table 26, we took care to choose the most precise estimates of energetic returns available in the ethnographic and experimental literature. Critics sometimes question the reliability of such figures because today's amateurs probably cannot duplicate the returns obtained by expert hunter-gatherers of the past (Bettinger 1991:103). But the important question here is not whether modern scholars forage as well as the prehistoric Toedokado—we can safely assume that they do not—but whether the inexperience of modern foragers distorts the relative rank of resources as presented in Table 26. In other words, whether or not the ranking precisely duplicates the returns obtained by prehistoric foragers is unimportant, but accurately reflecting the relative ranking of resources is essential. We are confident in the Table 26 rankings for two reasons.

First, independent researchers have derived similar experimental return rates for several resources, including iodine bush (Simms 1987:108-109; Barlow and Metcalfe 1994), cattail roots (Simms 1987:133; Jones and Madsen 1991:71), Indian ricegrass (Larralde and Chandler 1980:107; Simms 1987:119-121; Jones and Madsen 1991:71-72), Great Basin wild rye (Simms 1987:114-115; Bullock 1994), bitterroot (Simms 1987:118; Couture et al. 1986:158), and pinyon (Simms 1987:121-123; Barlow and Metcalfe 1994). That many of the return rates are replicable allows us some confidence in the reliability of the rankings.

Second, there is a pattern in the rankings of kinds of resources. With some exceptions, resources rank from highest to lowest in the following sequence: large mammals, medium sized mammals, small mammals/birds/fish/shellfish/insects, nuts/roots/annual seeds/fruits/shrub seeds, and small perennial seeds/forbs. This general rank order of resource classes by return rate reflects many modern analyses of the energetic return rates procured by living hunter-gatherers. For example, ethnographers have calculated similar diet rankings from observations of hunter-gatherers in the Arctic and Subarctic (Winterhalder 1981; Smith 1992), South America (Hawkes et al. 1982; Hames and Vickers 1982), and Australia (Cane 1987; Jones 1980; O'Connell and Hawkes 1981, 1984; M.M. Raven 1990).

Nevertheless, given the experimental nature of return rates used here, we decline to predict foraging decisions based on deceptive precision in the return rates. For example, we will not predict that hunter-gatherers should always take wildrye seeds before ricegrass seeds because the former return only 43 more calories per hour than the latter. This minor difference between return rates is far too small for predictive purposes, given the limited number of experiments conducted thus far. Here, as in Raven and Elston (1989:136), we group resources into classes defined by ranges of similar return rates (Table 27). This allows us to compare potential rates available from foraging in different habitats without making predictions based on empty specificity among resource return rates.

Table 27. Resource Classes Ranked According to Caloric Returns.

Rank by Class	Range of Caloric Return	Resource	Rank by Calories/Hr
8	20000+	Winter-killed fish	1
		Grasshopper/brine fly larvae	2
		Deer	3
		Bighorn sheep	4
		Antelope	5
7	9000 - 19999	Jackrabbit	6
		Gopher	7
		Cottontail rabbit	8
6	3500 - 8999	Ground squirrel (large)	9
		Woodrat	10
		Marmot	11
		Cattail pollen	12
		Muskrat	13
5	1500-3499	Ground squirrel (small)	14
		Biscuitroot	15
		Tui chub (lake)	16
		Duck	17
		Duck eggs and fledglings	18
		Tui chub (pond)	19
		Hardstem bulrush seed	20
		Sage grouse	21
4	900-1499	Tansymustard seed	22
		Bitterroot root	23
		Pinyon pine nut	24
		Shellfish	25
		Arrowleaf balsamroot	26
		Shadscale seed	27
		Onion root	28
3	600-899	Peppergrass seed	29
		Currant	30
		Cooper wolfberry	31
		Anderson peachbrush	32
		Silver buffaloberry	33
		Wild rose	34
		Serviceberry	35
		Four-wing saltbush seed	36
		Torrey quailbush	37
		Seepweed	38

Table 27, continued.

Rank by Class	Range of Caloric Return	Resource	Rank by Calories/Hr
2	300-599	Sunflower seed	39
		Salt marsh bulrush seed	40
		Bluegrass	41
		Great Basin wildrye seed	42
		Indian ricegrass seed	43
		Small bulrush seed	44
		Creeping wildrye	45
		Western wheatgrass	46
		Slender wheatgrass	47
1	0-299	Cattail seed	48
		Scratchgrass seed	49
		Dropseed seed	50
		Alkali sacaton seed	51
		Sago pondweed seed	52
		Forbs	53
		Foxtail barley seed	54
		Meadow barley seed	55
		Sedge seed	56
		Western dock seed	57
		Spikerush seed	58
		Bulrush root	59
		Pickleweed seed	60
		Kochia seed	61
		Mariposa lily root	62
		Cattail root	63
		Needlegrass seed	64
		Princes Plume greens	65
		Saltgrass seed	66
		Squirretail Grass seed	67

Notice that there are generally more resources in lower ranked classes than in higher ranks, suggesting that more choices are available to hunter-gatherers at the lower end of the diet. Because of this, we have grouped resource ranks according to an approximate logarithmic scale rather than the linear scale devised by Raven and Elston (1989:136; Table 14). Classes 1 through 3 have equal intervals of 300 calories per hour (up to 900 cal/hr). In contrast, Class 4 contains resources yielding from 900 to 1499 calories per hour, Class 5 resources provide between 1500 and 3499 calories per hour, Class 6 contains resources producing between 3500 and 8999 calories per hour, Class 7 resources provide more than 9000 calories per hour, and Class 8 resources yield 20000 or more calories per hour.

When we divide the set of resources in this way, the robustness of the energetic return rate data becomes apparent. Although the reliability of the return rate data for predicting foraging decision among closely ranked resources such as Indian ricegrass and Great Basin wild rye is questionable, it is more difficult to argue that the experimental data are insufficiently accurate to distinguish foraging decisions between different classes of resources. For example, the return rates for Great Basin wild rye presented in Table 27 must be overestimated by at least 20% in order to shift from a Class 2 resource to a Class 1 resource. The rates would have to be underestimated by at least 35% for Great Basin wild rye to move into Class 3 and 65% to move into Class 4 (cf. Simms 1987:79). Given the replicability of many return rate estimations, it is difficult to imagine returns ever being off to such significant degrees.

The only situations we foresee in which resources could produce much higher return rates than represented in Table 27 would be exceptional cases where selected resources might occur in superabundance. For example, shallow lakes and marshes sometimes deposit resources such as insects, fish, and seeds in immense quantities in windrows along lake edges. Experimental harvests of grasshopper windrows along Great Salt Lake, for example, produced phenomenally high return rates (Madsen and Kirkman 1988). Ethnographic accounts (Sutton 1989, Miller 1972) indicate that brine fly larvae, bulrush seeds, and iodine bush also occasionally occur in windrows and should produce similarly high return rates (Bettinger 1993:51). Since such special circumstances do occur, we have included two windrow resources known to occur the study area (grasshoppers and winter-killed fish), in Table 27.

It is worth noting, however, that the location and timing of windrow resources are unpredictable. For example, in order for grasshoppers to provide such high returns they must swarm, fall into water, drown, and be washed up on shore in windrows (Madsen and Kirkman 1988). Similarly, fish in shallow ponds and lakes occasionally succumb to evaporation, to induced increases in water salinity, and to sudden freezing, as they did in the Carson Sink in the winter of 1986-87 (Rowe and Hoffman 1988), resulting in dense accumulations of salted, frozen fish along 40 miles of lake shorelines. Because such events are so erratic, we do not consider windrow resources further in this model except to note that the prehistoric Toedokado should exploit them whenever they are available.

Diet and Sexual Divisions of Labor

Sexual division of labor represents a fundamental aspect of the organization of hunter-gatherer subsistence strategies (Kaplan and Hill 1992:195; Hames 1992:226), one shared by ethnographic Great Basin groups (Steward 1938:44). Males and females specialize in the procurement of different sets of resources: males typically hunt whereas females emphasize gathering. From the perspective of evolutionary ecology, gender division of labor among hunter-gatherers is a consequence of selection for behaviors that increase the reproductive fitness of both sexes. The degree of mobility necessary to procure large game induces selective pressure for sexual division of labor. The mobility of women is constrained by child-rearing (Hurtado et al. 1985:1-28); however, large game are sufficiently valuable to women and children, nutritionally and calorically, to prompt males to specialize in hunting so as to provision offspring or prospective mates with large packages of meat (Hill 1988; Hawkes 1990). Evolutionary ecologists working among present-day hunter-gatherers warn that sexual division of labor cannot be ignored when applying optimal foraging models to humans, because men and women forage under different constraints (Hill et al. 1987; Simms 1987:36). Thus, we model men's and women's foraging strategies separately.

Table 28 lists resources (by resource class) for which the ethnographic record specifies Toedokado gender-related procurement; tabulated data therein argue against the simple generalization that men hunt and women gather. While only men procure deer, sheep, woodrat, marmot, and muskrat, women participate in the procurement of all other faunal resources. Similarly, while most plant procurement falls to women, men participate in the harvest of pinyon and Indian ricegrass seeds.

The greatest difference between men's and women's prey is the absence of a male role in procuring most of the relatively low ranked plant resources, an observation consistent with Simms's (1987:80-86) previous analysis demonstrating that seeds should be excluded from the optimal diet of men. This is methodologically unfortunate for us because the optimal foraging models we employ to rank habitats demand that we emphasize the highest ranked resources, which is where male and female resource procurement behavior overlap most. To distinguish male and female foraging decisions, we must discriminate between men's and women's prey with more exclusivity than is inherent in Table 28.

Table 28 Ethnographically Recorded Men's and Women's Resources.

Class	Resource	Womens' Resource	Mens' Resource	Date Source
8	Deer		X	Fowler 1989:11
	Bighorn sheep		X	Fowler 1989:11
	Antelope	X	X	Fowler 1989:14-16
7	Jackrabbit	X	X	Fowler 1992:78
	Cottontail rabbit	X	X	Fowler 1992:78
6	Ground squirrel (large)	X	X	Fowler 1992:79
	Woodrat		X	Fowler 1992:78
	Marmot		X	Fowler 1992:78
	Cattail pollen	X		Wheat 1967:23, Fowler 1992:65-66
	Muskrat		X	Fowler 1992:70,
5	Ground squirrel (small)	X	X	Fowler 1989:23, 1992:79
	Biscuitroot	X		Fowler 1992:81
	Tui chub (lake)	X	X	Fowler 1992:61-64, Fowler 1989:30, Wheat 1967:61)
	Duck	X	X	Fowler 1992:46, 58-59, Wheat 1967:9
	Duck eggs and fledglings	X	X	Fowler 1992:55, Fowler 1989:57
	Tui chub (pond)	X	X	Fowler 1992:61-64, Fowler 1989:30, Wheat 1967:61)
	Hardstem bulrush seed	X		Fowler 1992:68, Wheat 1967:15
	Sage grouse		X	Fowler 1989:58
4	Tansymustard seed	X		Wheat 1967:10
	Bitter root	X		Fowler 1992:81
	Pinyon pine nut	X	X	Fowler 1989:51, Wheat 1967:29-31
	Arrowleaf balsamroot	X		Fowler 1992:81
	Shadscale seed	X		Fowler 1992:76
	Four-wing saltbush seed	X		Fowler 1992:76
	Onion root	X		Fowler 1989:44
3	Torrey quailbush	X		Fowler 1992:76
	Silver buffaloberry	X		Fowler 1992:75, Wheat 1967:23
	Seepweed	X		Wheat 1967:15
2	Sunflower seed	X		Fowler 1992:83
	Salt marsh bulrush seed	X		Fowler 1992:68
	Great Basin wildrye seed	X		DeQuille 1963:53
	Indian ricegrass seed	X	X	Fowler 1989:46
	Small bulrush seed	X		Fowler 1992:68
	Creeping wildrye	X		DeQuille 1963:53
1	Cattail seed	X		Wheat 1967:15, Fowler 1992:66
	Sago pondweed seed	X		Fowler 1992:68
	Sedge seed	X		Fowler 1989:44, Fowler 1992:69
	Western dock seed	X		Fowler 1992:70
	Cattail root	X		Fowler 1992:65

Reviewing the ethnographic record, we note a distinction between women's *cooperative* role in the procurement of antelope, rabbit, fish, and waterfowl, and their *independent* role in small mammal procurement. In the cases of antelope, rabbit, fish and waterfowl, women cooperate with men in communal or family efforts. Procurement of these resources involves technologies, the tools of which are the responsibility of men to fabricate and maintain, and men hone their skills in the necessary capture techniques. While women dispatch and process game trapped by communal or family effort (Fowler 1992:78), the ethnographic record hints that women rarely conduct such pursuits independently of men, but men frequently do so without the assistance women (but see Fowler 1992:62 for an exceptional example of how women occasionally use seed harvesting technology to fish independently). In contrast to cooperative communal and family hunting endeavors, the ethnographic record is explicit about women making snares and being skilled at trapping small rodents independently (Fowler 1989:23, 1992:79).

Similarly, the ethnographic data are clear that men's role in Indian ricegrass and pinyon procurement is supplemental to that of women (Fowler 1989:46). Women manufacture and maintain the specialized tools of the technology, and are expert at the techniques necessary for the procurement and processing of these resources. There is no evidence that men procure and process Indian ricegrass independently, although men occasionally help women harvest (Fowler 1989:46) and grind (Fowler 1989:11) seeds. Both men and women participate in pinyon harvests (Wheat 1967:29; Fowler 1989:51), and men frequently own pinyon groves (Fowler 1989:143-144). However, women occasionally harvest pinyon without the aid of men (Fowler 1989:10, 30), but we find no evidence in the ethnographic record that the converse is true. We also see a similar distinction in the gathering of bird eggs and fledglings. While men and women may cooperatively raid nests (Fowler 1989:57), ethnographers report only women harvesting eggs and fledglings alone (Fowler 1992:55).

In light of these considerations, we draw a finer line between male and female prey than is seen in Table 28, classifying antelope, fish, rabbits, gophers, marmots, woodrats, and waterfowl as men's resources, ground squirrels and small rodents as both men's and women's resources, and mollusks, bird eggs, and fledglings as women's resources. Similarly, we exclude men from Indian ricegrass and pinyon procurement, classifying these as women's resources.

Table 29 revises the gender division of prey for purposes of this model. With the notable exception of Class 6, the highest ranked resources tend to be those obtained by hunting and fishing, activities dominated by men in the traditional culture of Toedokado Paiute (Wheat 1967; Fowler 1992). Men's and women's strategies overlap only in resource Class 6, where cattail pollen and large ground squirrels are profitable resources for women, and in Class 5, where the returns of both men's and women's prey are comparable.

Table 29. Modified Mens' and Womens' Prey Sets.

Class	Range of Caloric Return	Resource	Women	Men
8	20000+	Deer		X
		Bighorn sheep		X
		Antelope		X
7	9000+	Jackrabbit		X
		Gopher		X
		Cottontail rabbit		X
6	5000+	Ground squirrel (large)	X	X
		Woodrat		X
		Marmot		X
		Cattail pollen	X	
		Muskrat		X

Table 29, continued.

Class	Range of Caloric Return	Resource	Women	Men
5	1500-3499	Ground squirrel (small)	X	X
		Biscuitroot)	X	
		Tui chub (lake)	X	X
		Duck		X
		Duck eggs and fledglings	X	
		Sage grouse		X
		Tui chub (pond)	X	X
		Hardstem bulrush seed	X	
4	900-1499	Tansymustard seed	X	
		Bitterroot root	X	
		Pinyon pine nut	X	
		Shellfish	X	
		Arrowleaf balsamroot	X	
		Shadscale seed	X	
		Four-wing saltbush seed	X	
		Onion root	X	
3	600-899	Peppergrass seed	X	
		Currant	X	
		Cooper wolfberry	X	
		Anderson peachbrush	X	
		Silver buffaloberry	X	
		Wild rose	X	
		Serviceberry	X	
		Torrey quailbush	X	
		Seepweed	X	
2	300-599	Sunflower seed	X	
		Salt marsh bulrush seed	X	
		Bluegrass	X	
		Great Basin wildrye seed	X	
		Indian ricegrass seed	X	
		Small bulrush seed	X	
		Arrowhead (wapato)	X	
		Creeping wildrye	X	
		Western wheatgrass	X	
		Slender wheatgrass	X	
1	0-299	Cattail seed	X	
		Scratchgrass seed	X	
		Dropseed seed	X	
		Alkali sacaton seed	X	
		Sago pondweed seed	X	
		Other forbs	X	
		Foxtail barley seed	X	
		Meadow barley seed	X	
		Sedge seed	X	
		Western dock seed	X	
		Spikerush seed	X	
		Bulrush root	X	
		Pickleweed seed	X	
		Kochia seed	X	
		Mariposa lily root	X	
		Cattail root	X	
		Needlegrass seed	X	
		Princes Plume greens	X	
		Saltgrass seed	X	
		Squirretail Grass seed	X	

In all resource classes, men's prey are mobile, requiring considerable investment in search time, while women's resources are relatively stationary and entail higher investment in processing time. This has important implications for the relative weight of foraging decisions on settlement patterns based on "men's resources" (i.e., those involving hunting mobile, unpredictable, highly ranked resources, that may require long distance capture forays) versus "women's resources" (i.e., those that tend to be calorically lower ranked and immobile, exploitable by short trips from hearthside). Like Raven and Elston (1989:153; see also Madsen 1989), we expect that optimal residence locations generally are closer to women's foraging patches (because women's resources are immobile and frequently are too low ranked to carry high search costs and still remain profitable) than to men's foraging patches (because men's highly mobile resources are sufficiently high ranked calorically to sustain high search costs and remain profitable). The premise that the Toedokado divided foraging roles by gender based on mobility is supported by osteological analyses of skeletal populations from Stillwater Marsh, which show significantly higher occurrences of osteoarthritis among males than females. Prevalence of the skeletal pathology in the shoulders, hips, and ankles of males probably reflects physiological stress incurred in their performance of mobile resource procurement tasks in severe terrain (Larsen and Hutchinson 1994).

It should be noted that, by arbitrarily dividing men's and women's resources in the manner described in Table 29, we are not ignoring the variability in male and female foraging strategies indicated by the ethnographic record. Rather, it is our view that men and women specialize in procurement of different, but complementary, sets of resources which they share at central place base camps. The critical factor determining whether men or women take a resource is the mobility required to procure it (i.e., search and transport cost), not the kingdom (plant or animal) or rank (caloric return relative to handling cost) of the resource. In this scheme, men's resources generally tend to be calorically higher ranked (excluding search costs) than women's resources. The diet breadth of women tends to be broader (i.e., to include more lower ranked resources) than that of men (Simms 1987:80-86).

At times, the net return rate (including search time as a cost) obtainable from a resource ordinarily exploited by one gender was sufficiently high to prompt the opposite gender to abandon their own foraging opportunities and participate in procurement of the (momentarily) more profitable resource. For example, we suggest that the abundance of antelope or rabbit obtainable through communal drives was sufficiently high, on occasion, to prompt women to forego their ordinary foraging pursuit of the moment and participate in the drive. Similarly, the average return rate for gathering (cattail pollen, for example) occasionally may have been sufficiently higher than the average return of hunting for men to abandon the hunt in favor of gathering activity.

Seasonal Variation in Foraging Opportunities

Technically, the diet breadth model can predict forager choice only among resources that are available simultaneously, and thus incur an opportunity cost when one resource is forsaken in favor of another. So far, we have considered collectively all the resources available to Toedokado without regard to synchronicity, but now must control for patterns in the temporal availability of resources in order to predict accurately on the basis of the diet breadth model. For example, that the caloric return of shadscale is more than three times greater than that of Indian ricegrass cannot inform us about a decision to forage for either because seeds of the two ripen at different times. By procuring one, the forager does not forfeit an opportunity to harvest the other; she can take both by appropriate scheduling. Whether either or both appear in the diet is not a function of their rank and abundance relative to one another, but to the abundance of concurrently available higher ranked resources (ignoring the complication that, by virtue of storage, the availability of some resources can be extended over several consecutive seasons).

Consequently, we divide the resources of Toedokado territory into resource sets based on synchronicity of availability, relying on season as the temporal unit suited to our purposes (Table 30). Thus, spring begins in late February as forbs appear and ground squirrels begin to come out of hibernation. Summer, beginning in late June offers cattail pollen, molting (flightless) ducks, grass seed, and berries. Fall begins in late August or early September when pinyon pine nuts are available for greencone processing. Winter begins with the first significant snow, usually middle November, when only a few plant and animal resources remain available for foraging and primary resources are food stores prepared in previous seasons.

Table 30. Seasonality of Resources.

	Class	Range	Resource
Spring	8	20000+	Deer, antelope
	7	9000+	Jackrabbit, gopher, woodrat, marmot, cottontail rabbit
	6	5000+	Ground squirrel (large)
	5	1500-3499	Muskrat, small rodents, biscuitroot, tui chub (lake), duck, duck eggs and fledglings, sage grouse, tui chub (pond)
	4	900-1499	Tansymustard seed, bitterroot root, shellfish, arrowleaf balsamroot, onion root
	3	600-899	Unavailable
	2	300-599	Unavailable
	1	0-299	Other forbs, bulrush root, cattail root, prince's plume
Summer	8	20000+	Bighorn sheep
	7	9000+	Gopher, woodrat, marmot
	6	5000+	Ground squirrel (large), cattail pollen
	5	1500-3499	Muskrat, small rodents, tui chub (lake), duck, duck eggs and fledglings, tui chub (pond)
	4	900-1499	Shellfish
	3	600-899	Peppergrass seed, currant, Cooper wolfberry, Anderson peachbrush, silver buffaloberry, wild rose, serviceberry
	2	300-599	Sunflower seed, bluegrass, great Basin wildrye seed, Indian ricegrass seed, creeping wildrye, western wheatgrass, slender wheatgrass
	1	0-299	Scratchgrass seed, dropseed seed, alkali sacaton seed, sego pondweed seed, other forbs, foxtail barley seed, meadow barley seed, sedge seed, western dock seed, spikerush seed, kochia seed, mariposa lily root, needlegrass seed, saltgrass seed, squirreltail grass seed
Fall	8	20000+	Deer, bighorn sheep, antelope
	7	9000+	Jackrabbit, gopher, woodrat, marmot, cottontail rabbit
	6	5000+	Unavailable
	5	1500-3499	Muskrat, small rodents, tui chub (lake), duck, tui chub (pond), hardstem bulrush seed
	4	900-1499	Pinyon pine nut, shadscale seed
	3	600-899	Four-wing saltbush seed, Torrey quailbush, seepweed
	2	300-599	Sunflower seed, saltmarsh bulrush seed, Great Basin wildrye seed, small bulrush seed, creeping wildrye, western wheatgrass, slender wheatgrass
	1	0-299	Cattail seed, dropseed seed, alkali sacaton seed, western dock seed, spikerush seed, bulrush root, pickleweed seed, cattail root, needlegrass seed
Winter	8	20000+	Deer, bighorn sheep, antelope
	7	9000+	Jackrabbit, cottontail rabbit
	6	5000+	Unavailable
	5	1500-3499	Muskrat, small rodents, tui chub (lake and pond)
	4	900-1499	Unavailable
	3	600-899	Unavailable
	2	300-599	Unavailable
	1	0-299	Cattail seed, iodine bush

Since the set of available resources changes seasonally (especially in temperate regions), optimal diet should vary seasonally as well. In the following discussions, we consider the distribution of resources according to season as they occur in various habitat types, and rank habitat types in terms of their foraging importance as measured by their relative caloric returns.

Using Optimal Foraging Models To Rank Habitat Type

We have discussed the caloric return rates of food resources available in Toedokado territory, and organized those resources according to seasonal availability and to the gender of the forager who captures them. We now rank habitat types accordingly, still assuming that prudent hunter-gatherers will seek the highest ranked (most energetically profitable) resources available and still assuming that choice of prey depends not on its abundance but on abundance of higher ranked prey.

As we have discussed so thoroughly in previous chapters, food resources are not distributed randomly in Toedokado territory; consequently, foragers there had to decide where to forage as well as what to seek. The diet breadth model cannot predict where foragers should operate, therefore we must consider what the diet breadth model can predict, in light of insight derived from the patch choice model (MacArthur and Pianka 1966) in order to bring our resource ranking (cf. Table 27) to bear on ranking habitats.

The patch choice model is specifically designed to predict where foragers will search for food given an environment in which resource distribution is uneven. A patch is merely a concentration of food that is depleted as it is exploited (Stephens and Krebs 1986:13). Just as the diet breadth model ranks resources by rate of caloric return, the patch choice model ranks patches according to caloric return, doing so based on average caloric return rates for foraging within the patch. However, the patch choice model declines to include the cost of travel time between patches. Thus, just as food resources in the diet breadth model are ranked independent of their abundance, patches in the patch choice model are ranked independent of their abundance. A forager will abandon a patch when the net return of searching and foraging within the patch has declined to a point lower than the return of travelling to and foraging in a new patch. Patch choice predicts that foragers prefer the most energetically profitable patches and a change in resource abundance can alter patch selection.

For present purposes, we define a patch as an arbitrary but definable unit of land within a habitat the food resources of which hunter-gatherers will deplete as they forage within it (Stephens and Krebs 1986:35). Thus, the habitat types defined and described in Chapters 2 and 3 are classes of patches that differ in assemblages and proportions of resources they contain. Toedokado hunter-gatherers should prefer to forage in patches providing the highest average return rates; therefore, it should be possible to rank habitat types according to the average return obtainable given the net return rate and abundance of resources contained in each habitat type.

But such a ranking is here beyond our reach because net return rates are variable and difficult to model in complex heterogeneous resource structures. Usually, applications of the patch choice model assume that patches are composed of only one kind of resource (Stephens and Krebs 1986:192-194) so that the tradeoff between moving to a new patch or expanding the diet breadth within the old patch need not be considered. In the case of the Toedokado territory habitat model, we are dealing with patches composed of numerous kinds of resources yielding different net returns and abundances. In so complex an environment, the relative ranking of habitats will depend on the average foraging return rate as well as on the abundance and net return rates of the resources that are in the diet, in each habitat. Moreover, our measure of resource abundance within habitats (i.e., air-dried weight of annual herbaceous biomass) are not equivalent to measurement of food value to hunter-gatherers (see Chapter 2).

However, we can use the resource rankings of Table 27 as a proximate measure of the maximum overall foraging return rate obtainable within each habitat. In this mode, the return rate for any habitat can be no higher than the net caloric return rate of the highest ranked resource within it. For example, a forager who enjoys an average return of 1000 calories per hour (including travel time between patches) of searching and foraging can do so only in habitats containing resources yielding net return rates that are higher than 1000 calories per hour; habitats with only lower ranked resources will be ignored. If overall returns drop to 500 calories per hour, habitats with resources providing between 500 and 1000 calories per hour will be added to the range of patches available for foraging. Foragers still should use the higher ranked habitats except when they become so depleted that they fail to return at least 500 calories per hour. Indeed, the exploitation of some high ranked habitat patches may intensify if they contain resources returning between 500 and 1000 calories per hour that are incorporated into the diet.

As before, we assume that hunter-gatherers will prefer to forage in habitats that contain the highest ranked resources, holding in abeyance habitats lacking higher ranked resources for when higher ranked resources in other habitats are sufficiently rare to compel foragers to search wherever they must for lower ranked resources. Thus, we can use the rank of the resource providing the highest return rate in each habitat to rank the order in which foragers should add habitats to their repertoire of patches as overall foraging returns decline.

Such ranking will distinguish habitats with resources yielding different return rates but not those containing the same resource. Consider, for example, a situation where shadscale is in the diet. Shadscale occurs in 30 of the 40 plant habitats identified in the Toedokado model, in densities ranging from 4 to 139 kilograms per hectare. When we compare habitats containing shadscale, its abundance becomes critical in determining which habitats foragers should select, because relative abundance will be correlated inversely with the search time required to procure that resource. Given the principles of the patch choice model, we assume that foragers will achieve higher average foraging returns for shadscale in habitat types offering the highest densities of shadscale, simply because search costs will be lower in those habitats. Therefore, given a set of habitats containing shadscale seeds, a prudent hunter-gatherer will prefer to harvest shadscale in habitats where it occurs at 100 kilograms per hectare over habitats offering only 40 kilograms per hectare.

Recall that, in Chapter 4, we identified the five habitats where each resource was most abundant, except in cases where resources occurred in fewer than five habitats or were sufficiently abundant in more than five habitats. In forthcoming discussions, we will assume that the set of five habitats bearing the greatest amount of any resource constitute the highest ranking patches for that resource and, consequently, are the ones most likely to affect Toedokado decisions of where to forage when shadscale is in the diet. Note, however, that this does not constrain the Toedokado to forage shadscale only in its top five ranking habitats, ignoring it when they operate in other habitats; if shadscale is in the optimal diet, the Toedokado should harvest it whenever they encounter it.

Modeling Seasonal Foraging Opportunities Based on the Toedokado Habitat Model

Here, we consider how resource ranking, sexual allocation of subsistence tasks, and seasonal availability of resources may have determined habitat choice among ethnographic and prehistoric hunter-gatherers of the study area. Using the assumptions and principles of patch choice and diet breadth that we have previously discussed, we predict in which habitats male and female Toedokado should have preferred to forage and consider situations that may have prompted foraging in less productive habitats.

The Spring Habitat Type Mosaic

Spring offers the first opportunity for the Toedokado to procure for fresh food after a winter of subsisting primarily on stored food. Most interpretations of the ethnographic data suggest that the Toedokado dispersed from winter base camps, with small, mobile family groups embarked on a variety of subsistence activities (Wheat 1967:8-10; Bard et al. 1981:94; Thomas 1985:23; Fowler 1982:133, 1989:10, Madsen 1989).

Table 31 lists women's spring resources in caloric rank order. In this and following tables listing resource distributions by habitat type, we have indicated the most productive habitats for each resource as discussed in Chapter 4 (designated by "X") as well as the presence of the same resources in less productive habitats (designated by "p").

In spring, bird eggs and fledglings, and mussels represent the highest ranked resources for women in marshes (Habitats 1 and 53), while bulrush and cattail roots represent relatively unattractive, low-ranked resources available in these habitats. The high returns of eggs, young birds, and mussels may have tethered women to marshes for much of the spring and women may have embedded the procurement of low ranked marsh roots in the search for the higher ranked resources. However, they probably would take low ranked marsh roots only when they had sufficiently depleted higher ranked resources to allow roots to enter the optimal diet.

In such situations, Toedokado gatherers are likely to have had the opportunity to shift to new patches in spring, rather than pursue a broader diet breadth in wetlands. Hibernating rodents such as large ground squirrels emerge in February or March. By June, ground squirrels and other small mammals are fat and abundant. Ground squirrels and other small rodents rank high in the list of women's prey and could have been procured in a variety of habitats. We expect that marsh Habitats 1 and 53, upland springs Habitat 51, riparian Habitats 5 and 6, and sand dunes in greasewood-saltbrush Habitats 11 and 16 would have been preferred for rodent hunting because they simultaneously afford access to other spring resources procured by women.

For example, women obviously could combine rodent procurement in marsh habitats along with mussel, egg, fledgling, and root harvesting. Edible greens of annual forbs began to emerge about March and the fairly high ranked seeds of some annuals (particularly tansymustard) were available by June. Women easily could have harvested green annual forbs and tansymustard seeds in greasewood-saltbush Habitats 11 and 16 by embedding these activities in rodent procurement. High ranking roots such as bitterroot, biscuitroot, and arrowleaf balsamroot were available in upland Habitats 35, 34, and 47 in spring. Gatherers could have embedded procurement of these resources in procurement of small mammals around upland springs (Habitat 51), although we suspect that inclement weather may have barred access to high elevation areas for much of the spring in many years. These habitats could have been accessed by short foraging* excursions or logistic expeditions from marsh base camps (Fowler 1982:133, 1989:43, 1992:81), or by short term residential moves out of the marsh (Fowler 1982:133, 1989:43, 1992:81).

We doubt that the Toedokado regularly would have exploited the best habitats (Habitats 3 and 19) for princes' plume in the spring, because of its low rank and the lack of higher ranked resources in these habitats. Instead, the Toedokado probably only harvested princes plume on occasions when overall foraging returns were very low, and only incidentally to the pursuit of higher ranked resources. Consequently, prince's plume probably was procured rarely in habitats where it is most abundant.

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*Hereafter, use of the term "forage" is made with reference to the hunter-gatherer subsistence strategy of moving consumers to resource patches (sensu Binford 1980). Previous use of the term "forage" referred more nearly to behavior associated with searching for, subduing, capturing, and consuming food (McFarland 1987:214).

Table 31. Women's Spring Resources (in ascending caloric rank order).

	HABITAT																																								
	Abiotic		Wetland								Greasewood/Saltbush																					Sagebrush						Montane		
Resource	2	54	1	4	5	6	28	51	53	55	3	7	9	10	11	13	14	15	16	18	19	20	21	26	29	36	38	40	42	46	49	56	27	31	35	37	44	48	52	34	47
Bulrush root			X						X																																
Annual forb												p	p		X			X	X		X	X					p		p												
Cattail root			X						X																																
Princes' plume											X	p	p	p	p	p	p	p			X	p	p	p	p		p	p			p	p						p			
Arrowleaf balsamroot																																			X					X	X
Mussel			X						X																																
Tanseymustard												p	p		X			p	X		p	p					p		p												
Bitterroot																																			X					X	X
Biscuitroot																																			X					X	X
Duck eggs and fledglings			X		X	X			X	X																															
Small rodent			X	X	X	X	X	X	X	X	X				X			X	X			X																		X	
Ground squirrel					X	X		X		X					X				X							X							X	X		X					

X = most productive habitat
p = less productive habitat

Table 32 presents men's spring foraging opportunities. Ethnographic informants indicate that large game hunting opportunities were poor in this season although men hunted in times of famine (Fowler 1989:12). Presumably, the Toedokado took large game whenever they encountered them (because large game rank high in the diet), but spring encounter rates usually were too low to allow special purpose game forays except in conditions of overall resource scarcity. Consequently, we suspect that logistic hunting parties operating out of low elevation base camps, would have visited the best habitats for hunting deer (Habitats 34, 44, 47, 51, and 51) only sporadically in spring. More common would have been an occasional encounter by men searching for other game in these habitats, perhaps operating out of short term base camps in the highlands where women procured roots.

Other game available for men in the uplands would have included woodrat, marmot, and sage grouse. Woodrat and marmot procurement would have been feasible in Habitats 13, 31, 34, 37, 47, and 52. Spring offered the best opportunities for taking sage grouse, because they display on strutting grounds at this time (Fowler 1989:58). Upland spring Habitat 51, montane Habitat 47, and sagebrush Habitats 31 and 37 would have been good sage grouse procurement locations. These resources may have been the primary motivation for male hunting in the uplands, but the search for them could have facilitated encounter of larger game.

Communal antelope hunting could be fairly profitable in spring, but as discussed in Chapter 4, most of Toedokado territory provides only marginal antelope habitat. Consequently, we suspect that communal antelope drives usually took place outside Toedokado territory, probably around Pyramid Lake (Fowler 1989:14-15). If such drives ever occurred in Toedokado territory, greasewood-saltbush habitats 3, 7, 9, 11, 16, and 29 offered the best prospects. It is more likely that hunters occasionally stalked individual antelope locally in Habitats 11 and 16, which offer an abundance of other spring resources for men and women.

Rabbits would have been obtainable in Habitats 4, 5, 6, 16, 28, 31, 36. While spring was not the best season for their procurement, communal rabbit drives were feasible in Toedokado territory (Fowler 1992:77). Large ground squirrels would have been abundant in Habitats 5, 6, 11, 16, 27, 31, 36, 37 and 55; small mammals would have been obtainable in Habitats 1, 3, 4, 5, 6, 11, 15, 16, 20, 28, 51, 53 and 55. Habitats 1, 4, 5, 6, 11, 16, 34, 47, 51, and 53 seem the most likely rodent procurement locations because they offer the widest variety of high ranked men's and women's resources.

Marsh and riparian Habitats 1, 5, 6, 53 and 55 are attractive foraging territories for fish, muskrat, and duck. Vast numbers of ducks, geese, pelicans, and other water birds arrive in the marshes in March and April to begin nesting. Increasingly warm water in May promotes schooling behavior and spawning of tui chub and other fish (Raymond and Sobel 1990). Spring runs of cui-cui at Pyramid Lake, and trout on the Carson, Truckee, and Walker rivers, occasionally drew people to territories of neighboring groups (Fowler and Liljeblad 1986:441; Fowler 1992:60) when fish were plentiful and exogamous relationships were good. These first runs would have produced much higher returns than that of the tui chub gill netting we employ in the present model (cf. Tables 26, 27), but would have required a short-term residential move out of the study area. Nevertheless, high returns for gill netting tui chub would have been obtainable locally. Although marshes do not provide the highest ranked resources for males in the spring, the apparently high search time necessary to procure large game in the uplands likely rendered lowland marshes and riparian zones better patches for overall hunting returns in spring.

In summary, spring offers a relatively narrow array of resources dispersed over a wide range of habitats. The dispersion of high ranked resources in multiple habitats corresponds well with the ethnographic record implying high residential mobility and campsite dispersion in the spring. High elevation Habitats 34, 47, and 51 are attractive foraging patches for both men and women although weather may preclude access to these areas for parts of the season. Marsh Habitats 1 and 53, riparian

Table 32. Men's Spring Resources (in ascending caloric rank order).

H A B I T A T

	Abiotic		Wetland								Greasewood/Saltbush																						Sagebrush						Montane		
Resource	2	54	1	4	5	6	28	51	53	55	3	7	9	10	11	13	14	15	16	18	19	20	21	26	29	36	38	40	42	46	49	56	27	31	35	37	44	48	52	34	47
Fish			X						X																																
Sage grouse								X																										X		X					X
Waterfowl			X		X	X			X	X																															
Small rodent			X	X	X	X	X	X	X	X	X				X			X	X			X																		X	
Muskrat			X		X	X			X																																
Marmot																X																		X		X				X	X
Woodrat																X																		X		X				X	X
Ground squirrel					X	X		X		X					X				X							X							X	X		X					
Rabbit/Hare				X	X	X	X	X		X									X							X								X							X
Antelope				X	X	X	X			X	X	X	X		X				X						X																
Deer								X																										X			X			X	X

X = most productive habitat
p = less productive habitat

Habitats 5 and 6, and greasewood-saltbush Habitats 11 and 16 are also profitable as spring foraging patches for both men and women. In all of these habitats, the concurrence of multiple male and female resources allows considerable flexibility and embeddedness in daily subsistence trips. The Toedokado probably best exploited these habitats by residentially moving to them, but foraging or logistic campaigns from bases located elsewhere were also possible. In contrast, we expect that Habitat 35 is attractive for women's foraging alone, while Habitats 3, 4, 15, 20, 28, 31, 36, 37, and 55 are profitable only as hunting territories for males. Daily foraging forays or logistic expeditions from base camps in other habitats almost certainly exploited these habitats.

The Summer Habitat Type Mosaic

Interpretations of the ethnographic record differ as to whether the Toedokado remained dispersed in family groups in summer (Thomas 1985:23) or reaggregated in lowland riparian or marsh base camps (Fowler 1982:133; Madsen 1989). Many grass seeds, as well as dock and berries come available in summer. Ducks and coots molt in summer, allowing them to be more easily hunted. On the other hand, many rodents become available as they begin summer aestivation. Certainly, summer generally is the most productive time of year for total plant biomass.

As shown in Table 33, more potential food resources are available for women's foraging in summer than in any other season. Cattail pollen is available only briefly, in marsh Habitats 1 and 53, but provides the highest return of all plant resources, and can be stored without spoiling. Women could collect the last of the waterfowl fledglings and eggs, as well as mussels and non-aestivating small rodents, in marsh and wetland habitats. Consequently, marsh Habitats 1 and 53 should have been the highest ranked patches for women.

After cattail pollen, women's next most productive plant resources are the numerous berries that come into season in middle to late summer. Montane Habitats 34, 47, and 51 would have been most productive for currant, Anderson peachbrush, and serviceberry, but wolfberry would have been most productive in greasewood-saltbush Habitats 10, 14, 21, 26; silver buffaloberry in riparian Habitats 4, 5, 6, and 28; and wild rose in marsh Habitats 1 and 53, as well as wetland Habitats 5, 6, and 51. Altogether, most of these berries would have been available in or near marshes and riparian habitats. Although some berries are restricted to montane habitats, the occurrence of similar resources in lowland zones should have obviated any need to residentially leave marsh zones for berries.

The next most productive women's plant resources are relatively low ranked grass and dock seeds such as ricegrass, bluegrass, and wildrye. Traces of bluegrass occur in most marsh and riparian Habitats 1, 5, and 6 but bluegrass is most abundant in the lowland spring Habitat 55. Wildrye and wheatgrass are abundant in riparian Habitats 4, 5, 6, and 28, and greasewood-saltbush Habitat 29. Both bluegrass and wildrye are abundant around upland springs (Habitat 51). However, their ubiquity in lowland habitats would have allowed their procurement from marsh settlements, obviating a residential move to the uplands.

More problematic is ricegrass, which is relatively low ranked and most abundant in greasewood-saltbush Habitats 11, 16, 19, and 20, and in sagebrush Habitat 27. The ethnographic record is clear that the Toedokado often harvested Indian ricegrass in early summer (see Chapter 4). Considering the relatively low returns of ricegrass compared to almost simultaneously available cattail pollen, and the remoteness of the best ricegrass habitats from any lowland cattail habitat in Toedokado territory (cf. Figure 48), it is difficult to believe that ricegrass ever could have been economically profitable except when marsh production failed. Possibly, the Toedokado harvested ricegrass in its best habitats only in earliest summer, before cattail pollen was available and possibly slightly before full maturation of

Table 33. Women's Summer Resources (in ascending caloric rank order).

	HABITAT																																								
	Abiotic		Wetland								Greasewood/Saltbush																						Sagebrush						Montane		
Resource	2	54	1	4	5	6	28	51	53	55	3	7	9	10	11	13	14	15	16	18	19	20	21	26	29	36	38	40	42	46	49	56	27	31	35	37	44	48	52	34	47
Water plantain			X						X																																
Bottlebrush squirreltail				p	p		p		p		p	X	p	p	p	p	X	p	p	p	p	p	p	p	X	X	p	p	p	p	p	p	p	X	p	p	p	p	p	p	p
Saltgrass				X	X	X	X		p	X	p	p	p			p	p	p							p		p														
Needlegrass												p	p	p	p	p		p	p	p	p	p	p	p		p	p	p	p	p	p	p	p	p	X	p	X	X	X	p	X
Spikerush			X						X																																
Dock				X	X	X	X																																		
Sedge			X	p	p	X	p	X	X	X																							p								
Chufa fatsedge			X	p	p	X	p	X	X	X																							p								
Meadow barley								X																																	
Annual forb												p	p		X			X	X		X	X					p		p												
Sego pondweed			X						X																																
Mat muhly					X	X																																			
Dropseed				X	X	X	X	p	p	p	p	p	p		p	p	p	p	p		p	p			p	p	p	p	p	p	p		p					p			
Wheatgrass				X	X	X	X	X				p	p		p				p			p											p								
Indian ricegrass				p	p				p		p	p	p	p	X	p	p	p	X	p	X	X	p	p	p	p	p	p	p	p	p	p	X	p	p	p	p	p	p	p	p
Wildrye				p	X	X	X	X	p		p	p	p			p	p	p				p	p		X		p					p	p		p	p		p	p		p
Bluegrass			X	p	X	X	p	X	p	X				p	p	p						p	p	p		p		p		p	p	p	p	p	p	p	p	p	p	p	p
Serviceberry																																								X	X
Wild rose			X		X	X		X	X																																
Silver buffaloberry				X	X	X	X																																		
Anderson peachbrush								X																																	X
Wolfberry												p	p	X	p	p	X	p		p		p	X	X			p				p	p	p					p			
Currant																																								X	
Mussel			X						X																																
Tanseymustard												p	p		X			p	X		p	p					p		p												
Duck eggs and fledglings			X		X	X			X	X																															
Small rodent			X	X	X	X	X	X	X	X	X				X			X	X			X																		X	
Cattail pollen			X						X																																
Ground squirrel					X	X		X		X					X				X							X							X	X		X					

X = most productive habitat
p = less productive habitat

ricegrass seeds; certainly, the harvesting and processing techniques practiced by the Toedokado would have been ideally suited to immature seed procurement. In this scenario, early ricegrass procurement could be embedded in the harvest of the last tansymustard seeds, small mammals, and antelope which rank highly and are prolific in the same habitats (particularly Habitats 11, 16, and 20). Cattail pollen is available only briefly (Simms 1987:133; Fowler 1992:65, Wheat 1967:11), so it is possible that the windows of opportunity for cattail pollen and ricegrass overlap but do not coincide. Thus, diet breadth would be narrow while cattail pollen was available, then broaden to include ricegrass as pollen disappeared.

Remaining plant resources are so low ranked that it is unlikely they very much affected decisions about foraging locations. More likely, the Toedokado acquired them as needed by embedding their procurement costs in other subsistence pursuits.

Men's summer resources (Table 34) are similar to those of spring save that antelope, deer, sage grouse, and ground squirrel probably were less productive whereas sheep hunting was better. Nevertheless, summer was not the favorite time of ethnographic Northern Paiute for hunting sheep (Fowler 1989:19), probably because they are so dispersed in steep, high elevation areas at this time of year and thus require high search costs to procure. Sheep could be obtained in Habitats 34, 44, 47, and 51. Nonestivating small rodents, marmots, and woodrats also would have been available in montane Habitats 34, 47, and 51 through the summer, as well as in Habitats 3, 11, 13, 16, 20, 31, 37 and 52. However, given the rarity of high ranked women's resources in the uplands, and the high search costs incurred by hunting sheep, we suspect that only logistic hunting parties operating out of lowland base camps regularly used upland Habitats 31, 44, 34, 47, and 51 in summer.

Fish, muskrats, and molting ducks are still available in marshes Habitats 1 and 53 and riparian zones (Habitats 4 and 5) in summer. Toedokado could take rabbits in Habitats 4, 5, 6, 16, 28, 29, 31, 47, and 51, most within easy foraging distance of riparian or marsh base camps. However, summer was not the favored time for communal rabbit drives (Fowler 1989:26, 1992:77) and it is likely that hunters stalked or trapped rabbits rather than driving them in this season.

In summary, for a brief period in early summer greasewood-saltbush habitats (11, 16, and 20) and marsh and riparian Habitats 1, 4, 5, and 53 would have represented attractive foraging patches to both men and women, only lowland marsh and riparian Habitats 4 and 5 would have attracted both later in summer. Upland and desert Habitats 3, 13, 31, 44, 34, 37 47, 51, and 52 would have presented the most attractive hunting patches to men, who probably would have exploited them through logistic mobility from lowland bases. Given that the highest ranked resources for women occur in or near marshes and riparian zones in mid to late summer, there would seem to be little reason to residentially abandon them for upland or desert habitats, although the Toedokado may have dispersed *within* the wetlands. If ethnographic interpretations are correct that the Toedokado remained in small seed collecting settlements dispersed over multiple habitats through summer (Thomas 1985:23), it follows that high ranked summer wetland resources must have been sufficiently rare to prompt a very broad diet breadth. In these cases, high elevation Habitats 34, 47, and 51 would have offered the best alternative locations for male and female foraging. But given the usual richness of the wetlands, such selection must have been outside the norm.

The Fall Habitat Type Mosaic

Interpreters of ethnographic Toedokado settlement patterns agree that autumn presented the Toedokado with the option of anticipating winter village locations in either marshes or pinyon woodlands (Bard et al. 1981:94; Fowler 1982:133, 1989:10; Thomas 1985:22; Madsen 1989). The near simultaneous availability of many high ranked marsh and saltbush seeds in lowlands with pinyon in

Table 34. Men's Summer Resources (in ascending caloric rank order).

	HABITAT																																								
	Abiotic		Wetland								Greasewood/Saltbush																						Sagebrush						Montane		
Resource	2	54	1	4	5	6	28	51	53	55	3	7	9	10	11	13	14	15	16	18	19	20	21	26	29	36	38	40	42	46	49	56	27	31	35	37	44	48	52	34	47
Fish			X						X																																
Waterfowl			X		X	X			X	X																															
Small rodent			X	X	X	X	X	X	X	X	X				X			X	X			X																		X	
Muskrat			X		X	X			X																																
Ground squirrel					X	X		X		X					X				X							X							X	X		X					
Marmot																X																		X		X				X	X
Woodrat																X																		X		X				X	X
Sheep								X																													X			X	X

X = most productive habitat
p = less productive habitat

montane woodlands made this possible. However, the conflict between these resources could be ameliorated by pre-harvest estimates of the size and location of productive pinyon crops (Wheat 1967:14; Thomas 1983:62), and most of the lowland seeds remained available for collection until well after the pinyon harvest (Wheat 1967:15; Fowler 1992:67, 70). Appropriate scheduling allowed the Toedokado to exploit both resources and choose winter village locations according to the transport costs imposed by the size of the stored crop of each resource in that particular year (Thomas 1985:22)

The fall resource profile for women (Table 35) resembles that of summer, except that most grass seeds and berries are no longer available, having been replaced by higher ranked bush, tree, and marsh seeds. Hard seeds must have been of primary importance in fall when it was necessary to prepare for winter by laying in stores (Wheat 1967; Fowler 1992). In most years, this necessity must have required residential moves to the appropriate resource patches.

Pinyon (Habitat 34) is available in late summer and early fall. Since a good pinyon harvest could provide nearly all the winter needs of a family, travel to pinyon camps (Habitats 34 and 47) in the Stillwater and Clan Alpine Ranges was common (Wheat 1967; Fowler 1992).

Saltbush, shadscale, and seepweed seeds are also available by late summer, but since cold weather apparently renders the seeds easier to harvest, the Toedokado could postpone their harvest until late fall or even early winter. These seeds would have been most productive in greasewood-saltbush Habitats 3, 7, 10, 11, 14, 15, 16, 20, 29, 36, 42, and 46, many of which are among the least productive of total biomass (cf. Table 9), and almost all of which lack other high ranked fall resources that would have attracted women's foraging. The Toedokado might have delayed pursuing such diffuse foraging opportunities until after the pinyon harvest, possibly during the return trip to the valley floor. Otherwise, these habitats almost certainly would have been accessed by expeditions from base camps in montane or wetland habitats.

Hardstem bulrush seeds are available in marsh Habitats 1 and 53; under the right conditions, ripe seeds can fall into the water and accumulate at the edges of ponds, offering much higher returns for harvest (Bettinger 1993:53) than we project in Table 26. Like shadscale, best harvest times may have been late in the season. Wildrye remained available into the early fall at higher elevations in Habitat 51, so that Toedokado women could have harvested it simultaneously with pinyon, although they were not likely to unless the size of the pinyon harvest was small. The remaining seeds are too low ranked to have affected foraging decisions much; it is likely that the Toedokado embedded their procurement, as needed, in the harvest of higher ranked resources. For example, women could have harvested iodine bush simultaneously with seepweed in Habitat 3, and cattail seed with bulrush seed in Habitats 1 and 53 only.

Mussels were available only in marsh Habitats 1 and 53, but small mammals were obtainable in a variety of locations. Marsh Habitats 1 and 53 and montane Habitats 34 and 51 would have been particularly attractive for rodent procurement because they offer access to other women's resources at the same time.

Table 36 presents autumn resources of men. Fall was unquestionably the best time for hunting according to ethnographic informants (Fowler 1989:12, 17, 19, 26). The Toedokado usually participated in communal antelope drives in late fall, but as in spring, such drives probably occurred outside the Toedokado territory defined herein. Greasewood-saltbush Habitats 3,7, 9, 11, 16, and 29 may have attracted hunters stalking individual antelope.

Communal rabbit drives usually occurred in late fall when meat and fur are prime (Fowler 1992:77; Wheat 1967:14). Some areas sustained rabbit "blooms" that made communal drives possible, most likely in Habitats 4, 5, 6, 16, 28, 31, 36.

Table 35. Women's Fall Resources (in ascending caloric rank order).

	Abiotic		Wetland								Greasewood/Saltbush																						Sagebrush						Montane		
Resource	2	54	1	4	5	6	28	51	53	55	3	7	9	10	11	13	14	15	16	18	19	20	21	26	29	36	38	40	42	46	49	56	27	31	35	37	44	48	52	34	47
Needlegrass												p	p	p	p	p		p	p	p	p	p	p	p		p	p	p	p	p	p	p	p	p	X	p	X	X	X	p	X
Iodine bush				p	p				p		X	p	p			p		p							p		X														
Bulrush root			X						X																																
Spikerush			X						X																																
Dock				X	X	X	X																																		
Mat muhly					X	X																																			
Dropseed				X	X	X	X	p	p	p	p	p	p		p	p	p	p	p		p	p			p	p	p	p	p	p	p		p					p			
Cattail seed			X						X																																
Cattail root			X						X																																
Other bulrush seed			X						X																																
Wheatgrass				X	X	X	X	X				p	p		p				p			p											p								
Wildrye				p	X	X	X	X	p		p	p	p			p	p	p				p	p		X		p					p	p		p	p		p	p		p
Wada				X	X	X	X		p		X	p	p			p	p								p		p														
Torrey quailbush				p	p	p	X		p		p		p			p									X		p														
Four-winged saltbush				p	p				p		p	X	p		X	p	p	X	X	p	p	X	p	p	p		p					p	p	p							
Shadscale				p	p		p		p		p	p	p	X	p	p	X	p		p	p	p	p	p	p	X	p	p	X	X	p	p	p	p	p		p	p	p		
Mussel			X						X																																
Pinyon																																								X	
Hardstem bulrush seed			X						X																																
Small rodent			X	X	X	X	X	X	X	X	X				X			X	X			X																		X	

X = most productive habitat
p = less productive habitat

Table 36. Men's Fall Resources (in ascending caloric rank order).

	Abiotic		Wetland								Greasewood/Saltbush																						Sagebrush						Montane		
Resource	2	54	1	4	5	6	28	51	53	55	3	7	9	10	11	13	14	15	16	18	19	20	21	26	29	36	38	40	42	46	49	56	27	31	35	37	44	48	52	34	47
Fish			X						X																																
Waterfowl			X		X	X			X	X																															
Small rodent			X	X	X	X	X	X	X	X	X				X			X	X			X																		X	
Muskrat			X		X	X			X																																
Woodrat																X																		X		X				X	X
Marmot																X																		X		X				X	X
Rabbit/Hare				X	X	X	X	X		X									X							X								X							X
Antelope				X	X	X	X			X	X	X	X		X				X						X																
Deer								X																										X			X			X	X
Sheep								X																													X			X	X

X = most productive habitat
p = less productive habitat

Autumn was the best time of year for taking sheep and deer, in montane Habitats 31, 34, 44, 47, and 51. Marmots, woodrats, and small rodents also would have been available in these montane habitats in the fall, as well as in Habitats 3, 11, 13, 16, 20, 31, 37 and 52. Foraging trips from montane base camps or logistical trips from lowland camps could have procured these resources.

Marshes would have represented less attractive, yet still good, hunting opportunities in the fall. Although ducks had regained their flight feathers and were no longer available for drives, water bird hunting remained profitable as migrating flocks passed southward through the study area. Fishing and muskratting continued to be good into the fall. Like montane resources, marsh fauna could have been hunted either logistically from montane base camps, or by foraging from lowland camps.

In summary, the Toedokado territory habitat model supports ethnographic settlement pattern data indicating that the Toedokado faced the autumn option of foraging in two sets of habitats offering patches of high ranked resources: marsh Habitats 1 and 53 and montane Habitats 34, 47, and 51. For women, the choice seems an even split between the two with both offering resources of comparable return. However, scheduling could permit exploitation of both, emphasizing patches that were particularly abundant in resources in any particular year. For men, montane habitats unquestionably offered the best patches, although marshes continued to provide relatively good hunting and fishing opportunities. The extent to which men exploited marshes probably depended on how abundant upland game were in any year, and on female habitat choice. During the pinyon foray, men exploited marshes logistically (Fowler 1989:10, 30) and embedded upland game hunting in foraging activities in the mountains (Fowler 1992:86). Conversely, men logistically hunted in the uplands when women chose to forage in marshes (cf. Fowler 1992:85).

Habitats 7, 11, 16, 29, and 36 may have also have been attractive foraging patches for both sexes, allowing antelope and rabbit hunting for men and saltbush seed harvest for women. However, the Toedokado probably exploited these habitats from short term logistic or residential camps rather than from long term villages. Women occasionally may have foraged Habitats 10, 14, 15, 20, 29, 42, and 46 for saltbush seed, but these habitats were unattractive for hunting. Similarly, Habitats 3, 4, 5, 6, 9, 28, 29, 31, and 44 would have been attractive hunting territory for men but not for women.

The Winter Habitat Type Mosaic

In winter, ethnographic Toedokado inhabited long term winter villages that usually were near marshes, or more rarely in pinyon woodlands (Bard et al 1981:93-94; Thomas 1985:22; Fowler 1982:133). Food stores put away in the previous seasons were the primary winter food source because foraging opportunities generally were scarce.

Seeds of saltbush, seepweed bulrush, and cattail would have remained available for women's foraging for a brief period after the first winter snow fall (Table 37). We suspect that at this time Toedokado women most likely harvested such low ranked items as iodine bush, cattail seed, and sego pondweed to supplement shortfalls in the overwinter food supply.

Men enjoyed a wider variety of winter foraging opportunities (Table 38). Fishing (including ice fishing), and rabbit and rodent hunting continued through the winter as weather permitted (Wheat 1967:15), although returns probably were lowest in this season. Large game animals wintering on the valley floor (antelope), along riparian corridors (deer), and on the margins of the mountain snow fields (deer, mountain sheep) also should have been available. Large game hunting even could be particularly productive in winter when sufficient snowfall and cold weather confined animals to exposed, sunny, lower slopes (Fowler 1989:19). However, the same conditions that impeded large game movement would have imposed higher travel and search costs on male hunters. Consequently, overall returns from large game hunting in winter would have been lower than in other seasons.

Table 37. Women's Winter Resources (in ascending caloric rank order).

HABITAT

Resource	Abiotic		Wetland								Greasewood/Saltbush																						Sagebrush						Montane		
	2	54	1	4	5	6	28	51	53	55	3	7	9	10	11	13	14	15	16	18	19	20	21	26	29	36	38	40	42	46	49	56	27	31	35	37	44	48	52	34	47
Iodine bush				p	p				p		X	p	p			p		p							p		X														
Sago pondweed			X						X																																
Cattail seeds			X						X																																
Other bulrush seed			X						X																																
Wada				X	X	X	X		p		X	p	p			p	p								p		p														
Torrey quailbush				p	p	p	X	p		p		p			p									X		p															
Four-winged saltbush				p	p				p		p	X	p		X	p	p	X	X	p	p	X	p	p	p		p					p	p	p							
Shadscale				p	p		p		p		p	p	p	X	p	p	X	p		p	p	p	p	p	p	X	p	p	X	X	p	p	p	p	p		p	p	p		
Hardstem bulrush seed			X						X																																
Small rodent			X	X	X	X	X	X	X	X	X				X			X	X			X																		X	

X = most productive habitat
p = less productive habitat

Table 38. Men's Winter Resources (in ascending caloric rank order).

HABITAT

Resource	Abiotic		Wetland								Greasewood/Saltbush																						Sagebrush						Montane		
	2	54	1	4	5	6	28	51	53	55	3	7	9	10	11	13	14	15	16	18	19	20	21	26	29	36	38	40	42	46	49	56	27	31	35	37	44	48	52	34	47
Fish			X						X																																
Waterfowl			X		X	X			X	X																															
Small rodent			X	X	X	X	X	X	X	X	X				X			X	X			X																		X	
Muskrat			X		X	X			X																																
Woodrat																X																		X		X				X	X
Rabbit/Hare				X	X	X	X	X		X									X							X								X							X
Antelope				X	X	X	X			X	X	X	X		X				X						X																
Deer								X																										X			X			X	X
Sheep								X																													X			X	X

X = most productive habitat
p = less productive habitat

Winter, then, saw the Toedokado based in winter villages in or near marshes (Habitats 1 and 53) or sometimes in pinyon woodlands (Habitats 34 and 51). Although the choice of patches available for foraging narrowed dramatically, the variety of the stored food diet probably was rather broad. Mid-winter foraging trips to tap stores cached elsewhere are likely, however, and may account for the numerous storage pits archaeologically documented in the marsh (Raven and Elston 1988). Although the Toedokado probably foraged for winter food wherever it was available, they probably accomplished this from winter base camps rather than from residential relocations or by logistical expeditions.

Habitat Types and the Archaeological Record

We have discussed how efficient hunter-gatherers should have organized their foraging activities among habitat types defined for ethnographic Toedokado territory, by estimating the distribution of resources for each habitat, subdividing these resources by season and sex, and referring to their available caloric returns. We now rely on these predictions to generate expectations about how the distribution and composition of the archaeological record will vary according to habitat type. Specifically, we forecast the relative composition and diversity of archaeological assemblages likely to occur on each habitat type, based on the productivity of foraging there and on the likelihood that hunter-gatherers resided in selected habitats. From these inferences, we scale habitat types into classes of predicted archaeological complexity and frequency.

If we could assume that the archaeological record directly reflects foraging activity, this would be a simple task; archaeological remains should be most dense, diverse, and complex on habitat types that produce highest ranked resources in greatest abundance. However, hunter-gatherer foraging behavior does not translate directly into the archaeological record. Distributions of archaeological remains do not perfectly track the distribution of foraging activity; deviations between the two reflect the effects of central place foraging, sexual division of labor, food sharing, food storage, tool manufacture, tool curation, and refuse disposal (Binford 1979, 1980). Consequently, we structure our expectations about the archaeological record of habitat types in light of current understandings of how hunter-gatherer subsistence-settlement systems operate.

First, we assume that the archaeological record is biased toward residential bases that serve as the focus of hunter-gatherer settlement, inasmuch as residential bases are the loci where food is prepared, stored, and consumed; tools are manufactured, repaired, and discarded; and facilities for human habitation are constructed, maintained, and cached. Moreover, hunter-gatherers frequently reuse the same base camp locations over long periods of time because they offer best access to attractive foraging patches as well as constellations of physical factors (i.e., proximity to water, dry level ground, access to fuel) that compel hunter-gatherers to return to them. Therefore, base camps should contribute disproportionately to archaeological formation processes. While other site types exist, and while habitat types that are residentially unoccupied contain significant archaeological sites, the archaeological remains of most foraging activity represent, for the most part, field processing and hunting loss. Only in situations where abundant resources are available within short periods of time or recurrently in the same location over long periods of time should non-habitation sites produce archaeological manifestations comparable to those of residential base camps. Generally speaking, the decision of where to live has a greater affect on the archaeological record than that of where to forage.

Second, we assume that women's foraging resources and communal harvest resources are more important base location determinants than are men's resources. For the most part, the fauna targeted by men in Great Basin environments are mobile, rare, and unpredictable compared to the sessile, abundant, and reliable plants procured by women. This should make areas in proximity to profitable women's foraging patches favored base camp locations. Too, since hunter-gatherers must procure and store in bulk many seasonally available plants, plant foods should tend to tether hunter-gatherer bands to productive plant food patches. Only in cases of temporary gluts of animal resources harvested communally, such as winter fish kills, fish spawning runs, insect windrows, and rabbit and antelope drives, should men's resources affect base camp location importantly.

Third, we assume that away from base camps, men's hunting activities will be more archaeologically visible than those of women's gathering (Thomas 1985:439). This is because men emphasized a reductive lithic technology, field maintenance of which leaves abundant, archaeologically visible residues (i.e. debitage and discarded tools) on the landscape. In contrast, women generally employed foraging technologies the tools of which (i.e., ground stone, baskets) did not often leave archaeologically preserved detritus on the foraging landscape. Too, since men had to hunt game and transport the kill over large distances from base camps, they frequently constructed hunting facilities, field processed resources, and prepared overnight field camps. Women, as a rule, foraged within a few hours walk of base camp (although Toedokado women made overnight logistical trips to procure roots [Fowler 1989:43, 1992:81]) and were less likely to field process food, or construct camps and facilities. Consequently, men's subsistence activities are more likely to leave enduring diagnostic signatures on the landscape (i.e., faunal remains, debitage, processing tools, hearths, hunting blinds) than are those of women (i.e., isolated ground stone fragments).

Finally, we must assume that the ubiquity of lithic material in the archaeological record generally will bias the record toward sites where the procurement of toolstone and initial manufacture of lithic tools occurred. Since toolstone sources most frequently occur in upland terrain, we expect that upland habitat types frequently will host archaeological sites containing copious lithic debris from toolstone processing. Sites nearest toolstone sources will possess assemblages rich in lithic material reflecting early stage tool manufacture (hammerstones, cores, early stage bifaces, and associated debitage). Materials representing middle stage manufacture (middle stage bifaces, heat treated bifaces, and associated debitage) will be abundant in field camps convenient to toolstone sources. Finished and discarded tools, as well as evidence of late stage manufacture will be most prevalent in areas remote from toolstone sources (see Elston 1988 for a model of lithic assemblage variability in Toedokado territory based on toolstone proximity).

Working from these four basic assumptions, we have used the preceding ranking of habitat types to rank our expectations about the archaeological record. Presumably, habitat types providing the highest foraging returns for women are most likely to contain frequently reused, archaeologically visible residential base camp locations, a potential that is enhanced by the presence of water and diminished by excessive slope. The potential for base camps is further enhanced if men's foraging returns are also high. Habitats rich in men's resources but not women's should be relatively rich in archaeological remains; residential base camps are unlikely, but they may contain logistic field camps. Habitats bearing women's foraging resources but not men's should have low archaeological visibility. This order of archaeological visibility of habitat types will be complicated by the proximity of toolstone sources. Based on these criteria, we have divided the set of habitat types into four categories: habitat types that provide moderate to high foraging returns for both men and women, habitat types that provide moderate foraging returns for women but low returns for men, habitat types that provide high foraging returns for men but moderate to low returns for women, and habitat types that provide low foraging returns for both men and women.

Habitat Types Profitable for Both Women's and Men's Foraging

This category includes fifteen lowland wetland habitat types (1, 1a, 4, 4a, 4b, 5, 5a, 5b, 6, 6a, 6b, 28, 28b, 53, and 55), seven montane habitat types (34, 34b, 34c, 47, 47b, 47c, 51), and twelve greasewood-saltbush habitat types (3, 3a, 3b, 7, 7a, 7b, 11, 11b, 16, 29, 29b, 36). We also consider four additional irregularly inundated Habitat Types 2a, 9a, 10a, and 11a and eight habitat types with perennial water sources (2b, 3b, 9b, 10b, 18b, 37b, 38b, and 44b) in this category.

Of these, the lowland wetland habitats are botanically most productive, producing between 1400 and 3100 kilograms per hectare. For women, wetlands are unquestionably the highest ranked habitats in summer and winter. In spring and fall, other kinds of habitats compete for the foraging attention of women, but wetlands continue to maintain resources ranking as high as any in any other habitat. In these seasons, women probably scheduled their foraging according to yearly variability in production of key resources. However, we suspect that wetlands were the top producers under most circumstances. Lowland wetlands usually did not maintain the highest ranked game for men, but they consistently maintained abundant small and medium sized game populations. Consequently in winter, spring, and summer when large game hunting in desert and upland habitats incurred high search costs, it is likely that men's best patches were in marshes. Overall hunting returns for desert and montane habitats probably competed with wetlands only in autumn, when large game hunting in montane zones was most profitable.

Despite their attractions as foraging patches, marsh wetlands (Habitat Types 1, 1a) should be relatively unattractive places for hunter-gatherers to live. The damp would too much hinder travel and inhibit comfort, so we expect that hunter-gatherers rarely would have chosen to camp in marshes. Therefore, unless shorelines and islands are present, marshes per se should contain low densities of archaeological remains, reflective mostly of foraging locations and field processing stations.

In contrast, dry areas in proximity to marshes should have archaeological records most reflective of marsh use. This would encompass marsh islands and marsh shorelines of Habitat Type 53. These areas not only offer hunter-gatherers a dry place to sleep but also access to other habitat types within the same catchment. We also must note desert habitat types that are inundated irregularly: 2a, 9a, 10a, and 11a. Although these habitat types presently maintain playa or greasewood-saltbush vegetation, if they ever were flooded for more than a few years, then they probably would have developed into marsh Habitat Type 53. Consequently, irregularly inundated habitats offer high potential for exhibiting archaeological records that are incongruent with their present habitat but are typical of marsh wetland habitats.

Riparian Habitat Type 4 provides notably attractive foraging patches for women in summer and fall, and for men in fall, winter, and spring. This habitat type frequently occurs near marsh wetlands (Habitat Type 4a), allowing hunter-gatherers access to both kinds of wetland patches from a single foraging location. Also, Habitat Types 5, 5a, 5b, 6, 6a, 6b and 28, 28b, and 55 should also be potentially important wetlands offering productive foraging patches in themselves as well as advantageous locations in proximity to marshes. Although not as profitable as Habitat Types 53 and 4, these are moderately profitable for women's foraging in summer and fall because they contain abundant stands of Great Basin wildrye and shadscale, as well as access to small mammals.

We note especially Habitat Types 2b, 3b, 9b, 10b, 18b, 37b, 38b, and 44b, which are associated with perennial water sources. Small wetland communities associated with perennial water in this habitat have greater potential to attract hunter-gatherers than their less productive, arid counterparts. Thus, these examples have high potential for residential occupation and we assess them as equivalent in rank to Habitat Types 5, 5a, 5b, 6, 6a, 6b, 28, 28b, and 55.

The only habitats that compete with those of marsh and riparian wetlands are montane habitats, which offer attractive foraging opportunities to both men and women. Although not as productive in raw herbaceous biomass as wetland habitats (only 300-600 kg/ha), upland habitats offer large resource packages that are not included in the botanical calculation. These include upland roots, pinyon nuts, and several medium size and large game animals. Moreover, montane habitats have the highest probability of containing lithic toolstone sources.

Both pinyon-juniper habitats (Habitat Types 34, 34b, and 34c) and montane sage habitats (Habitat Types 47, 47b, and 47a) are attractive spring foraging patches for women because of the roots they offer, while abundant pinyon yields drew women from marshes in the fall. Too, these habitats are consistently among the highest ranked foraging patches for men in summer, spring, and fall, while upland berries and seeds also provide moderately high return rates for women in summer.

The steep slopes of Habitat Type 47c would inhibit residential occupation as well as hinder the harvest, field processing, and transportation of pinyon nut and of roots. However, steep slope montane habitats represent good terrain for hunting mountain sheep. Consequently, we expect that Habitat Type 47c should contain isolated hunting artifacts, game drive lines and hunting blinds, and field butchering sites.

Hunting related sites and isolates also should characterize the gentler slopes of Habitat Types 34 and 47, particularly where the two occur in proximity, offering the broken cover terrain favored by mule deer. We expect that the spring harvest of roots and autumn harvest of pinyon nuts also occurred in these habitat types. Root harvesting, however, should be almost archaeologically invisible, whereas pinyon harvesting may be apparent in the archaeological record when the Toedokado field processed or cached cones before transporting them to a field or base camp. Even then, archaeological remains are likely to be ephemeral.

The archaeological record of mountain habitats should be most extensive and complex in habitats containing springs (Habitat Types 34b and 47b). The access to water offered by these locations would have been of primary concern to hunter-gatherers seeking optimal location of central place field and base camps, and these locations offer access to Habitat Type 51, which represents the wet meadow communities of mountain springs. Springs habitats produce a high biomass (1960 kg/ha) rich in Great Basin wildrye, which would have fostered rich patches of small and medium sized mammals and game birds; proximity to Habitat Type 51 would have enhanced its value as a camp location.

Thus, archaeological evidence for the procurement and processing of large game, roots, and pinyon nuts should be most extensive in Habitat Types 51, 34b and 47b. We expect archaeological sites in these habitats to contain abundant food processing gear, hunting equipment, and storage facilities; certainly hearth features should be present. Occasions of lengthy stay in mountain habitats during the cool seasons of spring and autumn should have prompted the use of rock shelters or the construction of houses and other domestic facilities. The complexity of archaeological remains in these habitats may rival those of some low wetlands, but over-winter occupation of mountains should have been rare. Consequently, we rate them below Habitat Types 53 and 4, but equivalent to Habitat Types 6 and 28. As before, toolstone procurement and manufacture in montane habitats may tend to magnify the archaeological record of montane habitats relative to those of the wetlands.

Finally, we consider greasewood-saltbush Habitat Types 3, 7, 11, 16, 29, and 36, which offer high returns for men and women. We expect all to be associated with isolated artifacts and small sites pertaining to hunting activity, because all represent productive territory for antelope and other small and mediums sized mammals. All should be productive for women's small mammal procurement year-round and for large ground squirrels in spring and summer. Habitat Types 11 and 16 rich contain rich stands of Indian ricegrass, green annual forbs, and tansymustard in late spring and early summer. Habitat Type 3 is rich in seepweed; Habitat Types 7, 11, 16, and 36 maintain productive stands of saltbush, whereas Habitat Type 29 abounds in wildrye and Torrey quailbush. Consequently, seed grinding stations are probable in any member of the set.

Notably, Habitat Types 11 and 16 are among the highest ranked foraging patches available for men and women in spring and early summer. They manifest the greatest potential for residential occupation with concomitant greatest density of archaeological remains. These habitat types should have been occupied residentially for only short periods, generally in years when marshes were unproductive. Consequently, we rate them fourth as habitats suitable for residential occupation.

Habitat Types Moderately Profitable for Women's Foraging

This category includes three sagebrush Habitat Types 27, 35, and 35c and ten greasewood-saltbush Habitat Types 10, 14, 15, 20, 21, 26, 42, 42c, 46, and 46c. Because all are poor hunting patches for men, we expect few hunting related assemblages to be associated with them and all archaeological variability to reflect women's activities.

Only Habitat Types 35 and 35c, which contains bitterroot, biscuitroot, and arrowleaf balsamroot, and Habitat Types 15, 20 and 27, which maintain relatively high densities of small mammals and annual forbs, represent attractive patches for spring foraging. Since the collection of forbs, roots, and small mammals should be archaeologically almost invisible, we do not expect much evidence of spring foraging activity in these habitats.

Habitat Types 20 and 27 maintain relatively dense stands of Indian ricegrass, and therefore may have attracted attention in early summer before marshes are most productive. Habitat Types 10, 14, 21, and 26 produce berries in middle to late summer, whereas Habitat Types 10, 14, 15, 20, 42, 42c, 46, and 46c produce saltbush or shadscale in fall and winter. All should have attracted the attention of women's foraging parties at various times of the year, but we expect that women carried their harvest to nearby base camps rather than field processing them on location since all of these habitats lack water and generally are low producers. Consequently, archaeological remains in these habitat types should be meager and their potential for residential occupation should be low. We rate them lower than habitat types containing both men's and women's foraging resources.

Habitat Types Moderately Profitable for Men's Foraging

These include Habitat Types 9, 13, 31, 37, 37c, 44, 44c, and 52, all of which are relatively poor in women's resources. Although they contain resources for which women forage, they are exceptionally low ranked resources, such as bluegrass, bottlebrush squirreltail, and needlegrass, or they maintain higher ranked resources in minor abundance compared to other habitats. Women probably would have foraged in these habitats only when the diet breadth was exceptionally broad and other habitats were unproductive.

Habitat Type 9 is good antelope habitat, and Habitat Types 31 and 44 are good for sheep and deer. Habitats Types 13, 37, and 52 produce woodrats and marmots. We expect that the archaeological records of these habitat types should represent hunting but not residential occupation or seed processing.

Habitat Types Unprofitable for Men's or Women's Foraging

This set includes playa Habitat Type 2, badlands Habitat Type 54, eight greasewood saltbush Habitat Types 18, 18c, 19, 38, 40, 49, 56 and 56c, and sagebrush Habitat Type 48. All are low in total productivity, maintaining only lowest ranked resources or minor quantities of higher ranked resources compared to other habitats. Consequently, neither male nor female hunter-gatherers are likely to have foraged in these habitats except under conditions of extremely broad diet breadth. We expect a minimal archaeological record, if any at all, in these habitats. Unprofitability notwithstanding, Habitat Types 2b, 18b, and 19b are associated with water sources and so may contain assemblages out of character with surrounding habitat types.

Ranked Habitat Types

Table 39 ranks Toedokado territory habitat types in terms of the relative complexity and abundance of archaeological remains predicted to occur within them, in descending rank order.

Table 39. Habitat Types Ranked by Predicted Archaeological Complexity.

Habitat Type	Rank*	Habitat Type	Rank*
4	7	34c	4
4a	7	55	4
4b	7	9	3
53	7	9a	3§
2b	6	13	3
3b	6	31	3
5	6	37	3
5a	6	37c	3
5b	6	44	3
6	6	44c	3
6a	6	47c	3
6b	6	52	3
7b	6	10	2
9b	6	10a	2§
10b	6	14	2
11b	6	15	2
18b	6	20	2
28b	6	21	2
29b	6	26	2
34b	6	27	2
37b	6	35	2
38b	6	35c	2
44b	6	42	2
47b	6	42c	2
28	6	46	2
34	6	46c	2
51	6	2	1
3	5	2a	1
3a	5§	18	1
7	5	18c	1
7a	5§	19	1
29	5	38	1
36	5	40	1
47	5	48	1
1	4◊	48c	1
1a	4◊	49	1
11	4	54	1
11a	4§	56	1
16	4	56c	1

*Relative Archaeological Complexity Scale

7= Men's and Women's Foraging and Logistic Sites, Residential Base Camps Abundant
6= Men's and Women's Foraging and Logistic Sites,Residential Base Camps Likely
5= Men's and Women's Foraging and Logistic Sites, Residential Base Camps Less Likely
4= Men's and Women's Foraging and Logistic Sites, Residential Base Camps Rare
3= Men's Foraging and Logistic Sites Only, No Residential Base Camps
2= Womens Foraging and Logistic Sites Only, No Residential Base Camps
1= Few or No Men's or Women's Foraging or Logistic Sites, No Residential Base Camps

◊Rank 7 complexity sites are potentially present if shorelines and islands are present
§Rank 7 complexity sites are potentially present if marshes with shorelines and islands were present

Ranks 7 through 4 habitat types all contain high ranked resources for both male and female hunter-gatherers, and at various times of the year could represent the highest ranked foraging patches available. Since these habitat types tend to be profitable for both genders, we expect gender-specialized logistic camps and both-gender procurement locations to occur in all four habitats; sites should contain relatively small, specialized assemblages whose composition directly reflects the subsistence tasks performed at those sites. Female subsistence activities may be difficult to discern except where abundant ground stone tools reflect field processing of plant foods; certain general utility artifacts such as tule knives, choppers, and battered cobbles may also indicate female subsistence activity.

Reflections of male subsistence will be more identifiable because of the high visibility of lithic detritus and tools. Weapons (projectile points), fabrication tools (bifaces, drills, scrapers, unifaces), and general utility tools (utilized flakes) will dominate the assemblages of these sites. Sites reflecting the procurement and field processing of lithic toolstone may be difficult to distinguish from male subsistence sites. Lithic procurement sites should contain abundant bifaces, cores, and hammerstones.

The habitat types ranked 7 through 4 should differ primarily in their suitability as locations for central place base camps. This potential is ranked according to availability of water and to the caloric return and abundance of women's resources. Rank 7 habitat types are marshes with shorelines or islands (Habitat Type 53), riparian habitat types near marshes (Habitat Types 4, 4a, and 4b), and irregularly inundated habitat types that would contain islands and shorelines if flooded long enough for marshes to form (Habitat Types 2a, 3a, 7a, 9a, 10a, and 11a). These habitat types provide the majority of the most productive resources available to foraging women, at the same time offering advantageous spots for base camps. Rank 6 habitat types include riparian (5, 5a, 5b, 6, 6a, 6b, 28, 28b, and 55), greasewood-saltbush associated with perennial water (2b, 3b, 7b, 9b, 10b, 11b, 18b, 29b, 38b, and 55), sagebrush associated with perennial water (37b and 44b), and montane habitat types (34, 34b, 47b, and 51). These habitats offer profitable resources to foraging women as well as access to potable water, rendering them highly suitable for base camp locations.

Rank 5 habitat types are greasewood-saltbush (3, 7, 11, 16, 29, and 36) and montane Habitat Type 47 which offer relatively high ranked seepweed seeds, saltbush seed roots, and berries for women's foraging. At times, particularly late spring, late summer, and late autumn, these may be the most profitable women's foraging patches, but their lack of water should limit their suitability as residential base camp locations. Similarly, included among rank 4 habitat types are dunes and sand sheets (Habitat Types 11 and 16) which offer moderately profitable seeds and forbs for women's foraging, perhaps the most profitable foraging patches available for brief periods in late spring and early summer. Nevertheless, their lack of water and the brevity of production make them least suitable for residential occupation. Rank 4 habitat types also include marshes without islands or shorelines (Habitat Type 1) and steep pinyon-juniper woodlands (Habitat Type 34c) which, although highly profitable foraging territory, lacks feasible locations for residential occupation.

Base camps, which should be characteristic of rank 4 through 7 habitat types, should contain diverse assemblages with evidence of plant food procurement and processing (ground stone tools, choppers, tule knives, battered cobbles), of meat procurement and processing (projectile points, unifaces, utilized flakes, knives), of tool fabrication (cores, bifaces, scrapers, bone tools, hammerstones and abraders), and of leisure activities (ornaments). Facilities and features such as house pits, storage pits, hearths, middens, and burials should be common. We expect that the abundance, complexity, and diversity of residential occupation sites should be greatest in rank 7 habitat types and least (but still possible in rank 4 habitat types.

Rank 3 habitat types are those which may be relatively attractive hunting patches but contain exceptionally low ranked plant resources such as bluegrass, bottlebrush squirreltail, and needlegrass

(Habitat Types 9, 13, 31, 37, 37c, 44, 44c, 47c, and 52). Specialized assemblages related to male subsistence strategies should dominate the archaeological record in these habitats, while sites reflecting female subsistence and occupation sites should be absent. Projectile points, bifaces, drills, scrapers, unifaces, and utilized flakes will be common in these habitats. Since these habitat types are only moderately productive for men and unprofitable for women, site densities should be relatively low.

Rank 2 habitat types contain moderate ranked resources for women's foraging, such as roots, berries, and saltbush seed, but are unproductive hunting territories (Habitat Types 10, 14, 15, 20, 21, 26, 27, 35, 35c, 42, 42c, 46, and 46c). Therefore, assemblages with ground stone tools will dominate the archaeological record of these habitat types; sites reflecting male subsistence and occupation sites should be absent. Since these habitat types are only moderately productive for women and unprofitable for men, and since women's subsistence activities are relatively difficult to discern in the archaeological record, site densities should be lower.

Finally, rank 1 habitat types are abiotic habitat types (2 and 54) and other habitats that are so biotically impoverished that they rarely should be attractive foraging patches for either men or women (Habitat Types 18, 18c, 19, 38, 40, 48, 49, 56 and 56c). We expect particularly low site densities and no residential sites at all.

Chapter 6. SAMPLE SELECTION FOR ARCHAEOLOGICAL SURVEY

David W. Zeanah

The site prediction model of Toedokado territory was evaluated by intensive pedestrian survey of a 5% sample of lands administered or proposed for withdrawal by Naval Air Station Fallon. Sampling the total 273,199 acres spread throughout Toedokado territory was accomplished through inventory of 57, one kilometer square sample units: 13 units sampled 56,010 acres in October 1993 and the remaining 217,189 acres were sampled by selection and survey of a stratified random sample of 44 additional sample units in June and July 1994. Present and proposed Navy jurisdictions represent 10% of the entire area of the model; taken together with the previously sampled lands of the Stillwater Wildlife Management Area, just under one-fifth (18%) of Toedokado territory has been sampled at the 5% level.

The need to assay the model as a research and management tool, particularly in sampling areas that are biased, demands careful sample selection. Sampling considerations are reviewed in the following discussion, beginning with lands under present and proposed NAS Fallon administration. Next, distribution of the sample units surveyed in autumn 1993 is analyzed. Finally, we describe selection of the 44 sample units surveyed in summer 1994.

Present and Proposed Navy Jurisdictions

The lands sampled by the present test are administered by Naval Air Station Fallon (NAS) or are administered by BLM but are proposed for withdrawal for Navy use. Each parcel is described below; selection and sampling considerations unique to individual parcels are reviewed.

Lands Administered by NAS Fallon

These include NAS Fallon Main Station, Dixie Valley parcels, and four elements of the NAS Fallon Range Training Complex (FRTC): Bravo 16 (B-16), Bravo 17 (B-17), Bravo 19 (B-19), and Bravo 20 (B-20). The locations of all appear in Figure 73.

NAS Fallon Main Station

NAS Fallon Main Station, 10 kilometers southeast of the city of Fallon and approximately 12 kilometers north of Carson Lake, occupies 8,382 acres. Five percent inventory of this area (419 acres) required selection of two, one kilometer square sample units. Existing data generated by the many archaeological surveys that have been conducted in this vicinity, rather than additional field work, are used for model testing purposes.

Dixie Valley

NAS Fallon administers 9,740 acres distributed among fourteen discrete parcels in central and northern Dixie Valley, located approximately 60 miles east of Fallon, Nevada. These parcels include the townsite of Dixie Valley, Dixie Hot Springs, Bar A-3 Ranch, Boyer Ranch, and Horse Creek Ranch. A 5% sample (487 acres) would consume two, randomly selected one kilometer square sample units. However, the considerable extent of historic period properties represented in the Dixie Valley parcels imposed additional selection constraints on random sampling. Since our model declines to predict

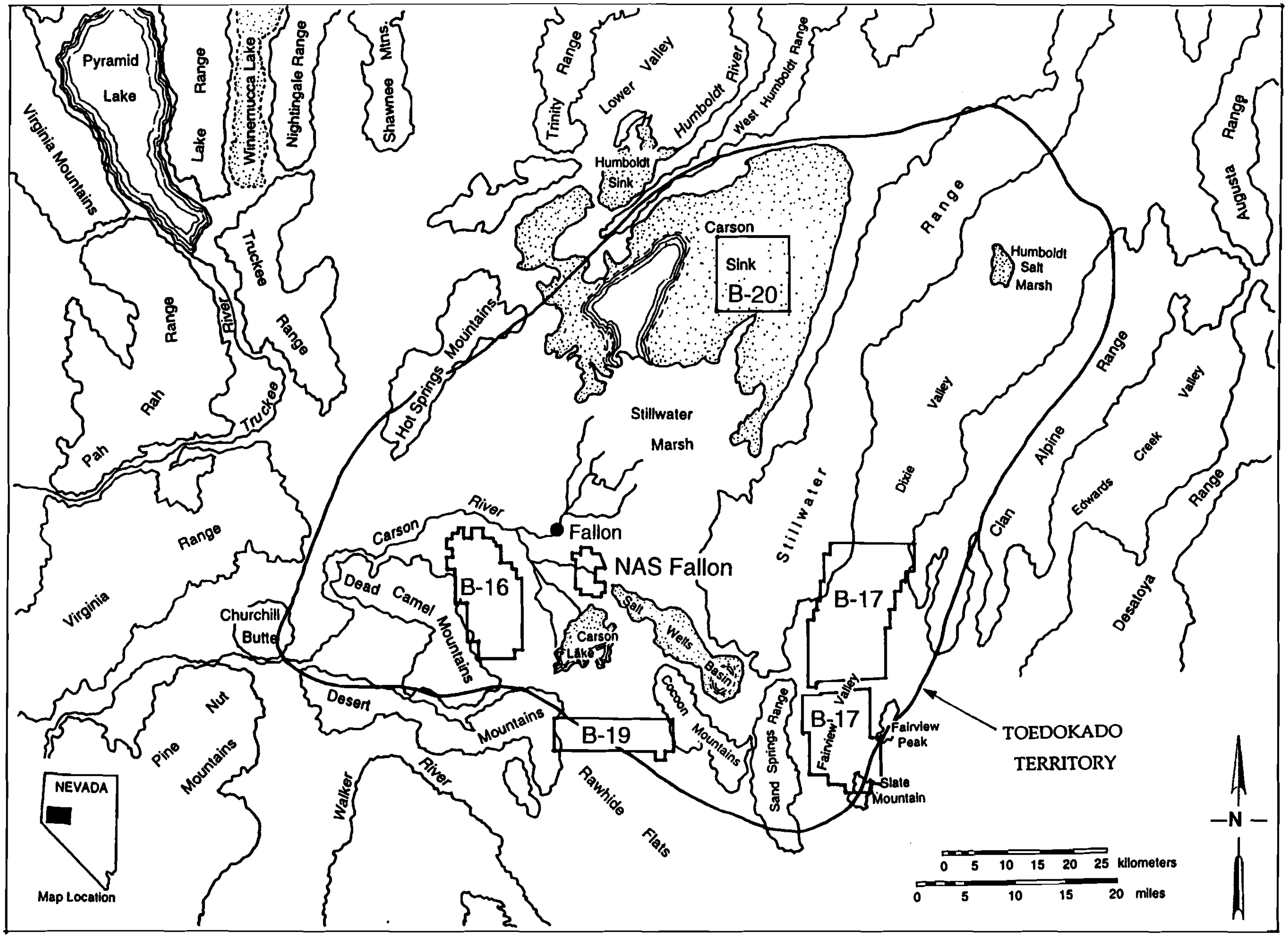


Figure 73. Map of Toedokado territory relative to Navy lands and public lands proposed for Navy withdrawal.

archaeological resources of the historic period, we elected to reject sample units containing known historic remains and reselect new units so that finite testing resources could be dedicated to that which is relevant to the research design. These were surveyed in 1994.

Bravo 16 Training Range (B-16)

B-16 encompasses 17,280 acres nine miles southwest of Fallon in the southwestern Carson Desert. This block was sampled at 5% in 1993, by four, one kilometer square units.

Bravo 17 Training Range (B-17)

B-17 takes up approximately 21,400 acres 35 miles southeast of Fallon in central Fairview Valley. Our field crews sampled B-17 in 1993 at the 5% level with five randomly selected sample units.

Bravo 19 Training Range (B-19)

B-19 comprises approximately 17,330 acres 15 miles south of NAS Fallon, west of the Blow Sand Mountains. Forty-five square kilometers of B-19 extend south of the Toedokado territory boundary defined in Chapter 2. For administrative purposes, we expanded the coverage of the model southward to include these quadrats. Four quadrats sampled B-19 at 5% in 1993.

Bravo 20 Training Range (B-20)

B-20 encompasses 40,987 acres 35 miles northeast of Fallon, in the Carson Sink. Eight randomly selected units sampled B-20 at 5% in summer 1994.

Live ordnance occurs in Navy-designated 'high impact' zones of training ranges B-17, B-19, and B-20, areas inaccessible to archaeological survey. Thus, selection of sample units in these training ranges is biased against high impact areas; each randomly selected unit falling within a high impact zones was rejected and replaced with another randomly selected sample unit.

Lands Proposed for Navy Withdrawal

The Navy proposes withdrawal of about 188,500 acres of public land for incorporation into the NAS Fallon Range Training Complex. Of these, fiscal constraints obliged sample of slightly more than 158,000 acres. These lands surround ranges B-16, B-17, and B-19 (Figure 73). Sampling them at the 5% level required random selection and systematic survey in 1994 of 32, one kilometer square sample units. Sample units were allocated among the three withdrawal parcels proportional to the relative size of the latter: five units in B-16, 23 in B-17, and four in B-19.

The 1993 Sample

The three training ranges sampled in 1993 were stratified in light of soil and range data available for each (USDA Extension Service 1991); selected sample units anticipated completion of the Toedokado model presented here. Table 40 lists habitat types assigned to each sample unit: five units sampled Habitat Type 10, three Habitat Type 11, and one each Habitat Types 10a, 15, 16, 20, and 38.

Table 40. Distribution of 1993 Sample Units by Habitat Type.

Sample Area	Quadrat No.	UTM Coordinates (1000s)	Habitat Type
B-16	10	336/4353	3
	11	335/4356	11
	12	338/4352	3
	13	334/4352	11
B-17	1	390/4342	10
	2	389/4341	11
	3	388/4346	2a
	4	394/4346	10
	5	397/4346	10
B-19	6	352/4338	20
	7	350/4334	16
	8	356/4334	38
	9	357/4335	15

Table 41 presents the distribution of all quadrats by habitat type in sample areas B-16, B-17, and B-19, together with the sample size necessary to achieve a 5% sample. It is immediately apparent that twelve habitat types are present in the three areas in which a 5% sample amounts to 0.5 sample units or less. This is a function of formulating habitat types on the significantly larger Toedokado territorial scale; numerous habitat types occur in the smaller Navy universe in frequencies too low to be sampled at the 5% level.

Nevertheless, it is clear that the 1993 sample units represent a valid 5% sample of habitat types represented in the three sample areas. All habitat types requiring a sample size greater than 0.75 units were sampled by at least one quadrat, and the three habitat types calling for sample sizes greater than one unit were sampled in sufficient proportion to achieve the 5% sample level. Habitat Type 11 was slightly over sampled.

Table 41. Distribution of All Quadrats by Habitat Type in 1993 Sample Areas.

Habitat Type	B-16	B-17	B-19	Total Quadrats	Sample Units Needed for 5% Sample	No. 1993 Sample Units
2	0	0	7	7	0.35	
2a	0	16	0	16	0.8	1
3	46	0	0	46	2.3	2
10	8	46	3	57	2.85	3
10a	0	5	0	5	0.25	
11	25	3	0	28	1.4	3
11a	0	1	0	1	0.05	
15	0	0	29	29	1.45	1
16	0	8	7	15	0.7	1
19	0	1	0	1	0.05	
20	0	0	22	22	1.1	1
21	0	6	0	6	0.3	
26	3	0	0	3	0.15	
35c	0	4	0	4	0.2	
38	0	0	15	15	0.75	1
38b	0	0	1	1	0.05	
40	0	0	2	2	0.1	
46c	0	7	0	7	0.35	
54	2	0	0	2	0.1	
Total	84	99	84	267	13.35	13

The 1994 Sample

Similarly, Table 42 presents the distribution of all quadrats by habitat type in the 1994 sample areas. These include B-16, B-17, and B-19 proposed land withdrawals, B-20 Training Range, NAS Fallon Main Station, and Dixie Valley parcels. The sample size needed to achieve a 5% sample of each habitat type is also indicated. As in 1993, numerous (n=31) habitat types in the 1994 areas appear in frequencies too low to be sampled by one kilometer square sample units, still a function of the incongruity of scale between modelling and sampling universes.

Table 42. Distribution of All Quadrats by Habitat Type in 1994 Sample Areas.

Habitat Type	B-17 Withdrawal	B-19 Withdrawal	B-16 Withdrawal	B-20 Withdrawal	Dixie Valley	NAS Fallon Main	Total Quadrats	5% Sample	No. 1994 Sample Units
1	0	0	0	0	3	0	3	0.15	
2	0	0	1	165	0	0	166	8.3	7
2a	0	0	0	11	0	0	11	0.55	1
3	0	0	28	0	2	3	33	1.65	1
3a	0	0	0	0	0	8	8	0.4	1
3b	0	0	0	0	0	2	2	0.1	
4	0	0	0	0	0	1	1	0.25	
4a	0	0	0	0	0	4	4	0.2	
5	0	0	0	0	0	1	1	0.05	
5a	0	0	0	0	0	5	5	0.25	
6	0	0	0	0	0	2	2	0.1	
6a	0	0	0	0	0	5	5	0.25	1
7	0	0	3	0	0	3	6	0.3	
7a	0	0	0	0	0	4	4	0.2	
10	164	17	14	0	4	4	203	10.15	7
10a	0	0	0	0	0	2	2	0.1	
10b	1	0	0	0	2	0	3	0.15	1
11	34	0	70	0	1	0	105	5.2	4
11a	1	0	0	0	0	0		0.05	
11b	0	0	1	0	0	0	1	0.05	
13	0	0	0	0	3	0	3	0.15	
16	86	3	0	0	0	0	89	4.45	4
18	13	1	4	0	0	0	18	0.9	2
18c	5	0	3	0	0	0	8	0.4	
20	0	30	2	0	0	0	32	1.6	2
21	79	0	0	0	7	0	86	4.3	4
26	37	0	4	0	0	0	41	2.05	2
27	1	0	0	0	0	0	1	0.05	
28	0	0	0	0	14	0	14	0.7	
28b	0	0	0	0	7	0	7	0.35	
29	2	0	0	0	39	0	41	2.05	2
29b	0	0	0	0	5	0	5	0.25	
31	3	0	0	0	0	0	3	0.15	
34	2	0	0	0	0	0	2	0.1	
34c	2	0	0	0	0	0	2	0.1	
35	6	0	0	0	0	0	6	0.3	
35c	14	0	0	0	0	0	14	0.7	
37	14	22	0	0	2	0	37	1.85	1
37c	21	2	0	0	1	0	24	1.2	2
38	0	2	2	0	10	0	13	0.65	
38b	0	0	1	0	2	0	3	0.15	
40	18	0	0	0	4	0	22	1.1	
42	0	1	3	0	0	0	4	0.2	
42c	0	2	0	0	0	0	2	0.1	
44	4	0	0	0	0	0	4	0.2	
44c	1	0	0	0	0	0	1	0.05	

Table 42, continued.

Habitat Type	B-17 Withdrawal	B-19 Withdrawal	B-16 Withdrawal	B-20 Withdrawal	Dixie Valley	NAS Fallon Main	Total Quadrats	5% Sample	No. 1994 Sample Units
47c	1	0	0	0	0	0	1	0.05	
48	1	0	0	0	0	0	1	0.05	
48c	1	0	0	0	0	0	1	0.05	
49	1	5	0	0	0	0	6	0.3	
54	0	0	11	0	0	0	11	0.55	
56	23	1	0	0	0	0	24	1.2	1
56c	37	0	0	0	0	0	37	1.85	1
Total Quadrats	572	86	146	176	105	44	1129		
Total Sample Units	23	4	5	8	2	2			44

We attempted to ensure that all habitat types sufficiently represented to demand one full sample unit or more to achieve the 5% sample level were sampled proportionally, but this occasionally was impossible because some of the suitable quadrats fell more than two-thirds outside the boundaries of the sample area (i.e., Navy jurisdiction), or fell in areas unavailable for inventory (i.e., high impact zones in training ranges). Moreover, we elected to underrepresent habitat types that had been well-sampled in 1993 or by the previous Stillwater survey (i.e. Habitat Types 2, 10, and 11), so as to allocate sample units to habitat types that are poorly represented in the sample areas available to us. Sample units were selected by dividing all quadrats into sets of the same habitat type in the same sample area and randomly choosing the appropriate number from each set, to match the appropriate number of units for both habitat type and land parcel. Table 43 indicates the coordinates, habitat type, and sample area of each of the 44 sample units so chosen; their locations are indicated in Figures 74–81.

Table 43. Distribution of 1994 Sample Units by Habitat Type.

Sample Area	Sample Unit No.	UTM Coordinates (1000s)	Habitat Type	Sample Area	Sample Unit No.	UTM Coordinates (1000s)	Habitat Type
B-16 Withdrawal	1	331/4362	18	B-17, cont.	37	399/4370	21
	2	333/4369	11		38	400/4360	11
	3	334/4362	10		39	400/4369	21
	4	340/4353	3		40	402/4364	26
	5	340/4361	11		41	403/4367	56c
B-17 Withdrawal	19	388/4335	10		43	403/4369	56
	20	388/4354	16	B-19 Withdrawal	6	346/4335	20
	22	390/4334	10		7	349/4336	20
	23	390/4365	18		10	364/4335	37
	24	391/4349	11		11	366/4336	10
	25	392/4331	10b	B-20	12	377/4413	2a
	26	392/4355	16		13	378/4416	2
	27	392/4360	26		14	382/4420	2
	28	393/4356	10		15	384/4410	2
	29	394/4333	37c		16	385/4412	2
	30	395/4350	16		17	385/4418	2
	31	396/4353	16		18	386/4411	2
	32	396/4365	10		21	388/4409	2
	33	397/4368	21	Dixie Valley	42	403/4382	29
	34	398/4333	37c		44	431/4423	29
	35	398/4359	21	NAS Fallon	8	353/4367	6a
	36	399/4364	10		9	356/4364	3a

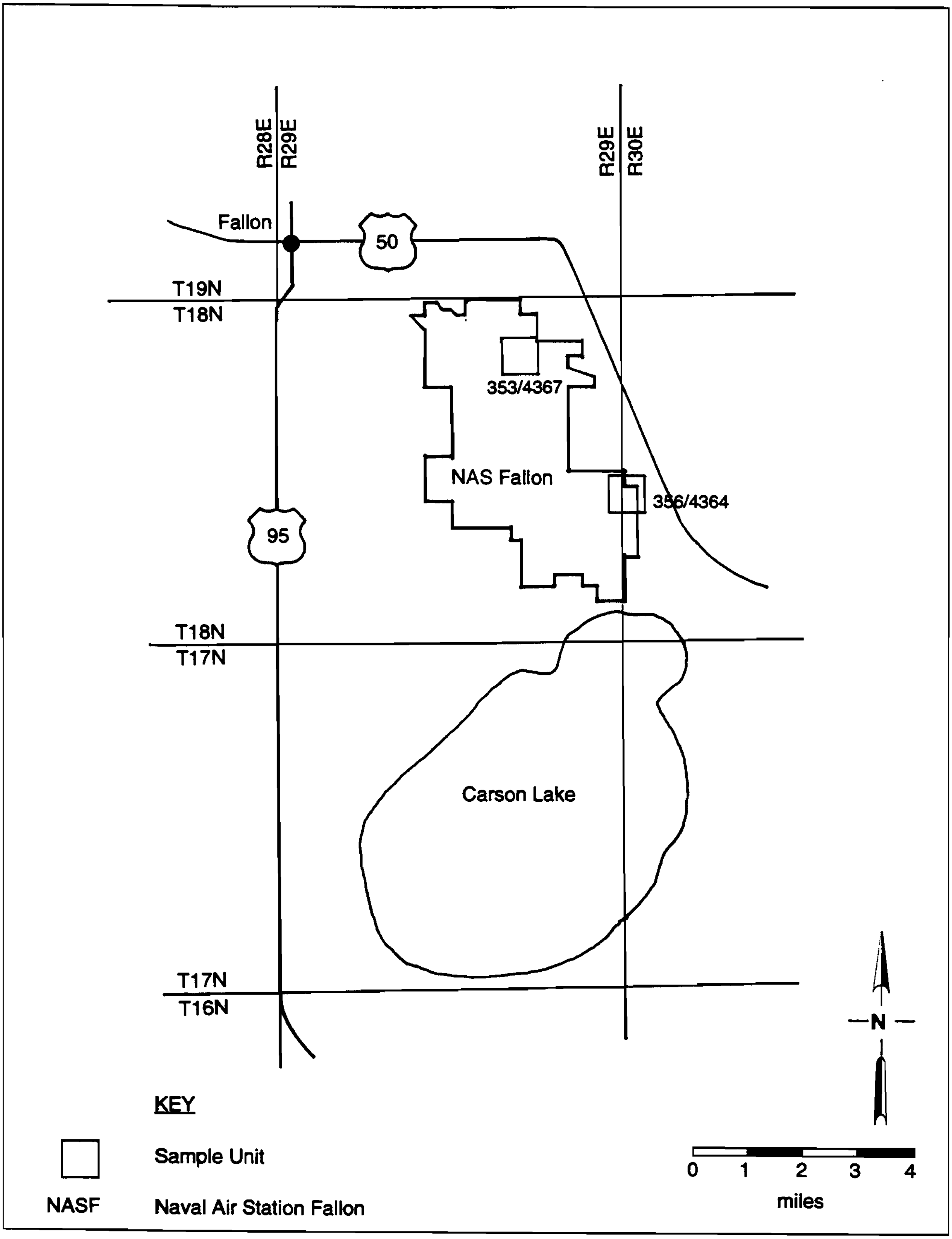


Figure 74. Map of 1994 sample units selected for NAS Fallon Main Station.

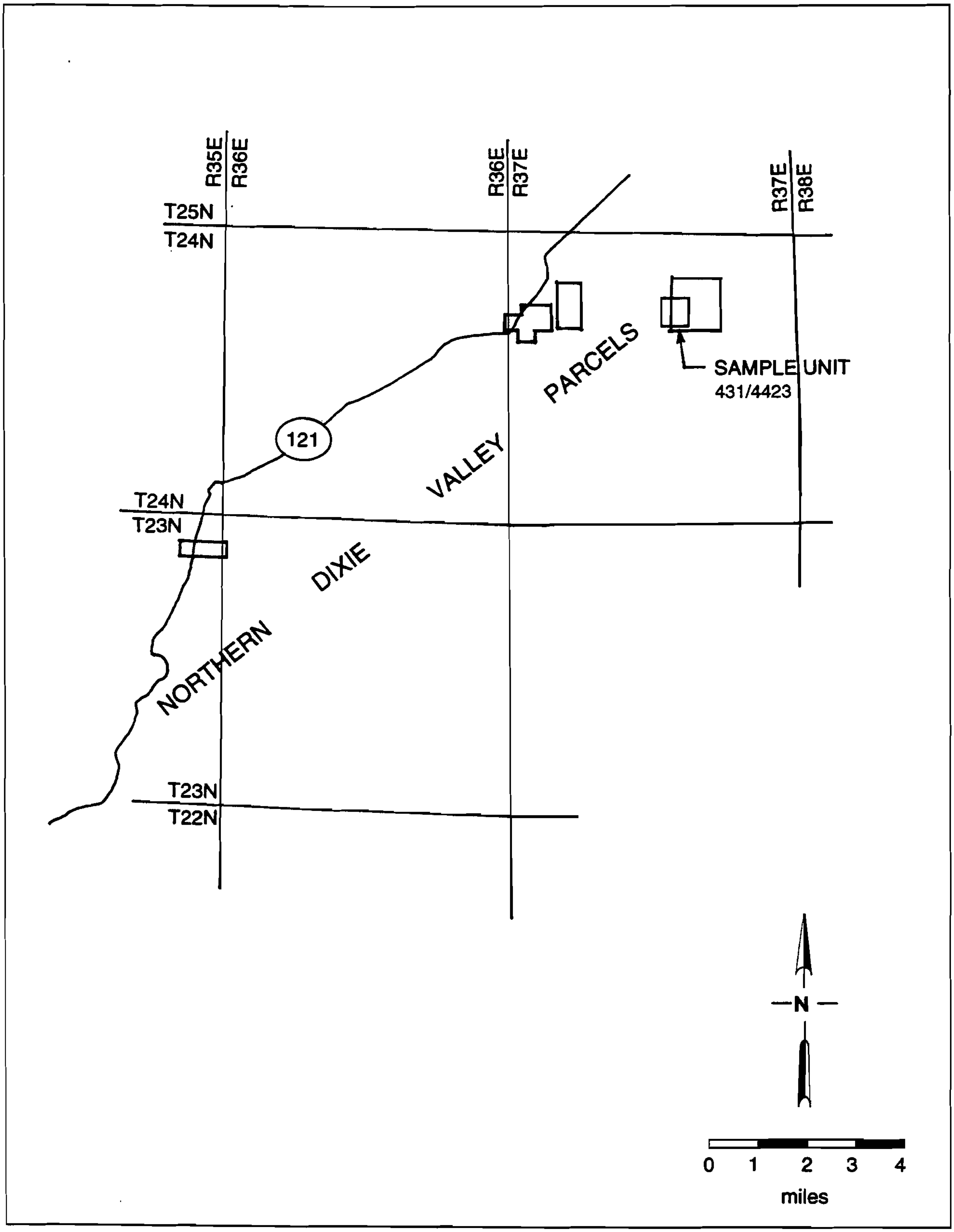


Figure 75. Map of 1994 sample unit selected in north Dixie Valley parcels.

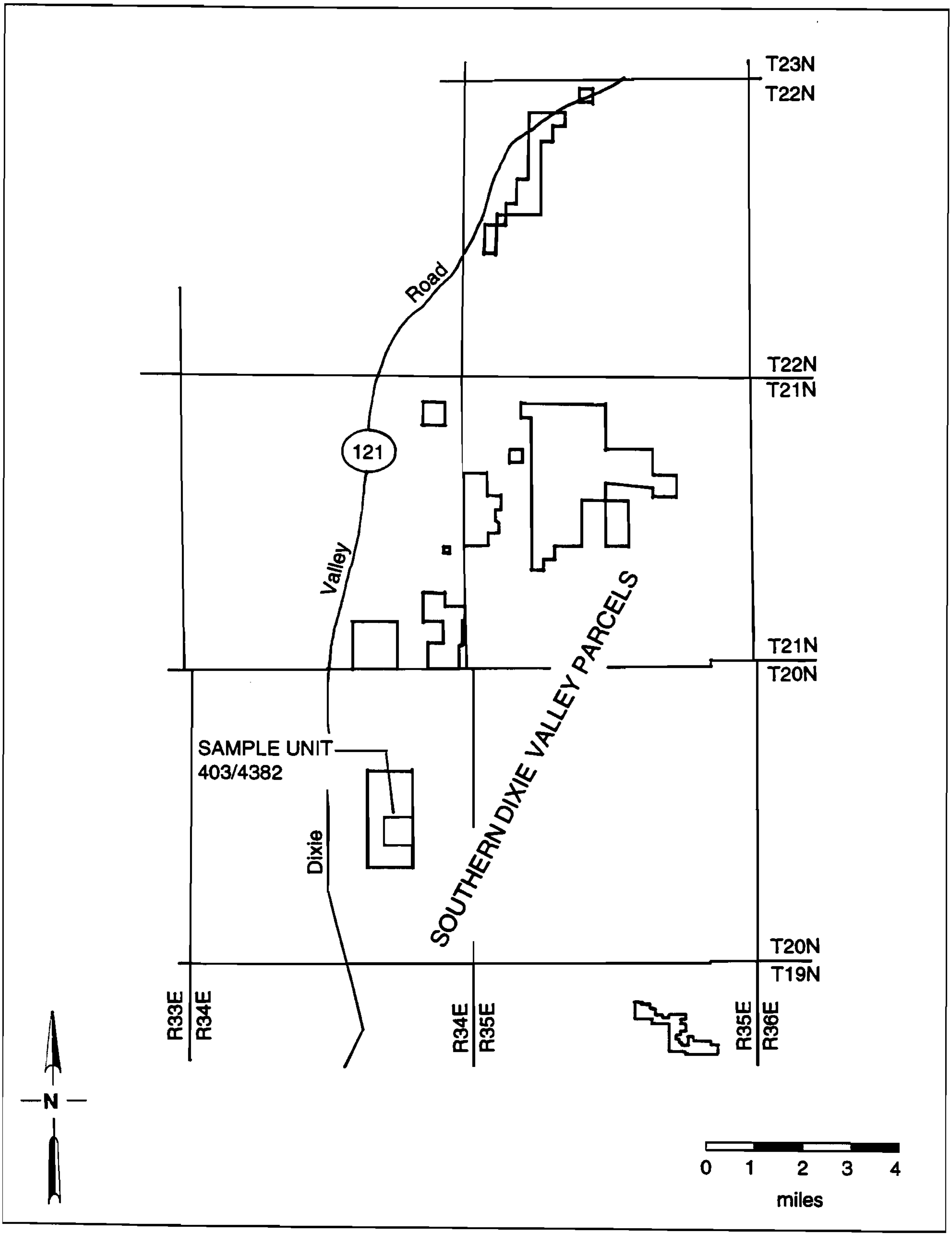


Figure 76. Map of 1994 sample unit selected in south Dixie Valley parcels.

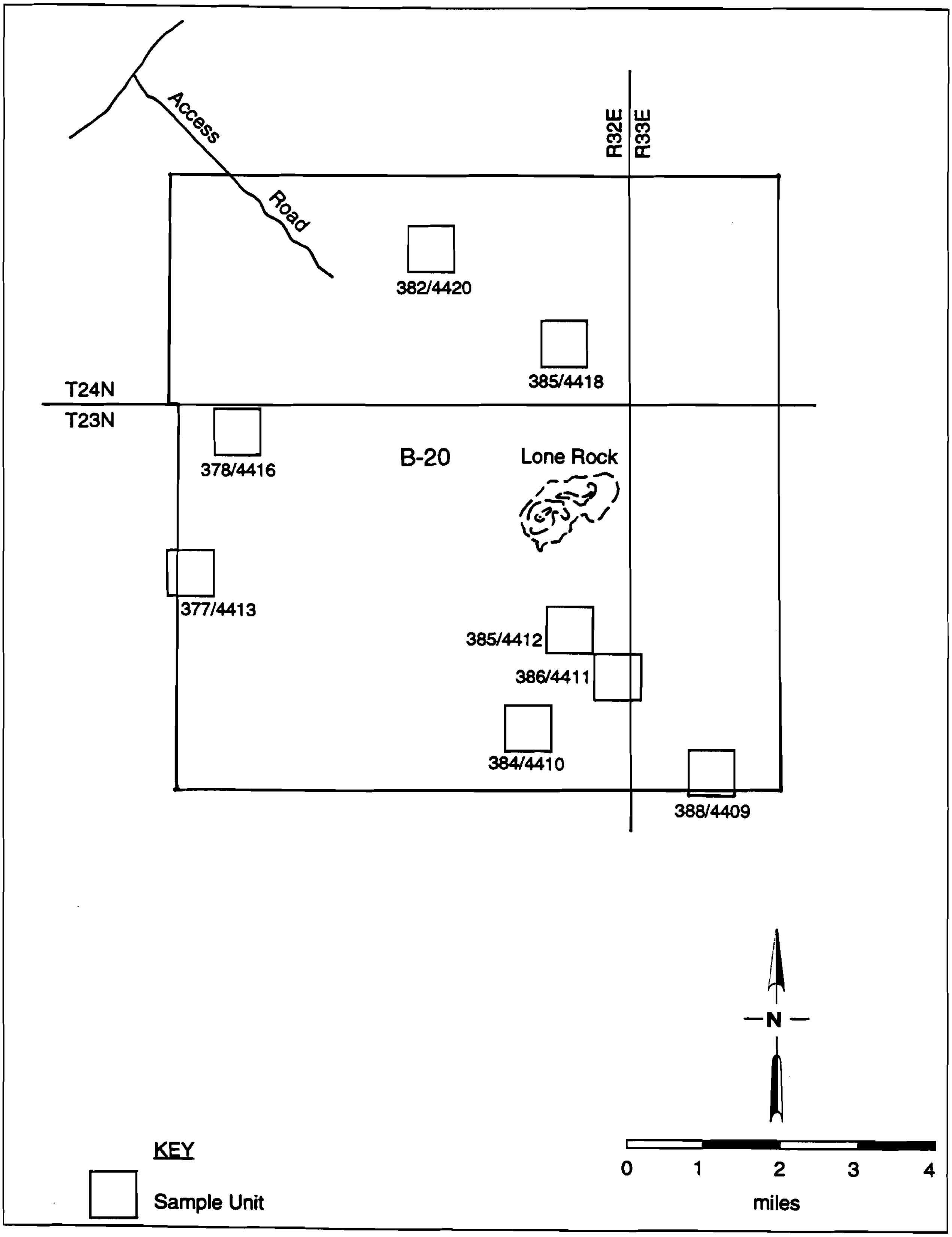


Figure 77. Map of 1994 sample units selected in B-20.

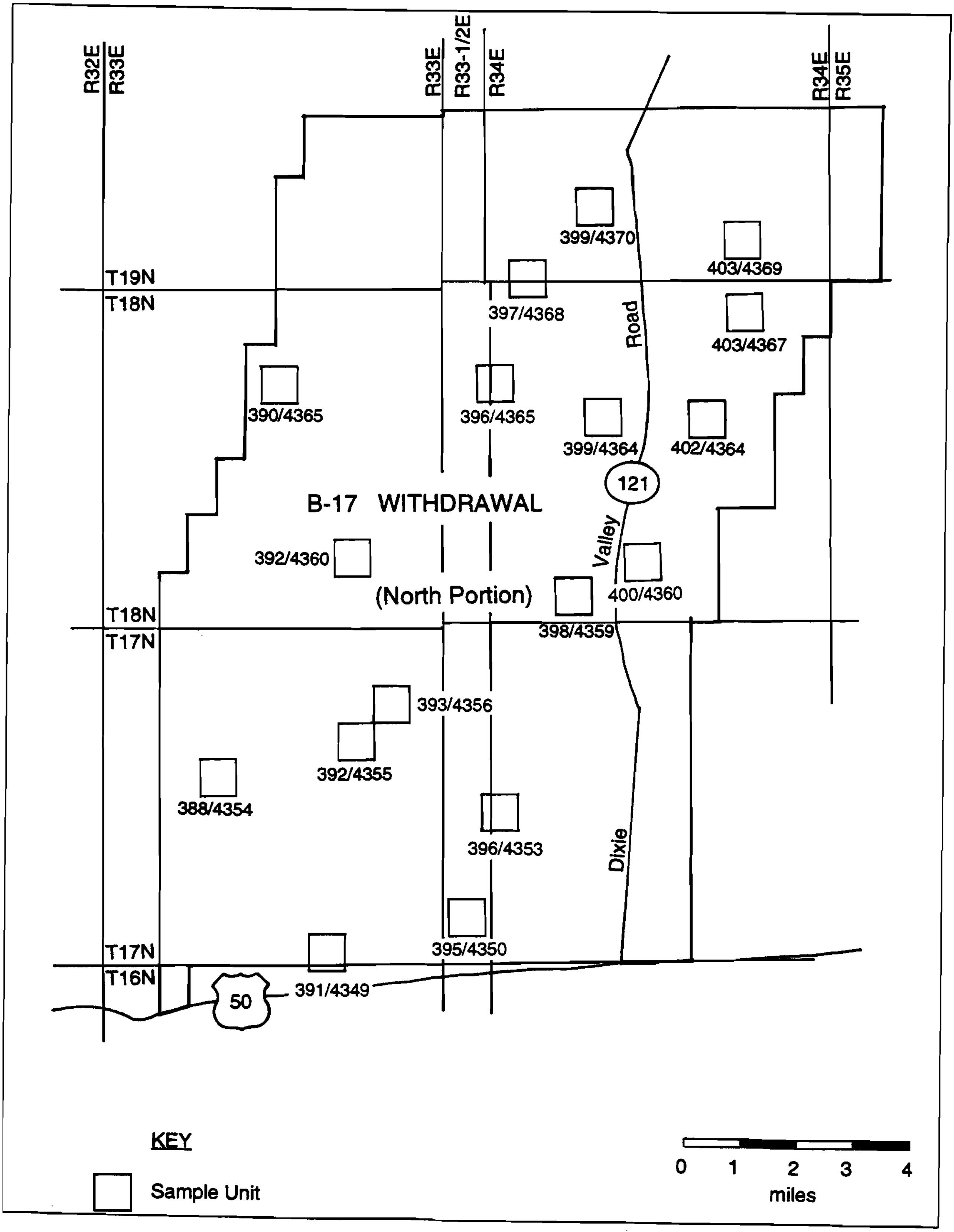


Figure 78. Map of 1994 sample units selected in proposed withdrawal lands north of B-17.

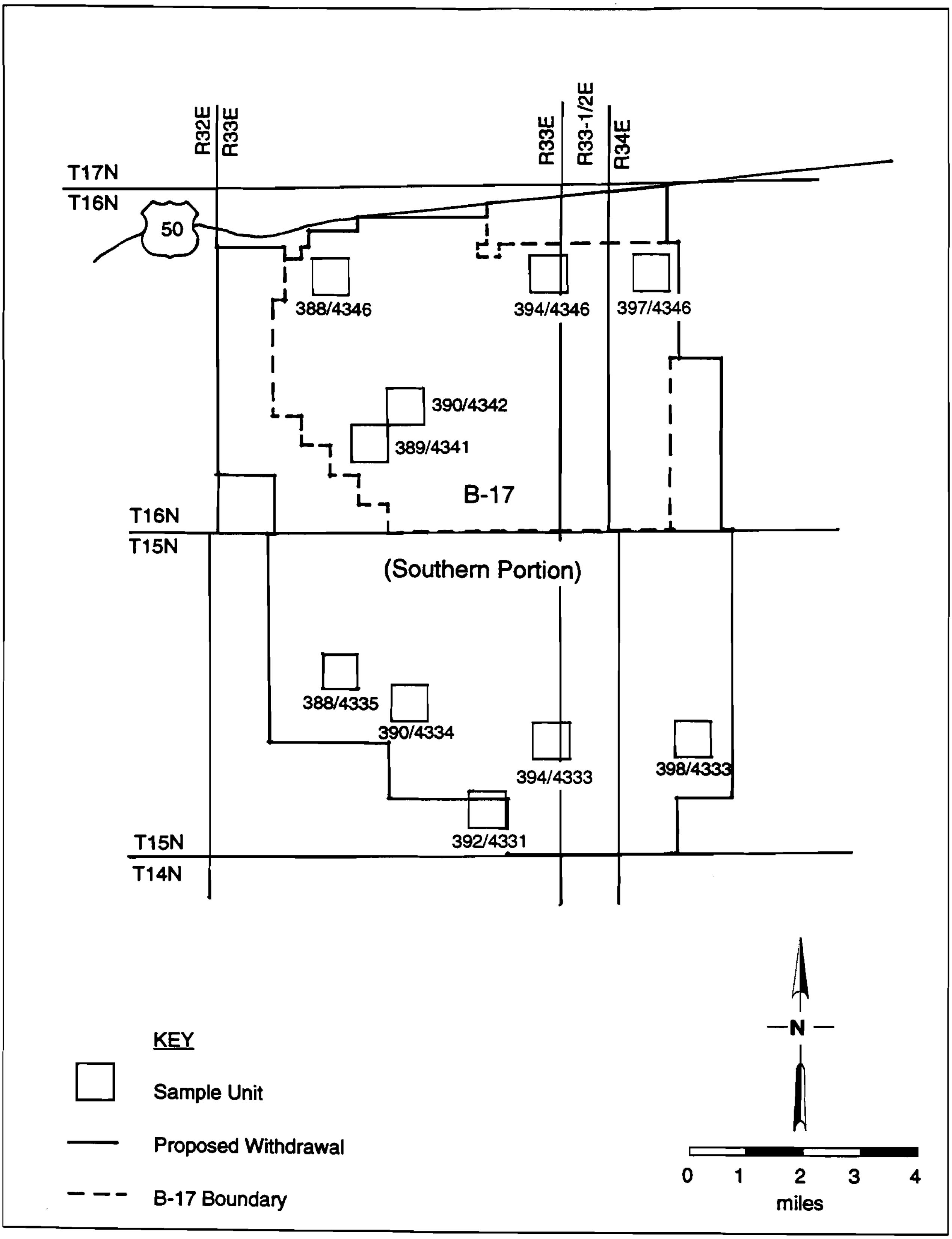


Figure 79. Map of 1993 and 1994 sample units selected in proposed withdrawal lands adjacent B-17.

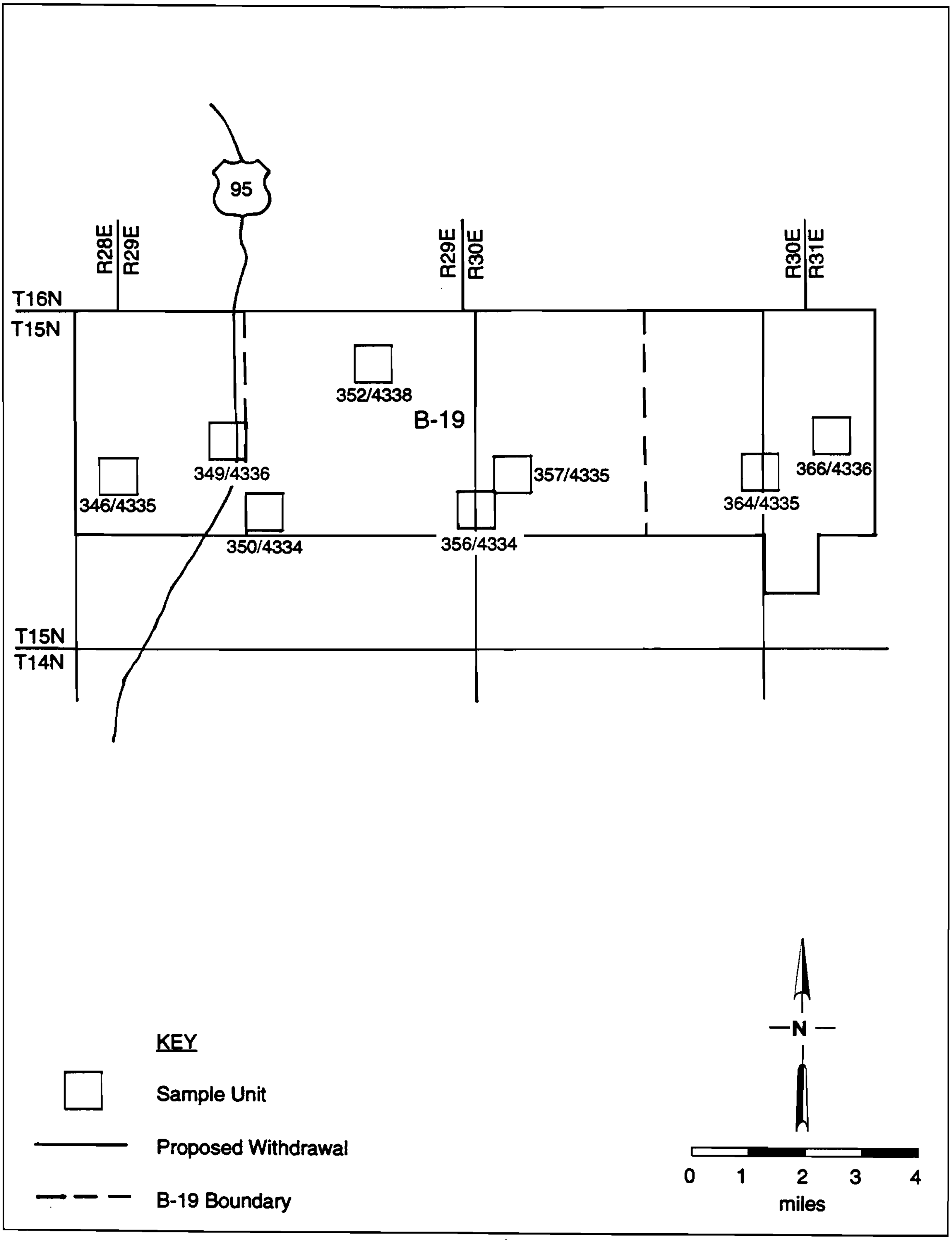


Figure 80. Map of 1993 and 1994 sample units selected in proposed withdrawal lands adjacent B-19.

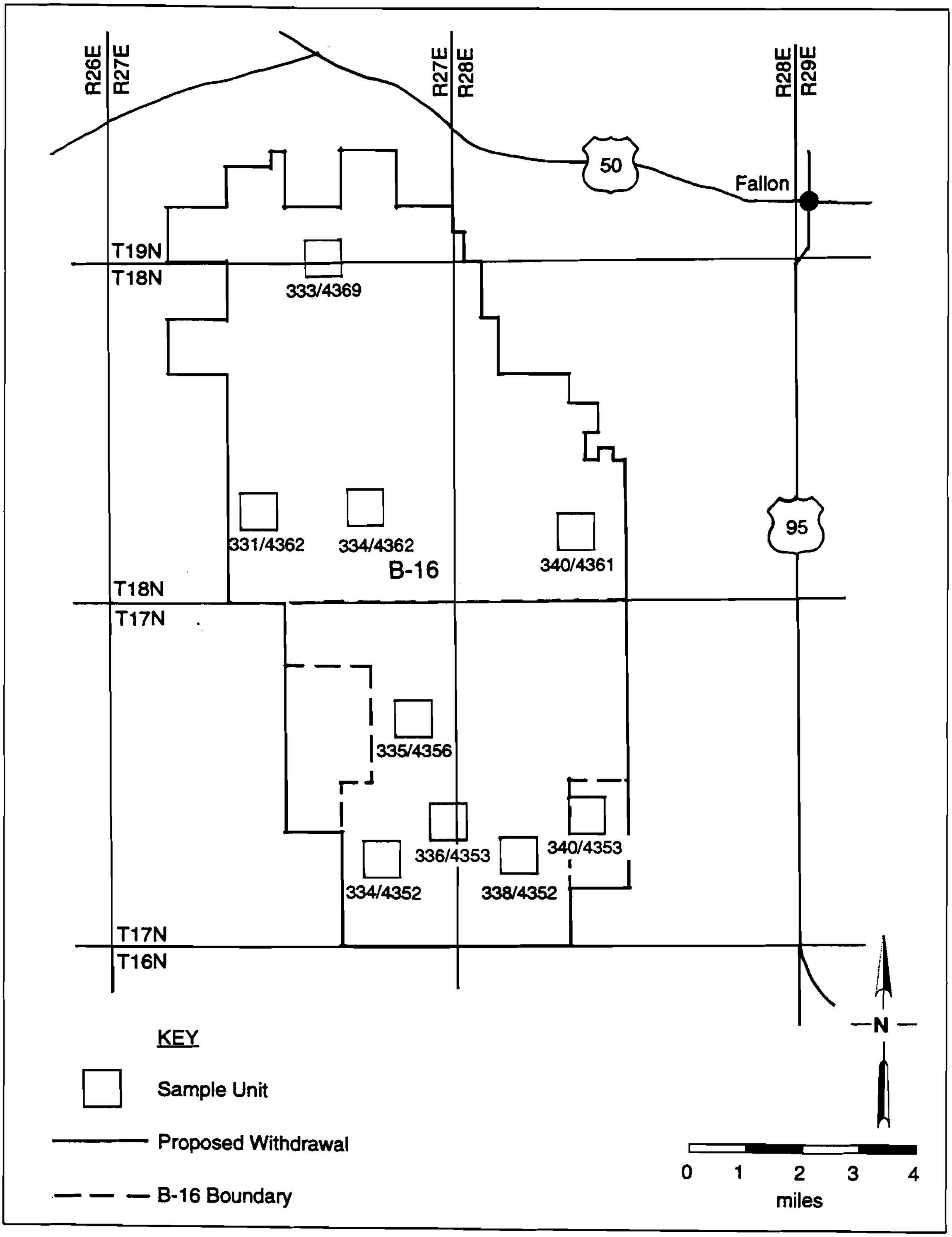


Figure 81. Map of 1993 and 1994 sample units selected in proposed withdrawal lands adjacent B-16.

Chapter 7. SAMPLE UNITS AND THEIR CONTENTS

James A. Carter and David W. Zeanah

Sample units (rather than archaeological sites) constitute the analytical units of our study, following the field test of the Stillwater model (Raven 1990). Viewed from this perspective, archaeological remains become attributes of the sample unit in which they appear. The following discussions describe the environmental and archaeological variability of units sampled in 1993 and 1994 field seasons, then turn to archaeological assemblage description.

Sample unit descriptions are organized in terms of habitats. Sample unit designators are comprised of a shorthand expression of the UTM coordinates of their southwestern corners; eastings always are given first. Thus, a sample unit designated 331/4362 refers to that one square kilometer quadrat anchored on the southwestern corner at UTM (Zone 11) coordinate 331000 E, 4362000 N. Archaeological sites are referenced according to the Bureau of Land Management numbering system, omitting the prefix convention CrNv-81-, unless otherwise noted.

The descriptions of sample units given in following pages are ordered in terms of our habitat number sequence of Chapter 3 so that the reader may cross-reference unit descriptions with habitat descriptions.

Following sample unit descriptions, we describe archaeological assemblages, irrespective of sample unit or habitat affiliation, in terms of site type classification. Then, in Chapter 8. these site types become attributes by which archaeological variability among sample units is analyzed.

Field Methods

The goal of field work was to secure a database from which to evaluate predictive powers of the Toedokado habitat model. We also satisfied site recordation and evaluation objectives required by the two Federal agencies administering survey areas: Naval Air Station Fallon and Bureau of Land Management, Carson City District. Federal guidelines prescribe standards for the recordation, characterization, and evaluation of data. For example, we recorded all historic period sites that we encountered, although the habitat model does not address historic phenomena. We also evaluated all prehistoric sites observed in terms of their eligibility for nomination to the National Register of Historic Places, an exercise that is irrelevant to present modeling objectives. Finally, Navy and BLM standards impose narrow (sometimes contradictory) definitions of large and small sites and isolates that are not suitable for our analytical goals; in this case, Federal mandates are followed on Intermountain Antiquities Computer System site forms, but are ignored in the present analysis.

Herein, we describe only survey data that pertain to the goal of model evaluation, i.e., prehistoric properties located in sample units. We classify these properties as large sites, small sites, and isolates according to criteria appropriate for model analysis rather than according to administrative definitions. National Register evaluations appear in Appendix E, without mention in the body of the report.

Two crews of three or four archaeologists, walking parallel transects spaced 30 meters apart, accomplished the survey. Crew chiefs located survey quadrats by Global Positioning System (GPS), and by triangulation from mapped points such as cadastral markers, structures and topographic landmarks. Crew chiefs completed a sample unit form for each surveyed quadrat, devised for the earlier Stillwater survey (Raven 1990:11), to ensure comparability of sample unit observations. The forms evoke description of modern disturbance, geomorphology, hydrology, soils, topography, and vegetation of sample units. A map template accompanied each sample unit form, upon which spatial details of the environmental and archaeological structure of the sample unit were recorded. A blank sample unit form and an example of a completed form appear in Appendix H.

Field survey and site recordation procedures followed standards and guidelines established in *Cultural Resources Inventory General Guidelines* (USDI, BLM [1989] 1990), as modified by Instruction Memorandum No. NV-91-194. When survey crews encountered an association of at least two cultural items, they recorded the location on the appropriate 7.5 minute USGS map and assigned it a temporary field number. They installed a permanent site datum (1/2 in. aluminum conduit with aluminum cap bearing temporary site designator, projecting about 3 in. above ground surface) in the approximate center of each site and mapped the site using the compass/traverse method. They then scrutinized the site surface intensively to identify horizontal boundaries and assemblage content. Special attention was devoted to locating diagnostic artifacts, features, and surface evidence of subsurface deposits. At least two photographs of each site were made from datum and numerous artifacts and all diagnostic or unique artifacts were illustrated; no collections were made. All cultural properties containing more than one artifact were recorded on Intermountain Antiquities Computer System (IMACS) site forms; permanent BLM site numbers were obtained from the Carson City District Office for all.

Individual artifacts isolated from other cultural phenomena were plotted as isolates on appropriate maps and described in survey notes. This procedure varied slightly on two quadrats (340/4353 and 388/4346), where isolated artifacts littered playa surfaces. Eroding from *in situ* sites in coppice dunes (cf. Nials 1994), the density of these displaced materials was too low (less than one flake per 1000 square meters) to warrant "site" designation, but too ubiquitous to warrant the location, map plotting, and description of every individual item. Therefore, in these two quadrats, we made general estimates of the quantity, distribution, and character of isolated debitage on the playa surface, and thereafter recorded only isolated formed tools.

Sample Unit Descriptions

Field Reclassifications of Sample Unit Habitat Types

Field observation of sample units verified prefield habitat type assignments based on soil and range data; vegetation, topography, and sediments of each unit were observed. Field description corresponded to prefield habitat type description in 54 of the 57 sample units. Observed characteristics of the remaining three sample units differed sufficiently from the expected that each was reassigned to a new habitat type (Table 44).

Table 44. Habitat Type Reassignment of Three Sample Units.

Designator UTM Coordinates (1000s)	Pre-Field Habitat Type	Revised Habitat Type	Comment
388/4346	2a	3a	Unit contains coppice dunes carrying seepweed.
344/4352	11	10	Unit is all gravelly alluvium lacking sand sheets, sand dunes, wolfberry, and Nevada dalea.
334/4362	10	11	Unit includes sand sheets, sand dunes, wolfberry, and Nevada dalea.

All three mismatches between expected and observed habitat type reflect the failure of present soil and range data to represent variability present in narrow transitions from playa to alluvial fan or lake terrace. We saw no tendency for particular soil and range type configurations to incorrectly identify habitat type; consequently, the range type and soil mapping unit concordances with habitat type (Appendices B and C) hold. We do caution that the greatest potential for habitat type misclassification lies in transitional zones between playa margins and bordering areas.

Habitat Types 2, 2a

We sampled eight units bearing abiotic habitat types, all playas: Sample Units 378/4416, 382/4420, 384/4410, 385/4412, 385/4418, 386/4411, 388/4409, but 377/4413 (Habitat 2a) is irregularly inundated. All are in Naval Training Range Bravo 20 in the northern Carson Sink proximate Lone Rock, a hill which offers the only topographic relief in this region.

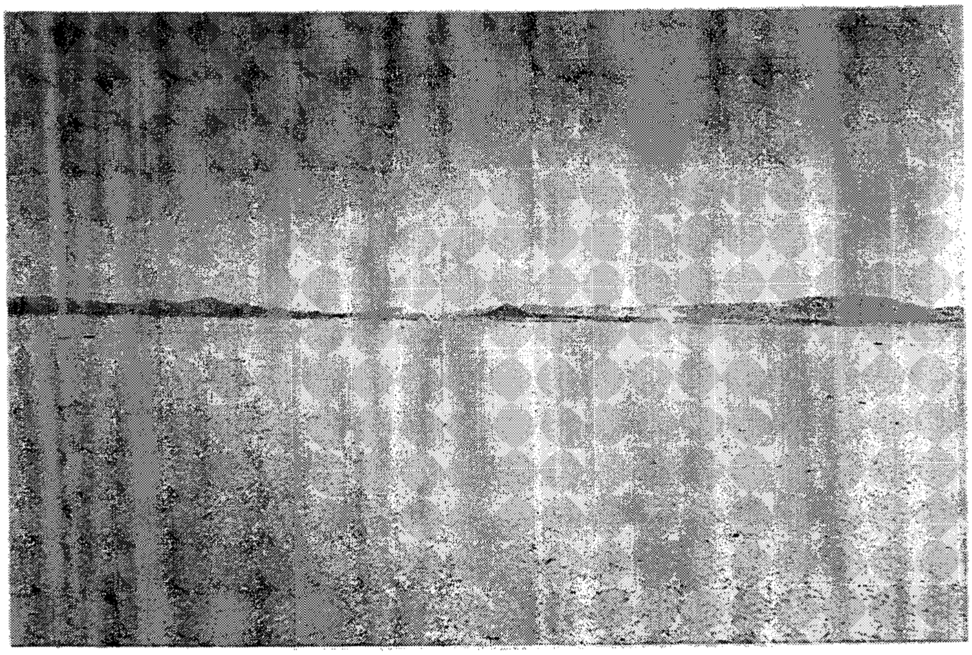
The sample units are between 1180 and 1184 meters (3871 and 3885 ft amsl) in elevation, with elevations rising gently towards Lone Rock. All eight sample units maintain a barren, playa surface; runoff from Lone Rock has channeled slightly the northern portions of Sample Unit 385/4412 (Figure 82). The elevation of Sample Unit 377/4413 (Figure 83) lies slightly below the 1180 meter (3871 ft amsl) contour, which by our definition renders it subject to irregular flooding with potential to develop a marsh wetland. However, when this particular quadrat is inundated. it should be subject to rapid evapotranspiration, and to effects of turbulent wind and wave movement because of its location on the leeward edge of the Sink. It is unlikely that calm floodwaters ever would have covered this quadrat long enough to develop a marsh. Occasional fish skeletons embedded in the crusty playa silts were the only direct evidence that the area had been inundated in the past. Modern disturbances to these sterile playas consisted of fence lines, bomb craters, and scattered shrapnel.

Prehistoric archaeological remains were observed in only one playa unit (Sample Unit 385/4412): two isolated projectile points, both so weathered as to be devoid of flake scars. One is a Desert side-notched point, the other a fragmentary Elko Eared point. Both points were adjacent bomb craters in the quadrat nearest (1.5 km south) Lone Rock, the only non-playa environment in the vicinity. We suspect that cultural material here represent redeposition by slope outwash and any additional material should be limited to areas immediately around Lone Rock.

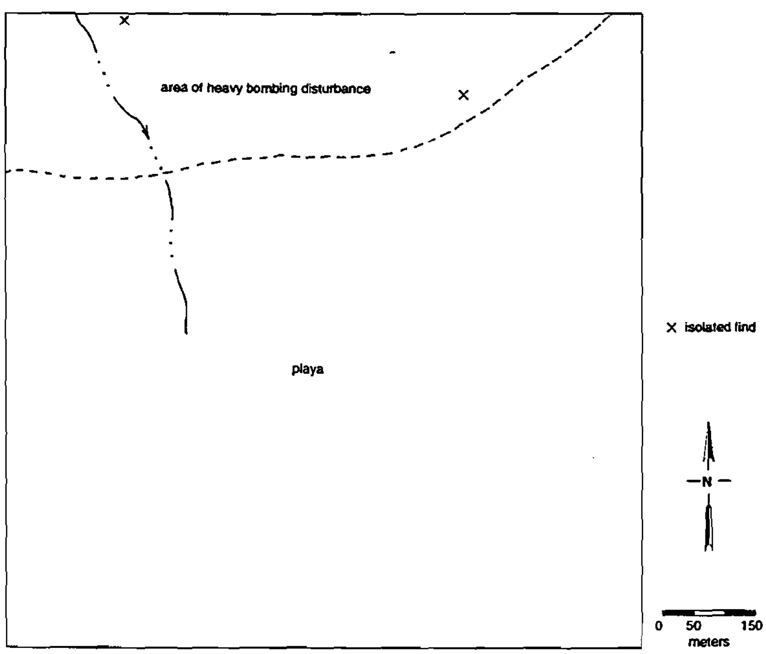
Habitat Types 3, 3a

Habitat Types 3 and 3a are represented by five sample units, three in Naval Training Range Bravo 16, one in Bravo 17, and one at NAS Fallon Main Base.

Alkali flats abutting a Pleistocene beach terrace comprise Sample Unit 336/4353. The terrace lies at the base of the east flank of the Dead Camel Mountains, overlooking Lahontan Valley to the east. Relief in the sample unit is low, ranging from 1202 meters (3944 ft amsl) to 1213 meters (3980 ft amsl). Sheetwash and numerous erosional channels drain the quadrat to the northeast, and a playa margin occurs in the extreme northwest corner of the quadrat. A gravel pavement caps the beach terrace located on the extreme west, while silts and clays comprise the flats over most of the quadrat. Black greasewood and seepweed occur only on the alkali flats, while shadscale, hopsage, and greasewood grow on the terrace. The beach terrace exemplifies Habitat Type 10 (Gravelly loam 4-8 inch precipitation zone), but the more extensive alkali flats in the sample unit typify Habitat Type 3 (Sodic Flat 4-8 inch precipitation zone). We recorded in this quadrat one small lithic scatter and nine isolated chert flakes of which the latter are all core reduction or early stage biface thinning flakes. The site

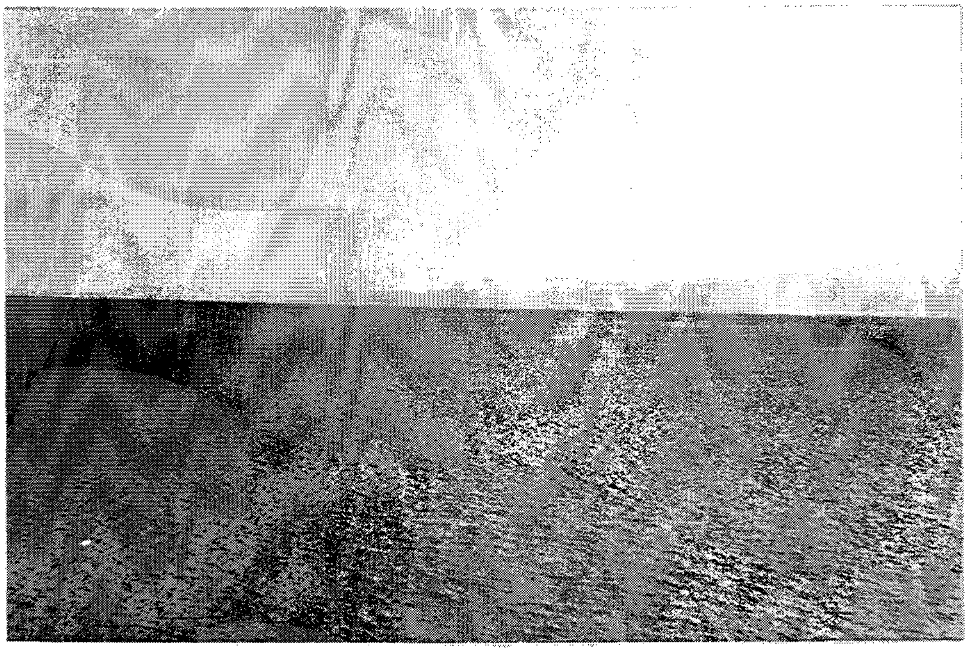


a. Surface view northwest.

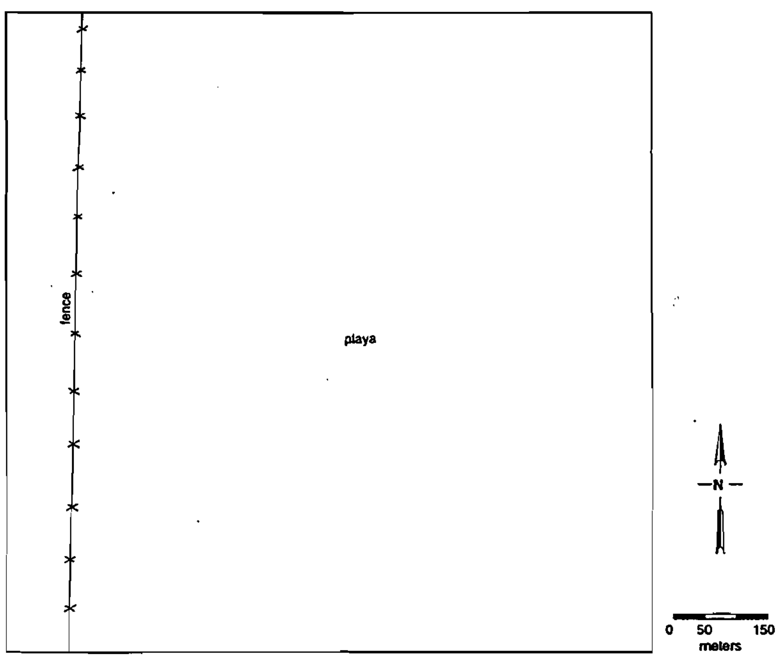


b. Plan view.

Figure 82. Sample Unit 385/4412.



a. Surface view north.



b. Plan view.

Figure 83. Sample Unit 377/4413.

(4725), which lies on a gravelly bar at the toe of the beach terrace, contains a few chert core reduction and bifacial thinning flakes, one local chert cobble core, and one flake tool.

Sample Unit 338/4352 (Figure 84) is on the western margin of Lahontan Valley, west of Carson Lake and east of the Dead Camel Mountains. Much of the sample unit is barren playa surface at about 1198 meters (3931 ft amsl) elevation, with relict sand and silt bars on the southern and western margins and occasional coppice dunes to the northeast rising to less than 1202 meters (3944 ft amsl). The playa surface generally is barren of vegetation, but isolated patches of black greasewood, seepweed, shadscale, Russian thistle, and halogeton appear on coppice mounds and bars.

One site and three isolates were observed in the sample unit. Isolated finds include a scoria mano, a chert biface, and a biface thinning flake. The site (4731) is on a low coppice dune, no more than 50 centimeters above the surrounding playa, at the eastern edge of the sample unit. It consists of about 40 large flakes representing primary core reduction of local chert material, three bifaces, one core tool, and seven flake tools, all of chert. Also recorded were two basalt bifaces and one obsidian, and one flake each of basalt and obsidian. Unlike the chert material, all basalt and obsidian lithics are highly weathered.

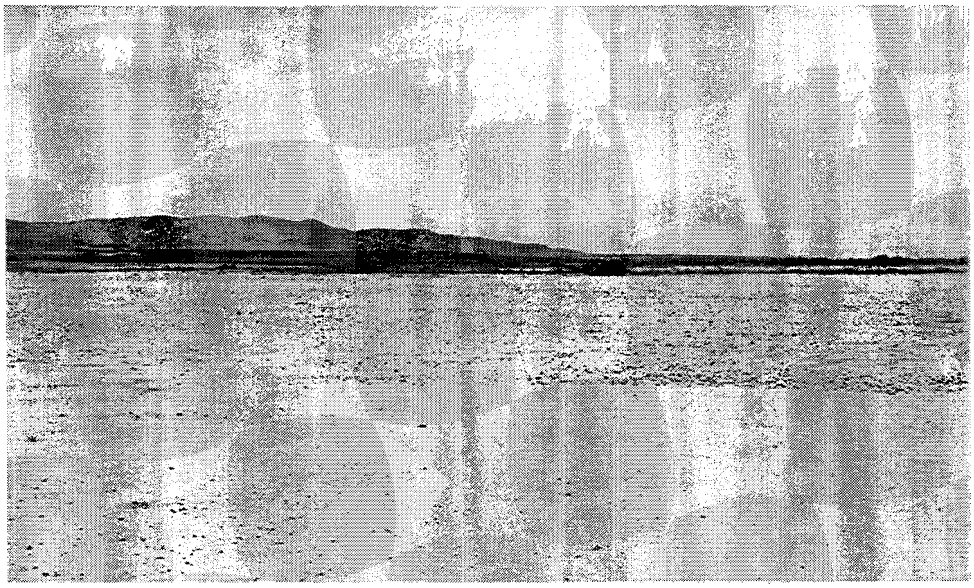
Sample Unit 340/4353, in the western portion of the Carson Lake basin, occurs in the proposed eastern expansion of Bravo 16 (Figure 85). The sample unit is predominately barren playa flats interspersed with coppice mounds. Elevations are nearly level, ranging only from 1198 to 1197 meters (3931 to 3927 ft amsl). Vegetation occurs only on coppice mounds and includes Bailey's greasewood, spiny hopsage, horsebrush, seepweed, inland saltgrass, and foxtail barley. Intermittent drainages flow generally from northwest to the southeast toward Carson Lake, but they are neither entrenched nor well-developed channels. An irrigation canal traverses the sample unit on the east.

We observed five sites in the unit, including portions of one known (site 4623), and 11 isolated finds. Lithic debitage occurs throughout the quadrat but we did not record them individually, rather we only recorded formed tools as isolates. The 11 isolates comprise individual occurrences of three basalt manos, three milling stones or milling stone fragments, two chert bifaces, a basalt core, and a unifacially retouched, utilized chert flake tool. The eleventh isolate, 4621, consists only of a mano, basin milling stone fragment and a mortar, all of vesicular basalt.

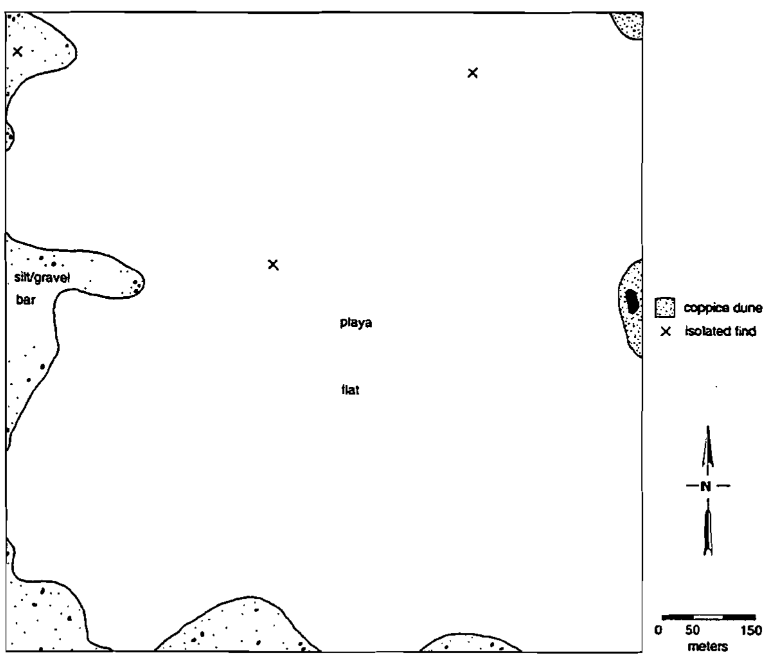
All five sites contain ground stone. Site 4618 contains three vesicular basalt pieces of ground stone, three chert biface fragments, and a chert core. At 4620 we recorded seven local chert flakes, a conglomerate milling stone, and a vesicular basalt mano. One chert flake accompanies two rhyolite ground stone fragments at 4622. Site 4619 contains 38 flakes of local chert, one chert flake tool, and an obsidian Eastgate projectile point, in association with 12 ground stone fragments of vesicular basalt.

Site 4623 presents the largest and most diverse assemblage within the quadrat. Along with 500 flakes concentrated on dune surfaces, we recorded numerous bifaces, chert cores, and basalt ground stone fragments. Unlike the other sites in this quadrat, about ten percent of the debitage and several of the bifaces are obsidian. Other formed tools include two obsidian drills, one Elko Series points, three Rosegate Series points, and several projectile point fragments. Two additional points may exemplify local Carson Variants (Kelly 1983b; Gedney 1994).

Dispersed among playa pans and eroded coppice dunes at 4623 are five concentrations of fire-altered rock and broken ground stone fragments, ranging from one to ten meters in diameter. These probably represent deflated hearths or other cultural features. Unique to the site are 12 biconically drilled *Olivella* shell beads, all pendant or oval variants. The site is centered on three semicircular, partially eroded sodic dunes, that probably retain intact buried deposits.



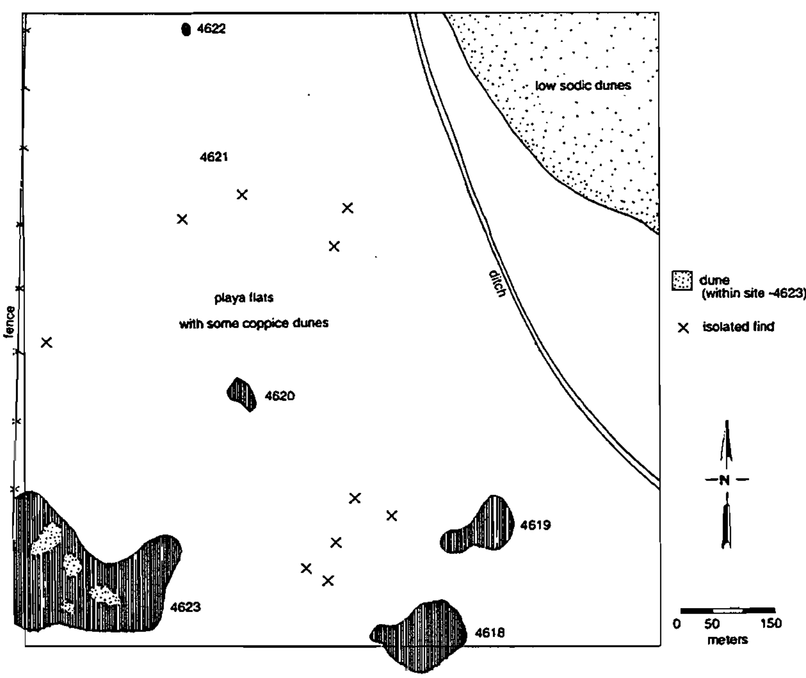
a. Surface view northwest.



b. Plan view.

Figure 84. Sample Unit 338/4352.

a. Surface view north.



b. Plan view.

Figure 85. Sample Unit 340/4353.

Sample Unit 356/4363 is on the Naval Air Station Fallon Main Base, approximately 1.5 kilometers northwest of Grimes Point. An irrigation canal traverses the southern half of the unit and drains it. The USGS Grimes Point, Nev., 1:24,000 (1985) topographic map indicates that two abandoned stream channels currently contain small oxbow lakes; we suspect that overflow from the canal produces these modern lakes. Relief in the sample unit is low, ranging from 1194 to 1195 meters (3918 to 3921 ft amsl). We identify the unit as irregularly inundated.

We did not survey this sample unit, relying instead on data from previous archaeological survey (Busby et al. 1989) to assess the habitat model. About 62% of the unit was archaeologically inventoried earlier, yielding one prehistoric site and an isolate. The isolate is a modified flake. Site 26Ch1408 is a large (ca. 21,500 square meters) scatter of lithic debitage and ground stone. The assemblage includes a pestle fragment, a milling stone fragment, an untypeable projectile point, and several bifaces.

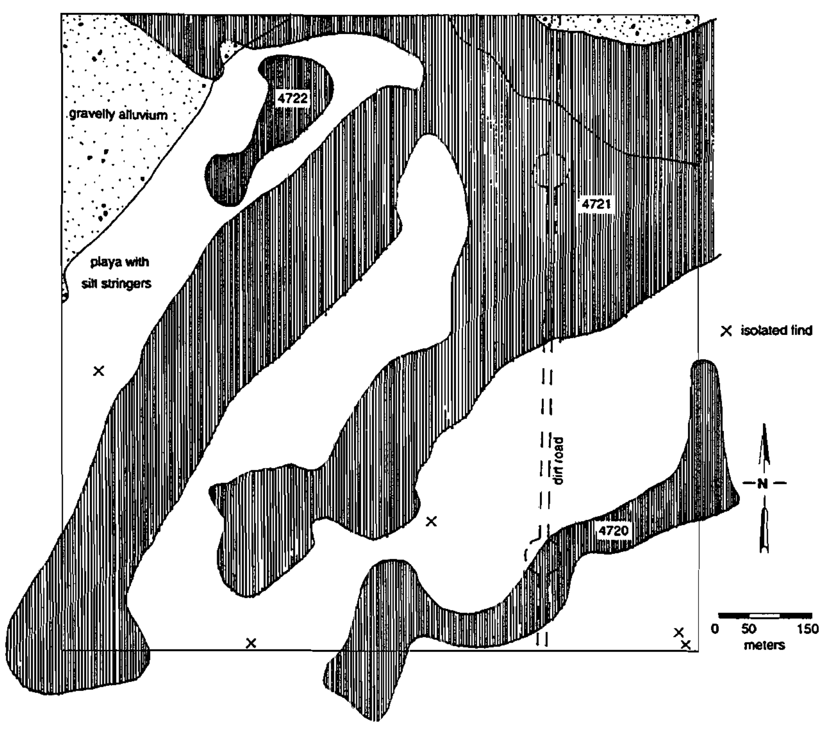
Sample Unit 388/4346 (Figure 86) occurs on the northwest margin of Labou Flat in Navy Training Range Bravo 17. Elevations vary only slightly, from 1264.4 to 1264.8 meters (4148 to 4150 ft amsl) elevation over most of the sample unit. Only the extreme northwest corner rises to 1267.5 meters (4159 ft amsl) elevation. Much of the sample unit is barren playa, which we originally classified as Habitat Type 2a—irregularly inundated playa. However, field crews found that stringers and patches of sandy silt mounded 20 to 30 cm above the playa surface lace the sample unit. Vegetation on dunes consists of Bailey's greasewood, seepweed, and Russian thistle. The sample unit is inundated intermittently and periodic flooding formed islands of the low coppice dunes. These characteristics typify Habitat Type 3a, therefore we reclassified the sample unit accordingly. The northern margin of the sample unit contains gravelly alluvium maintaining stands of Bailey's greasewood and shadscale typical of Habitat Type 10, but only in a minor portion of the total area of the sample unit. Several large, intermittent washes flow into the playa from the north.

Extensive areas of cultural debris occur on low silt stringer dunes and playa embayments at least irregularly inundated when Labou Flat becomes a shallow lake. Three sites and seven isolated artifacts occur in these areas. The isolates include five chert bifaces, a basalt hammerstone, and a gray vesicular basalt bifacial mano fragment; isolated flakes are ubiquitous throughout the quadrat. Site 4720 occupies a long, linear dune close to the playa basin of Labou Flat. It contains at least 28 ground stone fragments, a slate tule knife, one Elko and two Rosegate Series projectile points, and numerous biface fragments and utilized flake tools. In addition, several dispersed concentrations of fire-altered rock probably mark the locations of deflated hearth features. Site 4721 occupies low silt dunes 12-20 cm higher than site 4720. It contains nearly 100 ground stone fragments, many fire-altered; numerous bifaces and flake tools, most of local chert material; at least 11 projectile point fragments including one Humboldt, two Elko, and one Rosegate point fragments; two ground basalt tule knives; one drill; several hammerstones; and dozens of fire-altered rock concentrations probably representing hearth features. Two of the concentrations contain charcoal stains. The site occupies more than half the sample unit and extends beyond the quadrat an unknown distance to the north and northeast into the sandy dunes abutting Labou Flat. Site 4722 is located on the highest elevation silt dune on the Labou Flat playa (about 9-10 cm higher than 4721). This site is smaller than the other two, but contains a similar assemblage with numerous flakes of local chert, three biface fragments, at least nine fragments of ground stone, and a complete milling stone. No hearths are apparent.

Habitat Type 6a

Habitat Type 6a is represented by Sample Unit 353/4367, on the Naval Air Station Fallon Main Base. It lies on the Carson River floodplain east of the South Branch of the Carson River, and southwest of Stillwater Slough. The quadrat is relatively level at about 1198 meters (3931 ft amsl). The quadrat is assessed on the basis of extant survey data (Busby et al. 1989). The prior survey recorded one prehistoric site (26CH1436) bearing two flakes and two ground stone fragments.

a. Surface view northwest.



b. Plan view.

Figure 86. Sample Unit 388/4346.

Habitat Types 10, 10b

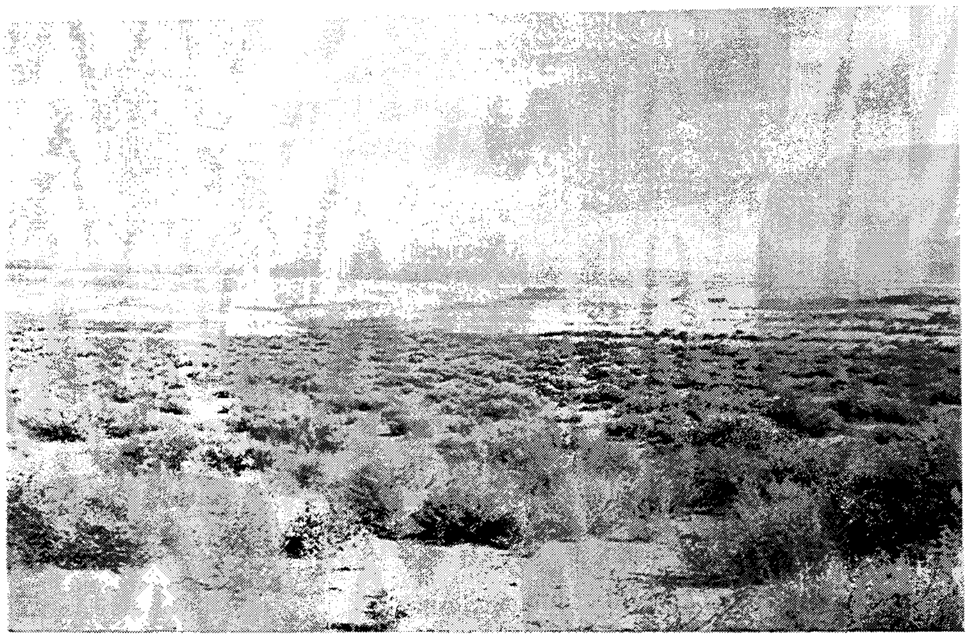
Bravo 16 hosts Habitat Type 10 sample unit 334/4352 (Figure 87). It occupies a Pleistocene beach terrace and lower piedmont slopes and ridges at the foot of the Dead Camel Mountains, overlooking Lahontan Valley to the east. Three intermittent drainages flow from the western and northern boundaries of the unit to their confluence in the southeastern corner. Desert pavements cap much of the unit. Shadscale is dominant on ridges while hopsage, Russian thistle, and saltbush are common. Rabbitbrush occurs along drainages and seepweed occurs on flats in the central and southeastern portion of the unit. Also observed were mustard, prickly pear, Indian ricegrass, and four-wing saltbush. We originally coded and sampled this quadrat as an example of Habitat Type 11. However, the sand sheets and dunes, and associated flora, typical of Habitat Type 11 are absent, compelling unit reclassification. Two isolated finds were observed here, both fine-grained local chert biface thinning flakes.

Sample Unit 366/4336 lies at the head of Diamond Field Jack Wash in the southern Cocoon Mountains, in the proposed expansion of Bravo 19. Diamond Field Jack Wash flows northwest through the southwestern corner of the unit. A westerly trending ridge occupies the northwestern quarter of the unit. Elevations range from 1449 meters (4754 ft amsl) on the floor of the wash to 1560 meters (5718 ft amsl) at the crest of the ridge. Sediments are a gravelly loam in all areas but the wash, and desert pavement caps lower gradual slopes and small knolls on the valley bottom. Mormon tea, Nevada dalea, rabbitbrush, Indian ricegrass, cheatgrass, and wildrye are common along the wash and in drainages. Bailey's greasewood, saltbush, and wolfberry are dominant on slopes and ridges. Gray horsebrush grows on ridgelines while hopsage and budsage grow on ridge slopes.

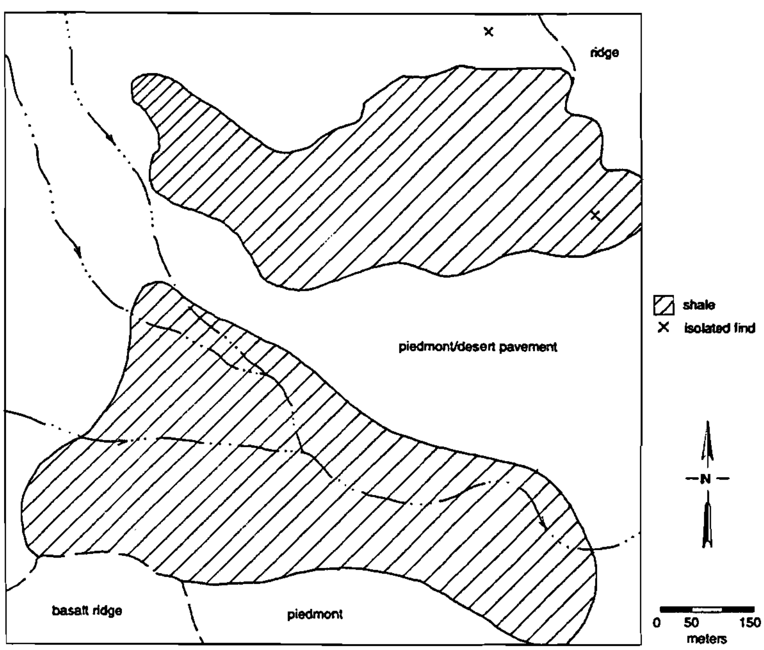
We recorded seven sites and 11 isolated finds here (Figure 88). Ten of the isolates include singular occurrences of eight flakes of early stage biface reduction, all but one chalcedony flake of local fine-grained cherts; one chert core, and one chert decortication flake. The remaining isolate, 4637, exhibits one piece of shatter and four decortication flakes of local material. Sites contain lithic material representing, primarily, local assay of the chert cobbles abundant on the deflated desert pavement surfaces that characterize the quadrat.

Five sites (4632, 4633, 4634, 4638, and 4639) each contain fewer than 50 debitage flakes and an occasional core (three at 4632 and one at 4638) of locally abundant fine-grained chert, with no formed or utilized tools observed. Core reduction flakes, up to 20 percent with cortex, are dominant, yet biface thinning flakes are also common. Site 4635 is slightly larger than the previous five, each with a diffuse scatter of more than 100 flakes, many being bifacial thinning flakes of fine-grained chert. We observed some medium-grain gray chert, one obsidian flake, and three chert bifaces here. The assemblage at 4636 is characterized by five lithic concentrations in a diffuse scatter of more than 1000 flakes. One of the concentrations contained more than 50 black, semi-translucent obsidian flakes. As at the other sites, the assemblage contains some biface thinning stages but is primarily core reduction. Obsidian flakes are smaller (most less than 40-by-30 mm in size), almost exclusively middle to late biface thinning stage with a single pressure flake noted. We also discovered two Great Basin Stemmed projectile points, two point fragments, three bifaces, and a cobble core of obsidian at this site. Chert formed tools are common here, including a Humboldt concave-base fragment and 14 bifaces.

Sample Unit 388/4335 comprises the juxtaposition of alluvial fans and valley floor in Fairview Valley, south of Labou Flat, in the proposed southern expansion of Bravo 17. Numerous small intermittent washes flowing northeast dissect the sample unit. The washes are broadest and most channelized along the eastern boundary of the unit. Elevation relief ranges between 1341 and 1365 meters (4400 and 4479 ft amsl). Sediment is a poorly sorted gravelly alluvium in all areas except wash

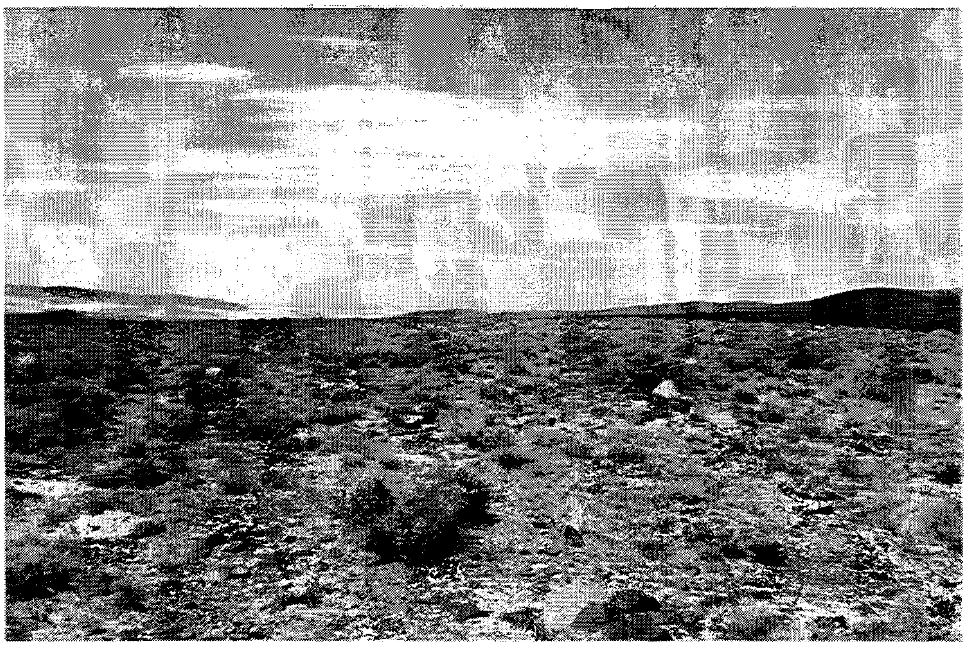


a. Surface view northeast.

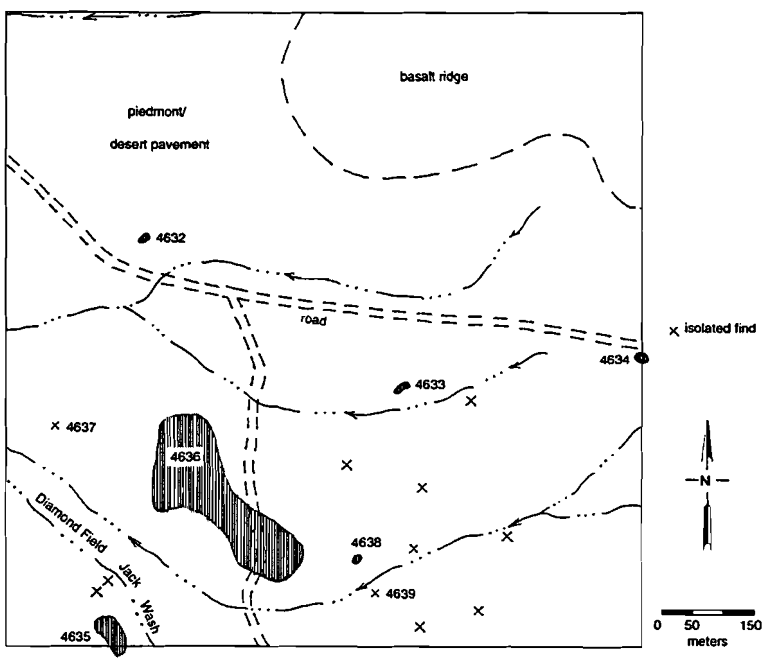


b. Plan view.

Figure 87. Sample Unit 334/4352.



a. Surface view northwest.



b. Plan view.

Figure 88. Sample Unit 366/4336.

bottoms. Gravel pavements occasionally armor surfaces on lower alluvial fans. Bailey's greasewood, spiny hopsage, shadscale, saltbrush, shortspine horsebrush, and Indian ricegrass are common in the unit; rabbitbrush and Indian ricegrass are most common in drainages. This sample unit contains one site and an isolated mid-stage biface thinning flake of local chert. Site 4640 is a small, sparse lithic scatter of mostly yellow local chert, with early and middle stage biface reduction represented.

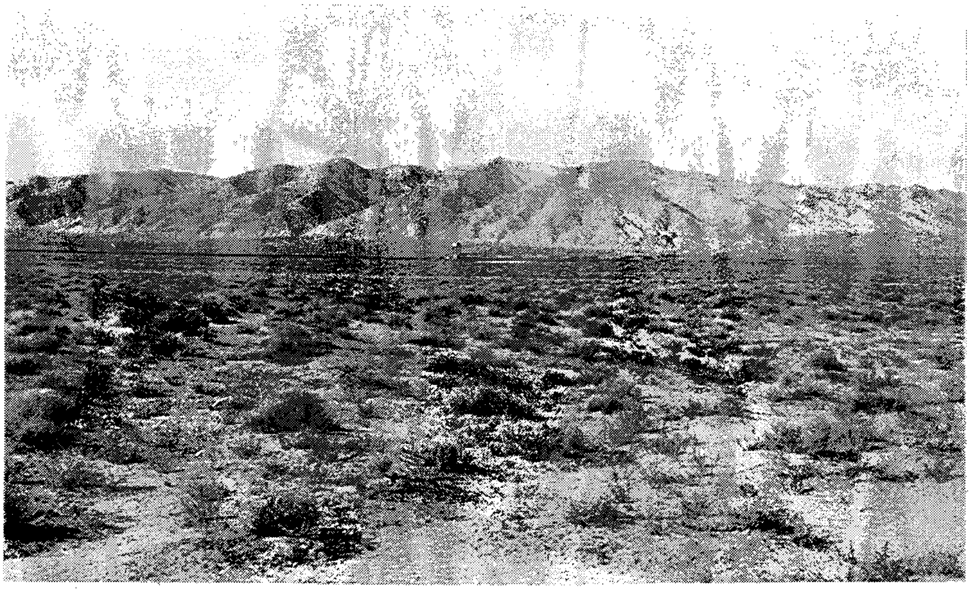
Quadrat 390/4334 lies near the floor of Fairview Valley, at the toes of alluvial fans emanating from Slate Mountain. Elevation ranges from 1372 meters (4502 ft amsl) at the northwest corner to 1423 meters (4669 ft amsl) in the southeast. Numerous small ephemeral washes flowing northwestward dissect the quadrat. A well-channelized wash occurs in the northeastern part of the quad. Sediments are loose alluvial sands and silts. Bailey's greasewood, wolfberry, hopsage, budsage, Russian thistle, prince's plume, globe mallow, prickly pear, cheatgrass, and Indian ricegrass grow in the unit. Rabbitbrush and Indian ricegrass are particularly abundant in washes.

The sample unit contains one site and two isolated finds of which the latter are local fine-grained chert mid-stage biface thinning flakes. The site is a very diffuse scatter of about 20 chert flakes (most mid-bifacial reduction stage), one randomly flaked expedient biface, and one Elko Corner-notched projectile point fragment.

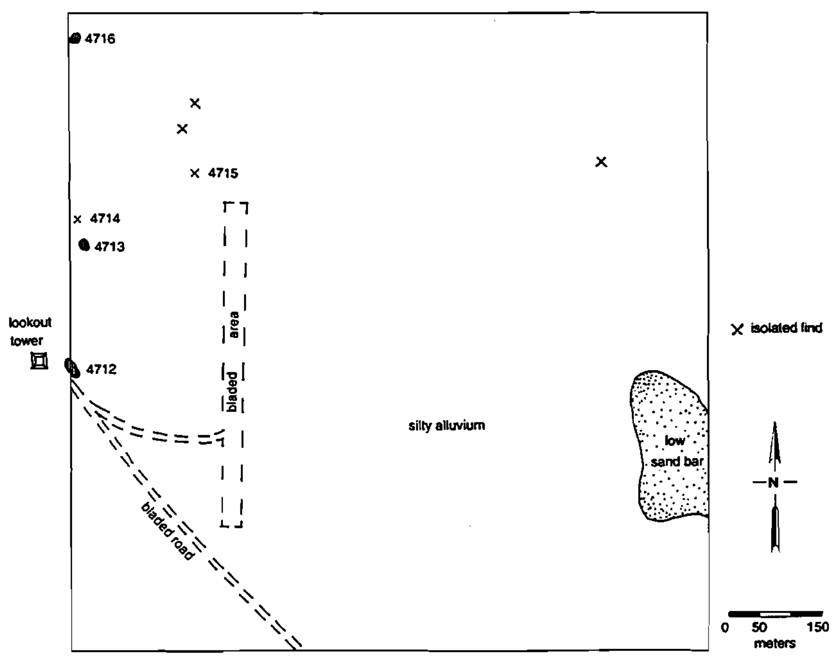
Sample Unit 390/4342 (Figure 89) is on the floor of Fairview Valley immediately south of Labou Flat, within Bravo 17. Elevations rise gently from 1274 meters (4180 ft amsl) in the northwest corner of the sample unit, to 1283 meters (4210 ft amsl) in the southeast corner. Sediments are predominantly silty alluvium, but a low, eroded sand bar occurs in the southeast quarter of the sample unit. Modern disturbances have impacted this sample unit: bladed target runways, vehicle trails, bomb craters, and shrapnel scatters. Desert thistle and halogeton with sparse cheatgrass, reflecting the extent of disturbance, dominate the vegetation. Bailey's greasewood and Indian ricegrass are also common. Three small lithic scatters and five isolated finds were recorded. Three of the isolates are biface thinning flakes, with the remainder represented by four to nine flakes each, all of local fine-grained chert. The sites represent chert cobble reduction and contain two or three formed tools each. We recorded an Elko Corner-notched projectile point fragment at 4712, the largest of these sites.

Sample Unit 392/4331 (Figure 90) is located at the extreme southern expansion of Bravo 17. Encompassing the transition from upper alluvial fan to lower mountain slope, on the west flank of Slate Mountain, it overlooks Fairview Valley. Elevations in the sample unit range from 1512 meters (4960 ft amsl) in the northwest to 1612 meters (5990 ft amsl) in the southeast. Granitic bedrock and boulders dominate the higher elevation eastern third of the sample unit, while gravelly loams are on lower elevation slopes. Several westward flowing intermittent drainages traverse the unit, but the largest wash neatly divides the sample unit into northern and southern halves. At its eastern extreme this drainage is a steeply entrenched canyon bordered by granitic bedrock walls up to 20 meters high.

A spring and a seep occur south of the canyon, hence the 10b designator for the sample unit, but both were dry when we visited them. Nevertheless, small isolated stands of Great Basin wildrye persist at these locations. Inasmuch as the unit lies above 1480 meters (4856 ft amsl) elevation, these small patches of wildrye mark the occurrence of upland spring habitat (Habitat Type 51- Loamy Bottom 8–12" p.z./ Wet Meadow 8–12" p.z.) in the sample unit. The most expansive vegetation habitat on the unit is Habitat Type 10 (Gravelly Loam 4-8" p.z.), prevalent on the lower western alluvial fan slopes. These areas maintain stands of Bailey's greasewood, spiny hopsage, Indian ricegrass, and bottlebrush squirreltail. However, the sample unit crosses the transition from greasewood-saltbush to sagebrush community where the upper eastern slopes of the sample unit bear Wyoming big sagebrush. This minor inclusion represents Habitat 31 (Droughty Loam 8"-10" p.z.).

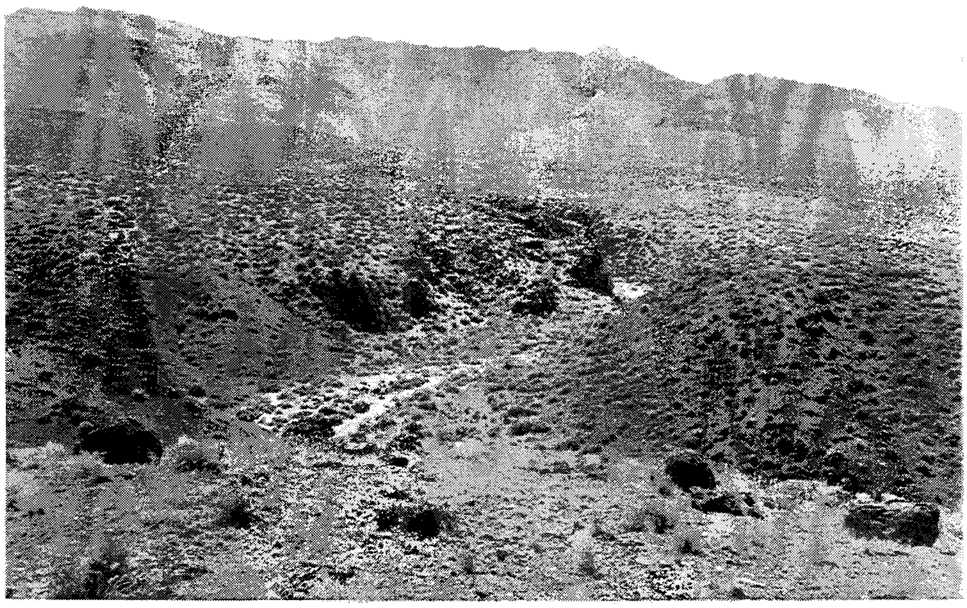


a. Surface view west.

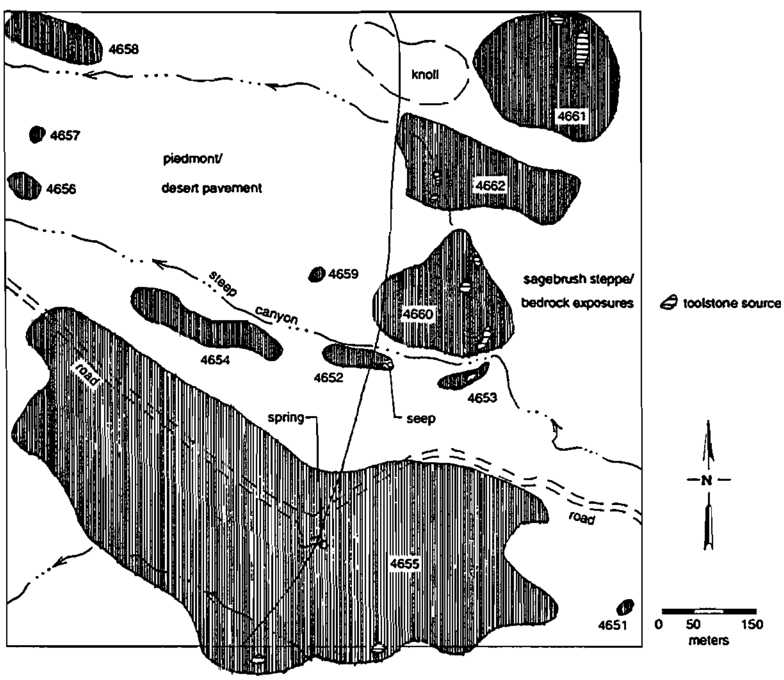


b. Plan view.

Figure 89. Sample Unit 390/4342.



a. Surface view southeast.



b. Plan view.

Figure 90. Sample Unit 392/4331.

Outcrops of poor quality toolstones occur widely throughout the unit. The most common raw material is a red or mustard cryptocrystalline silicate, but isolated exposures of a gray feldspar and a crystalline quartz are also present. Small bedrock exposures are scattered throughout the eastern part of the sample unit. Erosion has littered slopes below the exposures with cobbles. In the northeastern portion of the unit, a gently sloping ridge has cut a broad (50 m by 80 m) exposure through a cryptocrystalline silicate outcrop forming a surface pavement of cobbles.

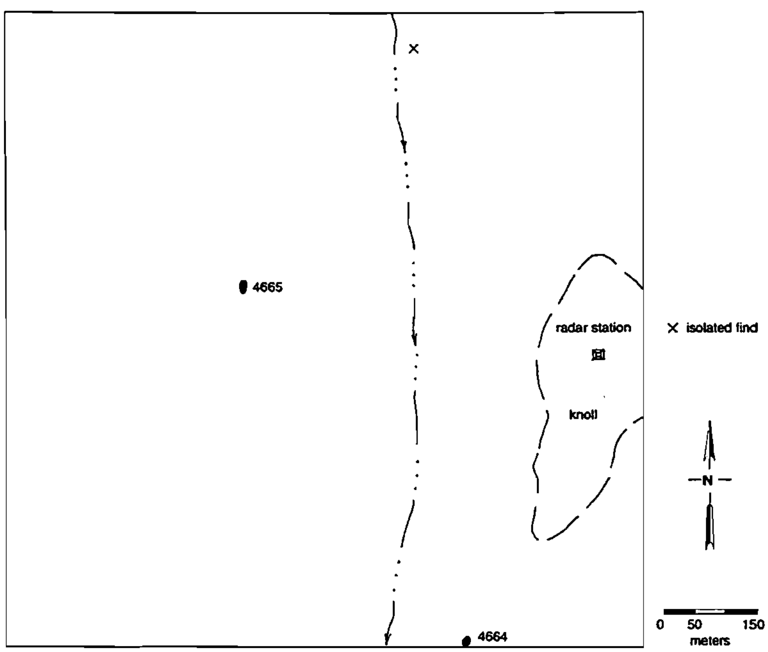
We recorded 12 sites within this sample unit. An extensive complex of lithic scatters surrounding the spring comprises the largest (4655). Many of these concentrations are loci of early stage reduction of the local toolstone, containing cores, early stage bifaces, and decortication flakes. Two toolstone exposures with associated scatters of shatter, early stage reduction flakes, and core fragments occur in the southern portion of the site. However, evidence of middle to late stage bifacial reduction of local and imported (including obsidian) toolstones is also present and particularly common near the spring. These areas also contained a drill, three unidentifiable projectile point fragments, three typeable points (Cottonwood, Rosegate, and Elko Corner-notched point) and a boulder milling slick. Unlike most of the other sites in the sample unit, this one contains rare examples of non-local toolstones such as obsidian, chalcedony, and crystalline quartz. Despite considerable modern disturbance to the spring itself (evinced by an extensive can scatter, four recent campfire rings, a well pipe, and an artificial dam), site 4655 manifests several areas of potential buried deposits.

A second, much smaller lithic scatter (4652) is associated with the small seep on the south side of the canyon. Like site 4655, 4652 contains a small toolstone outcrop. Most lithic debris on the site reflects early stage assay and reduction of the local toolstone. A third site (4651) is a small scatter of bifacial thinning and finishing flakes. The material on site is locally available red and mustard cryptocrystalline silicate but no toolstone source occurs here.

The remaining nine sites bear assemblages indicative of early stage reduction and assay of local toolstone. Of these, five lithic scatters (4654, 4656, 4657, 4658, 4659) are unassociated with toolstone outcrops, while four (4653, 4660, 4661, 4662) have toolstone outcrops. Sites 4653, 4657 and 4659 possess lithic assemblages of fewer than 30 flakes, whereas sites 4660, 4661, 4662 are extensive lithic scatters composed of more than 500 flakes. Two exposed pavements of assayed toolstone cobbles on site 4661 reveal densities of more than 500 flakes per square meter over an area of about 1600 square meters. Cores are numerous at 4654, 4661 and 4662, with a single core reported at 4660 and 4659. Most lithic debitage is shatter, core reduction and early to middle stage bifacial thinning of local chert materials; only at 4660 and 4661 is reduction of other materials (respectively basalt and quartzite cobbles) attempted. Discrete concentrations of lithic reduction appear at 4654 and 4656. Formed tools are rare at sites other than 4655; one dart-sized point fragment from 4658, and a total of 12 bifaces from 4653, 4654, 4659 and 4660 represent all other formed tools recorded.

Sample Unit 393/4356 (Figure 91) is near the watershed divide between Fairview Valley to the south and Dixie Valley to the northeast, in the proposed expansion of Bravo 17. It overlies the lower alluvial fan skirts emanating from the Stillwater Range, at elevations of 1315 to 1332 meters(4315 to 4370 ft amsl). A broad intermittent wash flows southward into Fairview Valley through the center of the sample unit. A large knoll occurs on the eastern margin of the sample unit. Soils are a gravelly loam intermixed with pockets of aeolian sand and desert pavement. Vegetation includes Bailey's greasewood, four-wing saltbush, spiny hopsage, Russian thistle, Indian ricegrass, and bluegrass. The unit contains one isolate and two sites. The isolate is a large projectile point midsection with collateral flaking on local brown chert. Site 4665 revealed a Great Basin Stemmed point base of rhyolite, eleven bifaces including one of basalt material, three utilized flakes, and a core. Although most formed tools and flakes (>500 observed) are of locally available cherts, we also noted basalt, chalcedony, and obsidian debitage. Site 4664 also contains a range of lithic material including local chert, chalcedony,

a. Surface view southwest.



b. Plan view.

Figure 91. Sample Unit 393/4356.

basalt, rhyolite, and obsidian as well as a complete, distally retouched basalt Great Basin Stemmed projectile point, a rhyolite scraper, and a chert core. Both sites occur on deflated desert pavement surfaces, but 4665 may contain subsurface deposits buried in aeolian sands.

Sample Unit 394/4346 is in Bravo 17, occupying the alluvial fan on the west flank of Dromedary Hump, overlooking Labou Flat to the west. Elevations range from 1289 meters (4229 ft amsl) in the northwestern corner of the quad to 1353 meters (4434 ft amsl) in the southeastern corner. Sediments are a gravelly loam, well armored by a gravel pavement. Numerous ephemeral channels flowing from west to east truncate the sample unit. Channels in the southern portion of the unit are up to half a meter deep and are actively eroding. Shadscale and hopsage are common throughout the unit, whereas rabbitbrush is common in drainages. Other plants in the sample unit include prickly pear cactus, halogeton, prince's plume, Indian ricegrass, and cheatgrass. One isolated biface thinning flake was observed in this quadrat.

Sample Unit 396/4365 occurs on the east flank of the Stillwater Range overlooking Dixie Valley to the east and Elevenmile Wash to the south. The unit covers the upper slopes of a dissected alluvial fan. Sediments are gravelly loams capped with desert pavements and truncated by shallow sandy washes flowing northeast into Dixie Valley. Elevations range from 1320 meters (4331 ft amsl) on the eastern margin to 1380 meters (4528 ft amsl) on the western margin. Bailey's greasewood is dominant on slopes and flats. Indian ricegrass, wheatgrass, rabbitbrush, and Mormon tea occur in washes. Also noted were gray and spiny horsebrush, wolfberry, Nevada dalea, bud sage, Russian thistle, prince's plume, halogeton, prickly pear cactus, and cheatgrass. No archaeological remains were noted in this sample unit.

Sample Unit 397/4346, three kilometers east of Sample Unit 394/4346, also occupies the fan head and lower mountain slopes of Dromedary Hump, overlooking Labou Flat to the west. Elevations range from 1414 meters (4639 ft amsl) in the northwestern corner of the quad to 1524 meters (5000 ft amsl) in the southeast. Landforms consist of stable, northwest trending ridgelines separated by steeply dissected intermittent draws. Sediment is a gravelly loam capped by desert pavement. Shadscale, hopsage, and Indian ricegrass are dominant throughout the quadrat, while Mormon tea and rabbitbrush are more common in drainages. Halogeton, winterfat, and prince's plume were also observed. Mining activities have heavily disturbed the quadrat: features such as rock or post cairns are numerous and the historic townsite of Fairview lies immediately west of the sample unit. We discovered no prehistoric materials here.

Sample Unit 399/4364 is in the proposed northern expansion of Bravo 17. The unit encompasses lower alluvial fan slopes west of Dixie Valley Wash and north of Elevenmile Wash. Numerous small washes flowing eastward through the unit dissect the slopes in the sample unit. Two larger intermittent drainages converge and flow eastward in the eastern side of the unit. Elevations range from 1237 to 1277 meters (4059 to 4190 ft amsl). Sandy sediments lie in the washes, but fan surfaces are loam armored by desert pavement. Bailey's greasewood, wolfberry, and hopsage dominate fan surfaces. Mormon tea and rabbitbrush are abundant along washes. Wheatgrass, needlegrass, prince's plume, globemallow, annual saltbush, and halogeton are most abundant on steeper slopes. We located no prehistoric archaeological remains in this sample unit.

Habitat Type 11

Sample Unit 333/4369 is located in the proposed expansion of Navy Training Range Bravo 16. Modern irrigation canals, dirt roads, powerlines, and cattle grazing have heavily affected this area of the Lahontan Valley, approximately two kilometers south of the Carson River. Sand sheets dissected by ephemeral drainages flowing northwest cover the surface of the sample unit, with semi-stabilized sand dunes in the northeast corner. Elevations range only from 1218 to 1220 meters (3996 to 4003 ft amsl).

Nevada dalea, black greasewood, hopsage, four-wing saltbush, seepweed, gray and shortspine horsebrush, shadscale, wheatgrass, and Indian ricegrass grow on sand flats and dunes. Well-developed riparian communities of cottonwood, willow, Russian thistle, Russian olive, and tamarisk grow along channeled drainages and irrigation canals, along all of which rabbitbrush is common. Four isolates were observed in this sample unit, including one obsidian and three local chert biface thinning flakes.

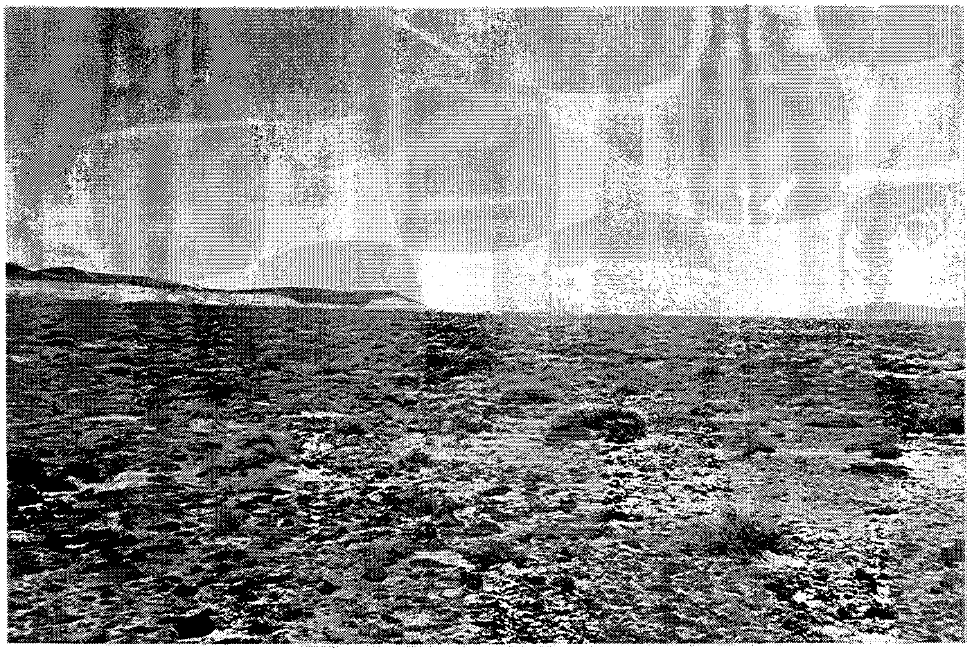
Sample Unit 334/4362 (Figure 92) is in the proposed northern expansion of Bravo 16 in Lahontan Valley at the edge of a Pleistocene lake terrace at the foot of the Dead Camel Mountains. Elevations range from 1215 meters (3986 ft amsl) in the northeast to 1250 meters (4100 ft amsl) in the southwest. Higher slopes in the southwest quarter of the unit are barren, eroded, lacustrine sediments (Habitat Type 54–Badlands). The extreme northeast corner of the unit clips an alkali flat (Habitat Type 3). However, the intermixed highly polished desert pavement and stabilized sand dunes and sheets typical of Habitat Type 11 cover the remainder of the unit. Slopes and pavement surfaces host wolfberry, Bailey's greasewood, saltbush, Russian thistle, and Indian ricegrass. Horsebrush, Nevada dalea, and saltbush occur on the margins of badlands, while dunes contain rabbitbrush, shadscale, and Nevada dalea. We first classified and sampled this unit as an example of Habitat Type 10, but the observed sand sheets and dunes coupled with gravelly alluvium speak to an example of Habitat Type 11. The frequency of Nevada dalea in the sample unit, a common element of Habitat Type 11 flora, supports reclassification.

Thirteen isolated finds and five sites appear in this sample unit. All isolates are of local chert material and all, but one complete biface, are an assortment of core reduction and early stage biface thinning flakes. The sites also represent prehistoric assay of the abundant local chert cobbles found on desert pavement surfaces. All five contain only the local chert material. Bifaces are the only formed tools observed. Cores are present at all sites except 4613, with most exhibiting random flake removal. Site 4617 is the largest, containing more than 250 flakes (mostly core reduction or early biface thinning stages), five bifaces, and four notable cores. The remaining four sites are smaller in size and content. We observed only one pressure flake in the sample unit, at site 4615.

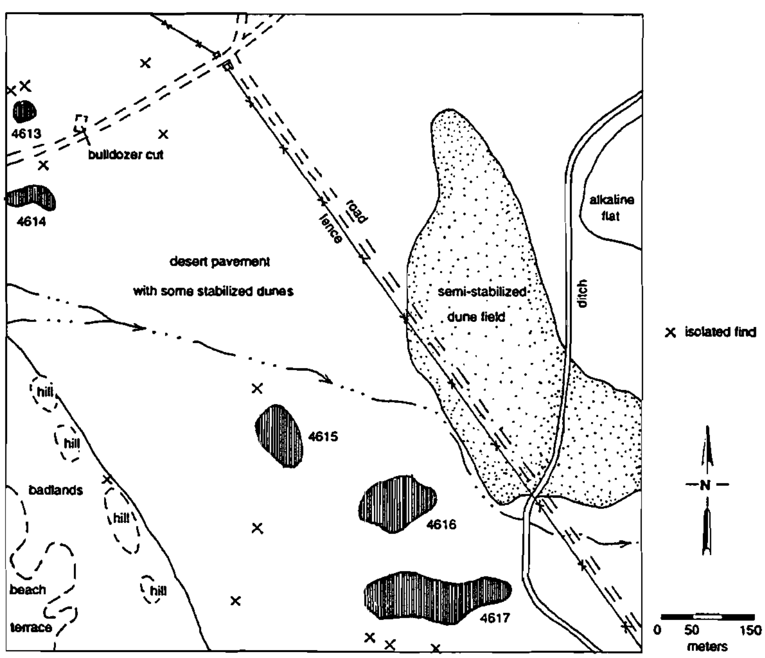
Sample Unit 335/4356 (Figure 93) occurs adjacent a Pleistocene shoreline on the eastern flank of the Dead Camel Mountains, overlooking Lahontan Valley to the east. The principal landform is a piedmont truncated by lacustrine shorelines. Small shale inselbergs occur along the eastern margin of the unit. A mature desert pavement covers much of the piedmont surface, but stable sand dunes are in the northern portion of the sample unit. Several intermittent stream channels have incised the piedmont. Shadscale, saltbush, hopsage, Nevada dalea, seepweed, and ricegrass grow throughout most of the unit. Rabbitbrush is common to dominant in drainages; horsebrush, Indian ricegrass, hopsage, and saltbush are common on dunes. Bailey's greasewood, four-wing saltbush, Russian thistle, winterfat, mustard, and prickly pear also occur here.

We recorded five sites and four isolates, all on desert pavement surfaces. Isolates include one biface and three biface reduction flakes, all of local chert material. Sites also contain flakes and possibly a cobble core of local chert. Site 4730, largest of the five, contains more than 100 flakes, formed tools, and exotic materials, including a few weathered obsidian flakes, a leaf-shaped obsidian projectile point, three bifaces, a large scraper, two flake tools, and a couple of chalcedony flakes.

Sample Unit 340/4361 is in the proposed eastern expansion of Bravo 16. An improved road and irrigation canals wander through this sample unit located in western Lahontan Valley, south and west



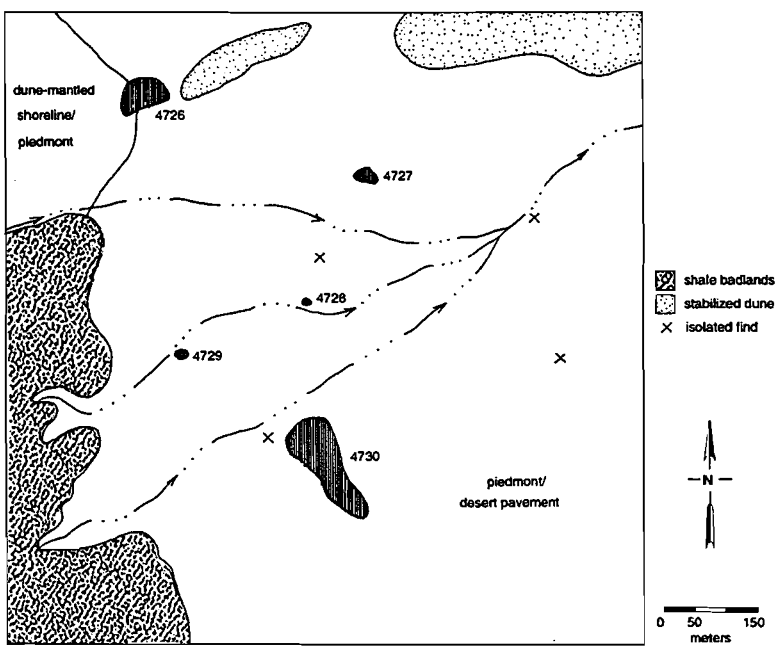
a. Surface view northwest.



b. Plan view.

Figure 92. Sample Unit 334/4362.

a. Surface view northwest.



b. Plan view.

Figure 93. Sample Unit 335/4356.

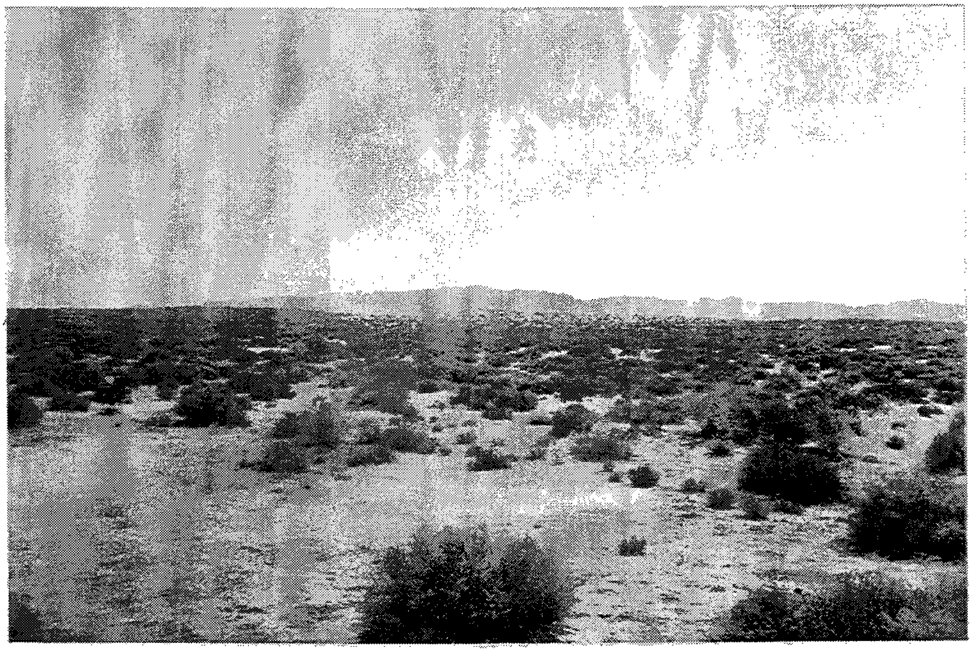
of the South Branch of the Carson River and northwest of Carson Lake. It contains a series of northeast-southwest trending sand dunes separated by flat sand sheets, and occasional small playa basins (Figure 94). The elevation of most of the unit ranges from 1202 to 1204 meters (3944 to 3950 ft amsl), with two dunes on southern and northern edges achieving another six meters. Field crews commonly observed gastropod and bivalve shells along playa margins at the base of dunes, suggesting that the small basins occasionally have been inundated for prolonged periods. Greasewood, shadscale, and spiny hopsage grow here.

The sample unit yielded five prehistoric sites and seven isolated finds. The isolates include individual occurrences of two decortication flakes of local chert, two biface thinning flakes (one of obsidian), a tuff ground stone fragment, and a chert biface fragment, and at 4629, a scatter of four flakes. Sites are relatively small and composed exclusively of lithic material, some with ground stone. Assemblage composition ranges from six flakes and three bifaces at 4625, to the larger 4628 with more than 150 flakes but no formed tools. Artifacts at these sites are of locally available cherts in a variety of colors.

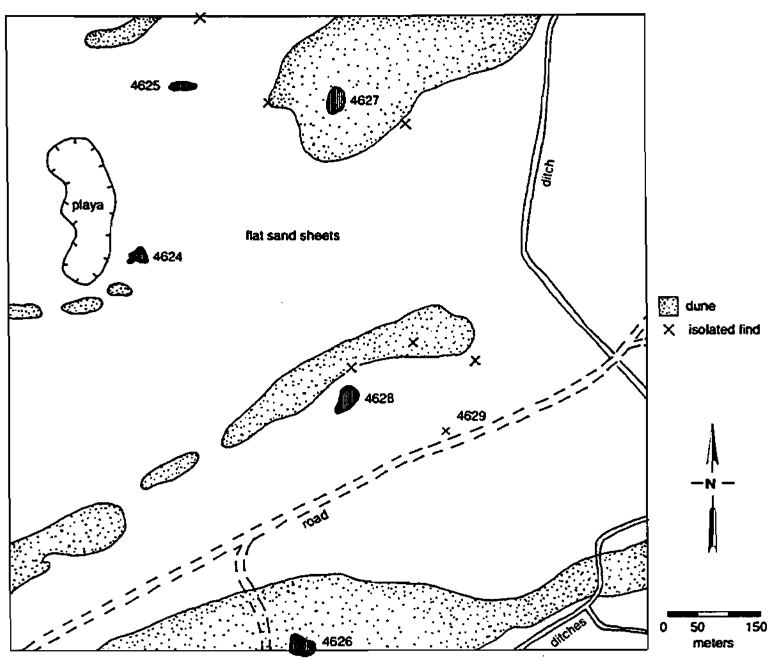
The remaining three sites contain small quantities of ground stone. Site 4626 yielded 13 chert flakes, one obsidian Rose Spring projectile point, one obsidian biface, and a milling stone fragment. A chert Rose Spring projectile point is present at 4624, along with a sparse scatter of eight chert flakes and six vesicular basalt ground stone fragments. Site 4624 also has a 1 m x 2 m area of fire-altered rock along an aeolian dune, probably representing a hearth feature. An apparent deflated hearth feature measuring 6 m x 3 m and composed of about 50 angular basalt rocks occurs at 4627. No formed tools are among the 30-plus chert flakes and three vesicular basalt ground stone fragments at this site.

Sample Unit 389/4341 (Figure 95) is south of Labou Flat on the floor of Fairview Valley. Its northeast corner constitutes the southwest corner of sample unit 390/4342. Elevations range from 1282 meters (4206 ft amsl) at the northeast corner to 1289 meters (4229 ft amsl) on the southwest. A north flowing drainage and several smaller washes bisect the unit. The channel is entrenched at the southern edge of the sample unit, but becomes braided, shallow, and indistinct on the north. The quadrat sits at the juxtaposition of an alluvial fan with the valley floor, and alluvial sediments are characteristic. Sand sheets and eroded sand dunes, however, are common in the north and west. Bailey's greasewood, shadscale, annual saltbush, Russian thistle, buckwheat, and Indian ricegrass grow throughout. Winterfat occurs in the southwestern quarter of the unit. The sample unit contains three small lithic scatters and five isolated finds, of which one is a biface fragment and four are biface thinning flakes of variously colored, local chert. Sites are also characterized by local chert material with small quantities of chalcedony. Site 4718 is the largest of the three, containing about 100 flakes and seven bifacial tools.

Sample Unit 391/4349 (Figure 96) lies just beyond the northern arm of Labou Flat. Low sand dunes interspersed with small silty alkaline playa pans, comprise the sample unit. Topographic relief is minor, with elevations ranging from 1265 meters (4150 ft amsl) to 1269 meters (4164 ft amsl). Playa pans located on the northern and eastern portion are likely subject to seasonal inundation. Disturbed flats on the south and west are overgrown with non-native halogeton and Russian thistle. Bailey's greasewood grows throughout the unit, while Indian ricegrass and Russian thistle are common on dunes. Also in the quadrat are wolfberry, budsage, saltbush, shortspine and gray horsebrush, annual buckwheat, cheatgrass, bluegrass, evening primrose, and globemallow. Seven sites and eleven isolated finds occur in this unit. The isolates are all bifaces or biface reduction flakes of local fine-grained chert. Sites are lithic scatters, some with ground stone.

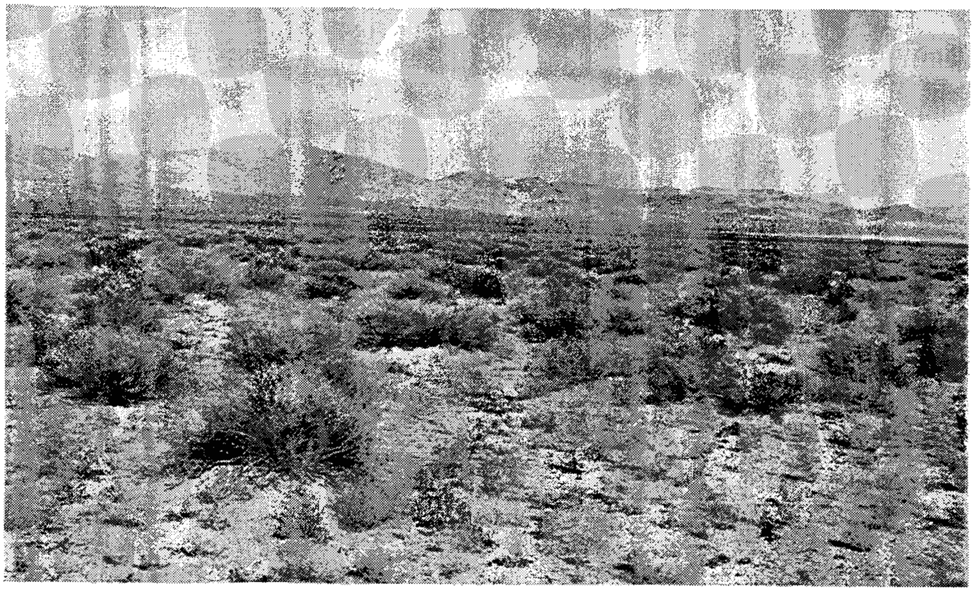


a. Surface view north.

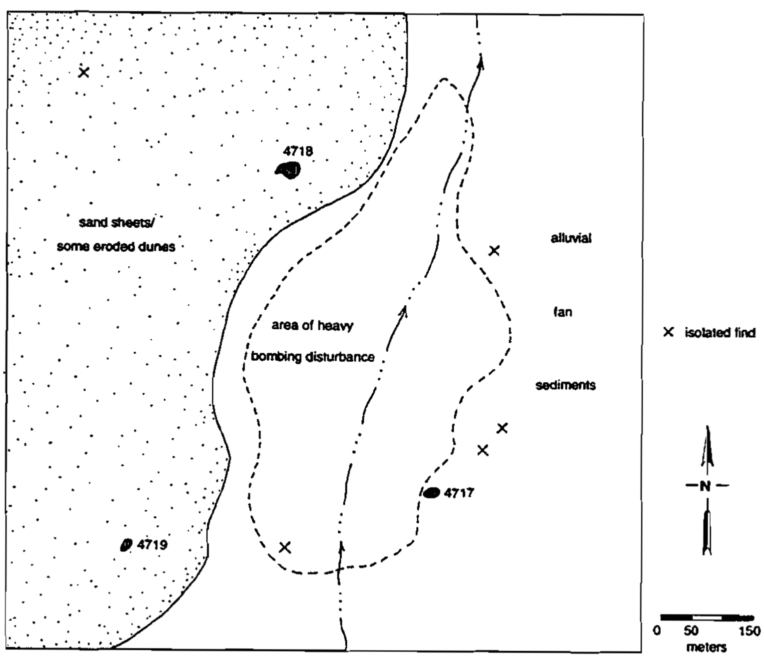


b. Plan view.

Figure 94. Sample Unit 340/4361.

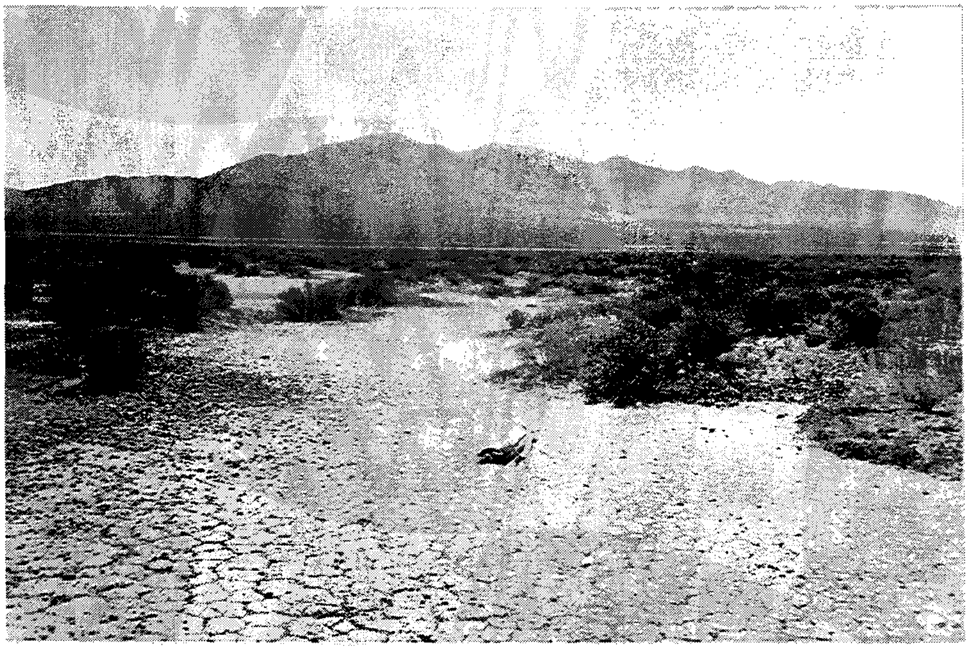


a. Surface view northwest.

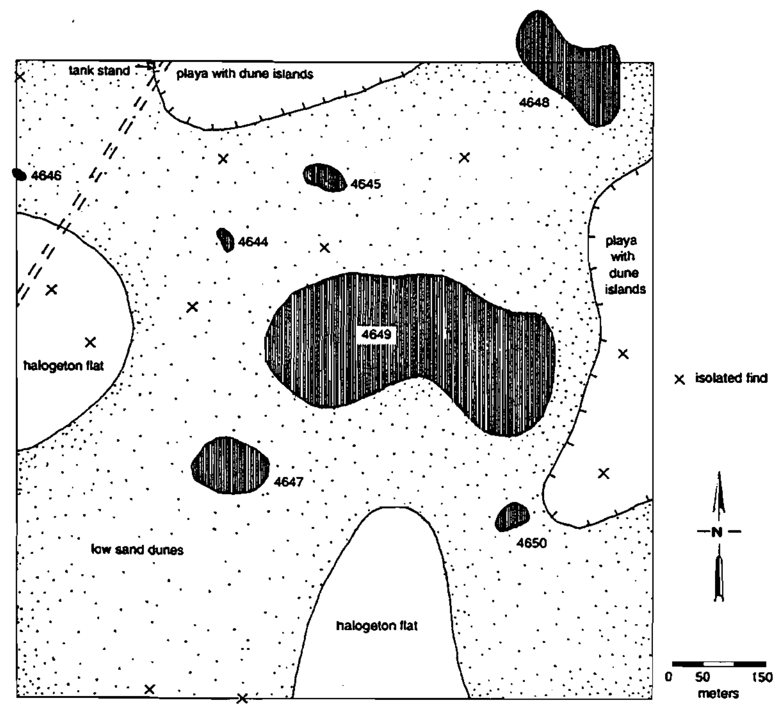


b. Plan view.

Figure 95. Sample Unit 389/4341.



a. Surface view southeast.



b. Plan view.

Figure 96. Sample Unit 391/4349.

All seven sites contain lithic debitage of local fine-grained chert; only two sites (4648 and 4649) exhibit more than 40 flakes. Obsidian, chert, and chalcedony are present at a few sites, yet these materials are rare, at well under five percent of any assemblage. Three sites (4644, 4649, 4650) contain Eastgate projectile points, with the point from 4649 having been reworked into a drill. Additional drills occur at 4645, 4648, and 4649. Two sites contain ground stone (4645 and 4646) and site 4645 revealed an area of slightly dispersed fire-altered vesicular basalt, likely representing a deflated hearth feature. Site 4648 contains lithic debitage, a few tools, and a unique ground chalcedony pendant or net weight fragment. Site 4649 contains in excess of 500 flakes, a dozen bifaces, and other lithic tools.

Sample Unit 400/4360 occurs in Dixie Valley in the proposed northern expansion of Bravo 17. Dixie Valley wash flows northwards through the northwestern corner of the sample unit. Much of the western and central portions of the unit occupies the Dixie Valley floodplain, and contains several arroyos. The eastern portion of the unit is characterized by the lower slopes of alluvial fans extending westward from Louderback Mountain. Sediments in the valley bottom are sand sheets while those on alluvial slopes are gravelly loams with occasional pockets of sand. Vegetation includes Bailey's greasewood, shadscale, Russian thistle, cactus, and Indian ricegrass. Neither sites nor isolates were observed in this sample unit.

Habitat Type 15

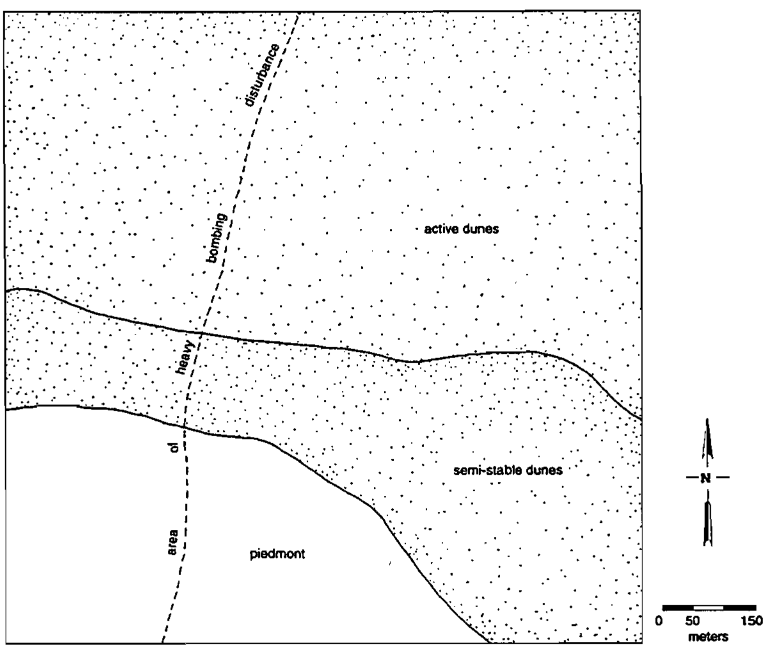
Sample Unit 357/4335 (Figure 97) is in Navy Training Range Bravo 19. It is situated on the southern face of the Blow Sand Mountains, overlooking Rawhide Flats to the south and west. Elevations achieve 1317 meters (4321 ft amsl) atop active dunes at the northeast corner of the quadrat, down to 1225 meters (4019 ft amsl) in the southwest. Approximately 50% of the sample unit is active dune, 35% semi-stable dune, and 15% piedmont surfaces. Hopsage, saltbush, Nevada dalea, wolfberry, horsebrush, four-wing saltbush, and Russian thistle grow in the southern portion of the unit on partially stabilized sand dunes and piedmonts. Indian ricegrass and amaranth dominate the flora of active dunes in the north. We located neither sites nor isolates in this sample unit.

Habitat Type 16

Sample Unit 396/4353 occupies the northwest slopes of an extensive knoll in northern Fairview Valley, in the proposed expansion of Bravo 17. The knoll is a remnant of eroded alluvial fan separating Fairview Valley on the southwest from Dixie Valley on the northeast. Several ridge spurs extend northwestward through the unit. Elevations range from 1292 meters (4239 ft amsl) to 1326 meters (4351 ft amsl). Aeolian sand sheets and occasional gravelly loams cap ridges. Bailey's greasewood and Indian ricegrass dominate the unit, which also hosts Russian thistle, prickly pear, and sand cholla. A biface thinning flake of local chert was observed in the unit.

Sample Unit 350/4334 is at the western edge of Bravo 19, at an elevation of 1198 to 1231 meters (3931 to 4040 ft amsl). It covers lower alluvial fans extending from the Desert Mountains and overlooking Rawhide Flats to the east. Multiple small erosional rills flow northeastward through the unit, while a large intermittent channel in the eastern portion of the quadrat is about two meters deep and four wide. Desert pavement armors the surface of much of the unit, but aeolian sand sheets cover the pavement variously. Indian ricegrass and Russian thistle dominate sand sheets while saltbush and hopsage are more common on gravels. Also present in the sample unit are Bailey's greasewood, horsebrush, winterfat, and sunflower. Four isolated finds are in this unit, including an assayed cobble and three decortication flakes, all of local chert.

a. Surface view west.



b. Plan view.

Figure 97. Sample Unit 357/4335.

Sample Unit 388/4354 occurs at 1310 to 1325 meters (4298 to 4347 ft amsl) elevation in the proposed northern expansion of Bravo 17. It lies on the lower slopes of an alluvial fan emanating southward from the Stillwater Range, overlooking Labou Flat to the south. Sediments are sand sheets and small dunes (about one meter high). Shallow ephemeral washes flow southward through the unit cutting small, narrow, established courses. Bailey's greasewood, Russian thistle, and Indian ricegrass grow throughout the unit. Rabbitbrush and Nevada dalea are more common along washes and gray horsebrush and dock thrive on dunes. Also present are shadscale, evening primrose, winterfat, and cheatgrass. The unit contained no archaeological remains.

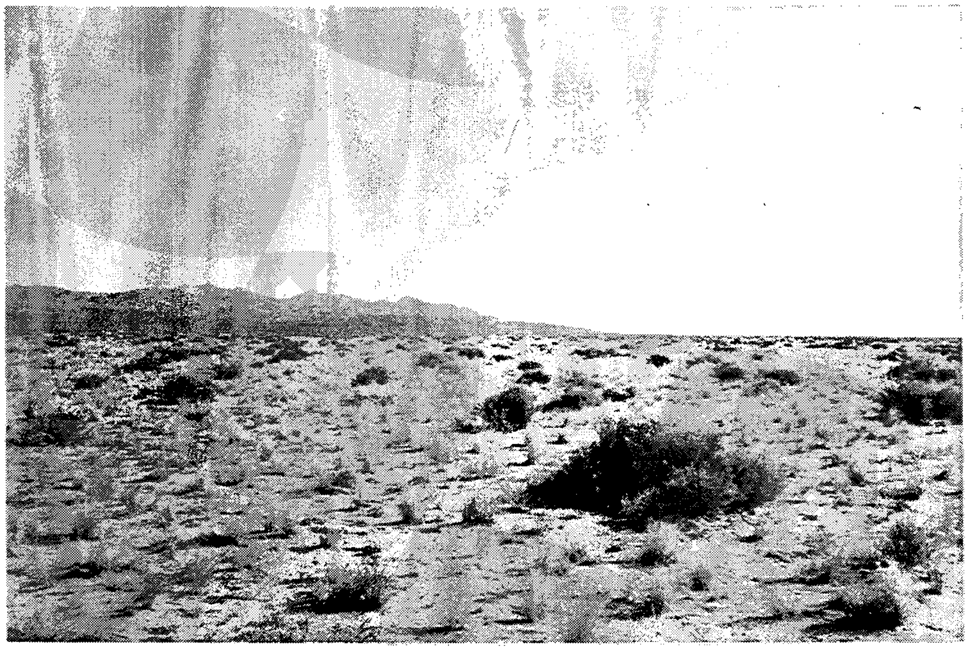
Sample Unit 392/4355 (Figure 98) is also in the proposed northern expansion of Bravo 17 on the rim of Fairview Valley north of Labou Flat. The northern portion of the unit contains gravel armored lower toes of alluvial fans emanating from the Stillwater Range (Habitat Type 10) which grades into sand sheets and low aeolian sand dunes in the south more typical of Habitat 16. Elevations range from 1300 to 1320 meters(4265 to 4331 ft amsl). Two intermittent washes with sandy bottoms merge and flow southward through the unit. Bailey's greasewood and hopsage prevail in the north, while Indian ricegrass dominates in the south. Also present are budsage, shadscale, rabbitbrush, winterfat, evening primrose, snakeweed, sunflower, Russian thistle, and bottlebrush squirreltail. Indian ricegrass occurs in pure stands in the sand sheets. We observed one site (4663) in the sample unit, consisting of 20 flakes, two bifaces, and a red chert Elko Corner-notched projectile point base. Flakes are middle to late stage biface thinning. Bifaces are of fine-grained chert material. The chert is locally available, although cobble sources are several hundred meters away from the site.

Sample Unit 395/4350 (Figure 99) occurs in the proposed extension of Bravo 17, occupying aeolian sand sheets northeast of Labou Flat and northwest of Dromedary Hump. Small ephemeral washes flow westward through the sample unit as does a broad, well-entrenched intermittent drainage in the southern portion of the unit. Elevations range from 1285 meters (4216 ft amsl) to 1310 meters (4298 ft amsl). We recorded of four sites and five isolates here, the latter include four middle to late stage biface thinning flakes and one biface midsection, all of local fine-grained chert material. The sites are small lithic scatters exhibiting from 18 to more than 400 flakes of local chert. A few bifaces, but no other formed artifacts, occur at 4666, 4668, and 4669. Middle to late stage bifacial thinning flakes dominate these assemblages, with a few core reduction flakes at 4667.

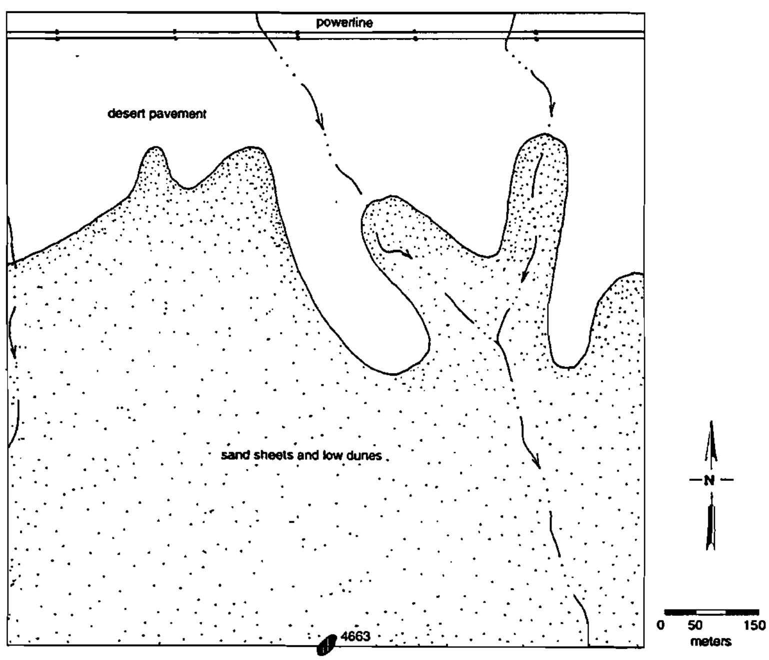
Habitat Type 18

Sample Unit 331/4362 (Figure 100) is in the proposed western expansion of Bravo 16. It occupies the lower piedmont slopes of the Dead Camel Mountains overlooking Lahontan Valley to the northeast. Steep hilly slopes, ridges, and knolls dissected by entrenched ephemeral washes characterize the unit. Rocky colluvial slopes cover most of the unit while desert pavements armor relatively level surfaces. Sandy slopes are common at the heads of drainages. Elevations range from 1325 to 1505 meters (4347 to 4938 ft amsl). Shadscale, Bailey's greasewood, wolfberry, four-wing saltbush, Mormon tea, hopsage, gray horsebrush, Nevada dalea, prince's plume, Russian thistle, globemallow, halogen, phlox, and cheatgrass were observed. The sample unit contained two isolated local chert late-stage core reduction flakes.

Sample Unit 390/4365 is in the northern expansion of Bravo 17, encompassing lower piedmont slopes of the Stillwater Range at 1585 to 1716 meters (5200 to 5630 ft amsl) elevation. Granite, quartzite, and basalt capped ridges and knolls separated by steeply entrenched ephemeral drainages characterize the topography. Gravelly loams cap lower slopes. Bailey's greasewood, Mormon tea, rabbitbrush, hopsage, budsage, wolfberry, gray horsebrush, shortspine horsebrush, buckwheat, prince's plume, winterfat, globemallow, halogeton, Indian ricegrass, and cheatgrass grow in the unit. This unit contained one isolate, a middle stage biface thinning flake of black obsidian.

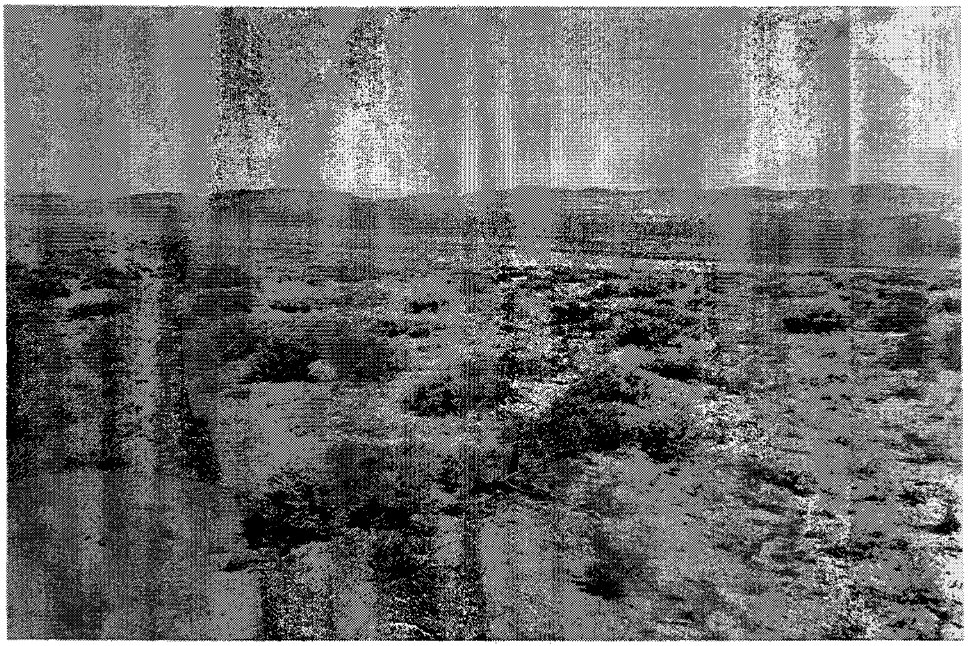


a. Surface view northeast.

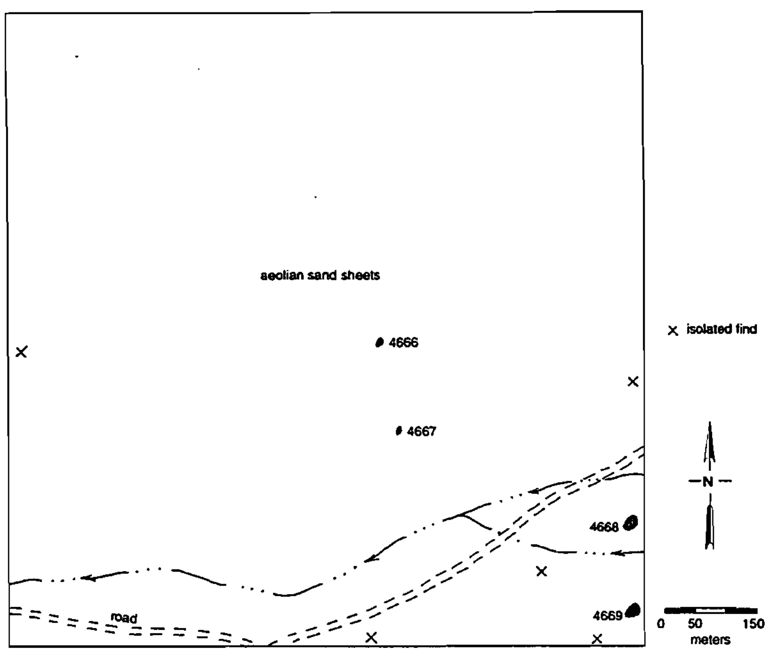


b. Plan view.

Figure 98. Sample Unit 392/4355.

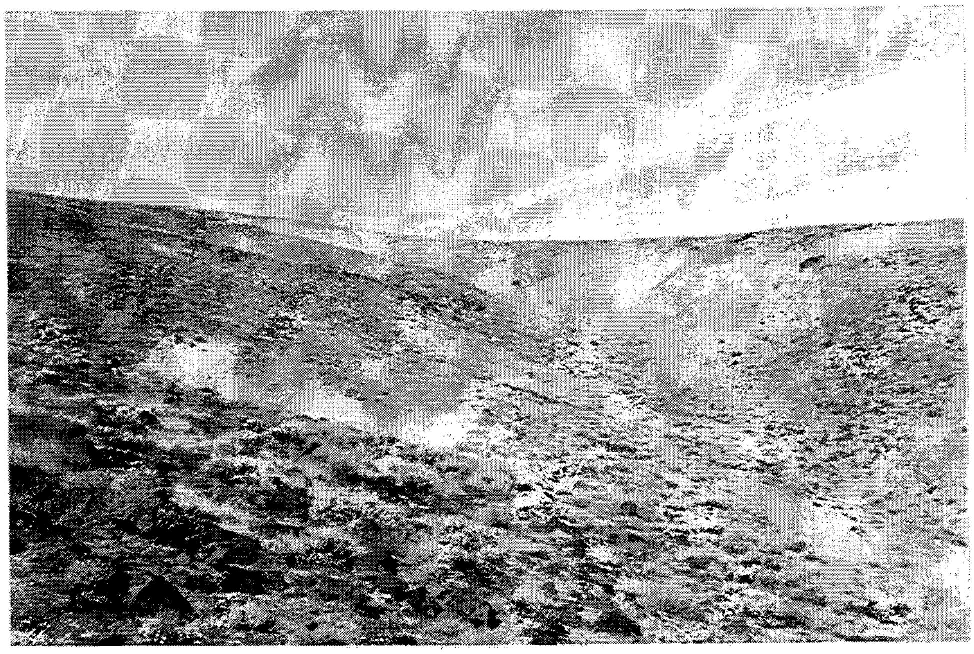


a. Surface view northwest.

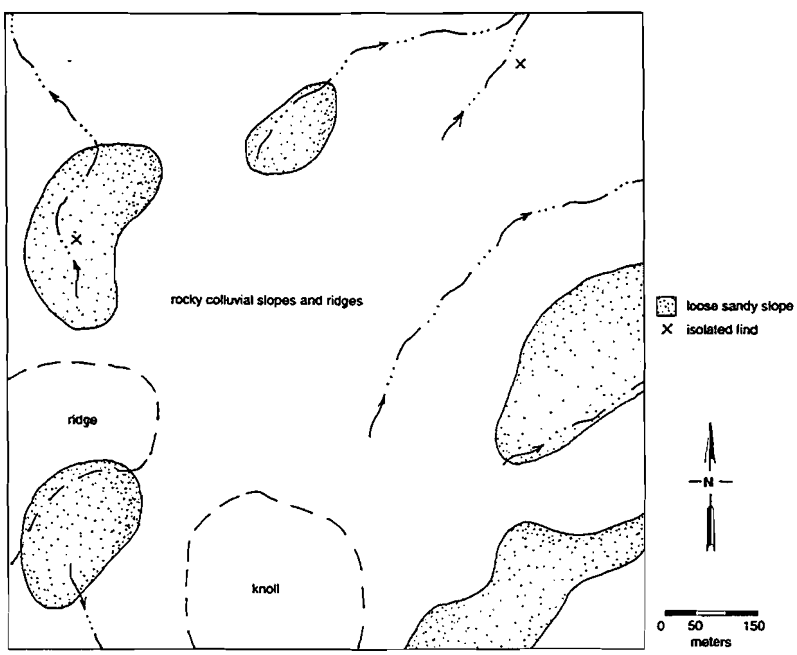


b. Plan view.

Figure 99. Sample Unit 395/4350.



a. Surface view west.



b. Plan view.

Figure 100. Sample Unit 331/4362.

Habitat Type 20

Sample Unit 346/4335 occurs in the proposed westward expansion of Bravo 19 in the Desert Mountains. Basaltic ridges and knolls, with colluvial talus covering lower slopes, structure unit topography. Sand sheets and dunes occupy intervening flats, saddles, and drainage bottoms. One steep canyon contains an ephemeral drainage flowing northeastward out of the southeastern corner of the unit. However, an ephemeral wash flowing to the northeast through the center of the unit, drains most of the sample unit. Elevations range from 1402 meters (4600 ft amsl) to 1524 meters (5000 ft amsl). Field crews observed Bailey's greasewood, Russian thistle, rabbitbrush, four-wing saltbrush, Mormon tea, littleleaf horsebrush, sunflower, Indian ricegrass, foxtail barley, bluegrass, and cheatgrass. No archaeological remains were observed here.

Sample Unit 349/4336 (Figure 101) is located in the western Bravo 19 expansion south of Carson Lake at the northwestern extreme of Rawhide Flat. An unnamed spring is in the northeastern portion of the sample unit. The presence of a water source qualifies this as an example of Habitat Type 20b, a variant not identified as an individual sampling stratum in Chapter 2 because of the small number of water sources on Habitat 20. Elevations rise quickly from 1198 meters (3930 ft amsl) at the spring to 1340 meters (4397 ft amsl) on the crest of a south trending basaltic ridge of the Desert Mountains. Sand sheets, partially stabilized sand dunes, and desert pavements on the eastern side of the unit are heavily disturbed where Highway 95 traverses this portion of the sample unit. An historic habitation sits near the spring, which has been enlarged. Consequently Russian thistle, sunflower, and Bailey's greasewood dominate the vegetation on the eastern side of the sample unit. Dunes surrounding the spring maintain black greasewood, shadscale, four-wing saltbush, and Indian ricegrass. Inland saltgrass grows in a thick mat around the spring. The ridge slopes and crest along the western edge of the site bear Bailey's greasewood, horsebrush, four-wing saltbush, Indian ricegrass, and galleta. This sample unit contains a prehistoric site centered on the spring; only a few flakes, a mano. and two milling stone fragments were observed. A previous record of this site (3532) (Petersen 1985) mentions a disarticulated concentration of fire-altered rock, possibly a hearth, but we did not relocate this feature.

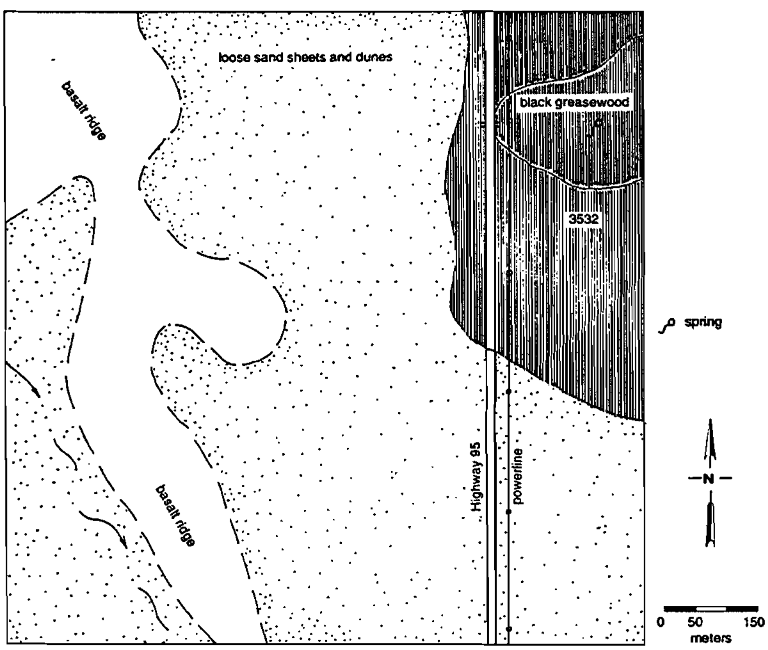
Sample Unit 352/4338 is in Bravo 19, at the foot of the Blow Sand Mountains, overlooking Rawhide Flats to the southwest. Gentle ridge slopes capped with desert pavement typify the northeast quarter of the unit; low, sharply undulating sand dunes, ridges, and interdunal playa pans, characterize the remainder. Shallow intermittent washes flow northeastward through the unit. Elevations range from 1189 to 1259 meters (3901 to 4131 ft amsl). Bailey's greasewood, Nevada dalea, shadscale, four-wing saltbush, horsebrush, Russian thistle, mustard, Indian ricegrass, and cheatgrass comprise the flora. Archaeologically, this sample unit contains an isolated basalt boulder milling stone

Habitat Type 21

Sample Unit 397/4368, at 1271 to 1323 meters (4170 to 4340 ft amsl) elevation, is in the northern expansion of Bravo 17. It comprises the lower slopes of an alluvial fan emanating from the Stillwater Range east into Dixie Valley. Several shallow ephemeral drainages and a well-defined intermittent wash flow eastward through the sample unit. Sediments are gravelly loams often armored with desert pavement. Plants observed include Bailey's greasewood, shadscale, spiny hopsage, wolfberry, Mormon tea, prickly pear, Russian thistle, halogeton, cheatgrass, and Indian ricegrass. No archaeological remains were observed here.

Sample Unit 398/4359 in the proposed northern expansion of Bravo 17 at the base of an alluvial fan emanating from the Stillwater Mountains eat to the floor of Dixie Valley. Elevations range from 1265 meters (4150 ft amsl) in the east to 1289 meters (4230 ft amsl) in the west. A broad intermittent wash

a. Surface view south.



b. Plan view.

Figure 101. Sample Unit 349/4336.

flows northward through the southeastern corner of the unit. Two large intermittent drainages flow eastward through the unit; the northern drainage is entrenched. Other drainages are small, east flowing, and ephemeral. Loose fluvial sands and gravels occur in washes and drainages, while gravelly loams occur on alluvial fan surfaces which are desert pavement armored. Bailey's greasewood, wolfberry, rabbitbrush, littleleaf horsebrush, and Indian ricegrass grow in the quadrat. We discovered no prehistoric archaeological remains here.

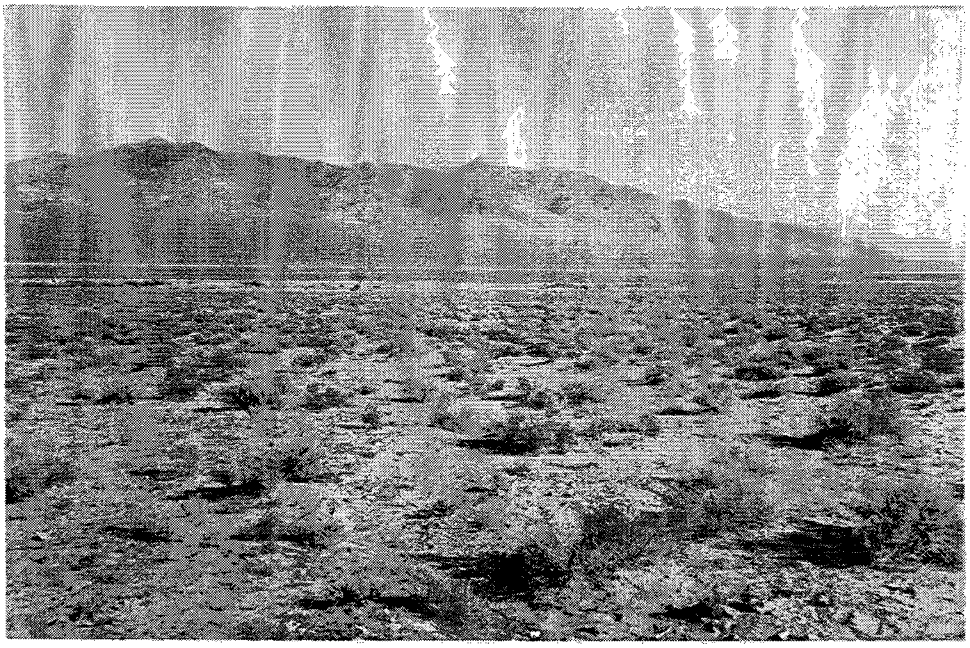
Sample Unit 399/4370 lies in the northern extension of Bravo 17. It occupies the lower alluvial fan surfaces west of Dixie Valley Wash at elevations from 1186 meters (3891 ft amsl) in the west to 1221 meters (4006 ft amsl) in the northeast corner. Several small ephemeral washes flow eastward across the unit. Sediments are a silty loam, frequently capped by desert pavement. Plants in the quadrat include Bailey's greasewood, budsage, hopsage, rabbitbrush, Mormon tea, halogeton, Russian thistle, prince's plume, winterfat, globemallow, and Indian ricegrass. A middle stage bifacial thinning flake of local chert was observed here.

Sample Unit 400/4369 (Figure 102) is immediately southeast of unit 399/4370 and is transected by Dixie Valley Wash flowing northward through the eastern portion of the unit. Arroyo truncation of this wash creates walls up to two meters high. Most of the sample unit encompasses toes of alluvial fans extending east from the Stillwater Range, with several small, ephemeral washes flowing northeastward across these fans and into Dixie Valley Wash. Sediments in washes are fluvial sands and gravels while fan surfaces are silty loams. Silts frequently form low, semi-stable dunes east of Dixie Valley Road. Desert pavements cap the southern and western portions of the quadrat. Vegetation includes Bailey's greasewood, wolfberry, budsage, hopsage, Russian thistle, prince's plume, halogeton, winterfat, globemallow, Indian ricegrass, and cheatgrass. Rabbitbrush and Indian ricegrass are most abundant in small washes while Dixie Valley Wash maintains stands of black greasewood and big sagebrush. This sample unit contains site 4672, a small scatter of 21 medium-grained chert flakes, most late bifacial thinning stage.

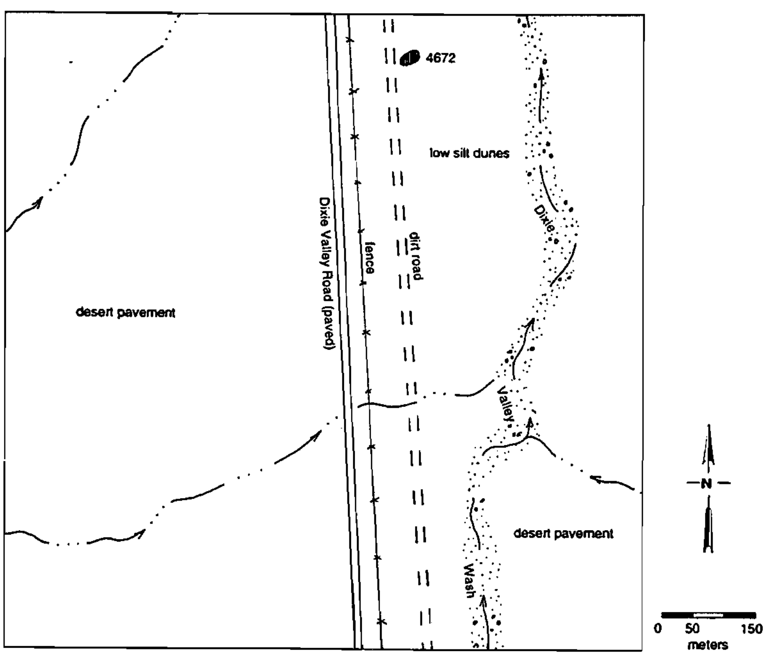
Habitat Type 26

Sample Unit 392/4360 (Figure 103) is in the proposed northern expansion of Bravo 17, astride the transition from lower piedmont slope to upper alluvial fan in the Stillwater Range. Steep, southeast-trending basalt ridges bisected by numerous deeply incised washes characterize the topography. Gravels pave drainage bottoms while colluvial talus covers slopes. Gravelly loams and desert pavement armoring occur on relatively gradual slopes and ridge tops. Elevations range from 1380 meters (4528 ft amsl) to 1463 meters (4800 ft amsl). Vegetation is predominately Bailey's greasewood, with some hopsage, budsage, and wolfberry, on ridges and slopes. Rabbitbrush, Mormon tea, and Nevada dalea are more abundant in washes and on sandy slopes in the southwest corner of the sample unit. Gray and spiny horsebrush, prince's plume, buckwheat, globemallow, Indian ricegrass, bottlebrush squirreltail, and needlegrass are also present. This sample unit contained an early stage biface reduction flake of local chert.

Sample Unit 402/4364 is in the proposed northeastern expansion of Bravo 17. The elevation at the western edge is 1258 meters (4127 ft amsl) , rising 100 meters (328 ft) higher in the east. The unit encompasses highly dissected alluvial fan surfaces on the western flanks of Louderback Mountain. Typical are steep, westerly-trending ridges separated by intermittent drainages. A broad ephemeral wash flows westward across the center of the unit and steep piedmont ridges occupy the northeastern corner. Most sediments are gravelly loams with well-developed desert pavements. Basalt talus covers steep ridge slopes while gravelly alluvium occurs in drainages. Plants observed in the quadrat include Bailey's greasewood, spiny hopsage, littleleaf horsebrush, globemallow, Indian ricegrass, bottlebrush squirreltail, and bluegrass. No prehistoric sites or isolates were observed here.



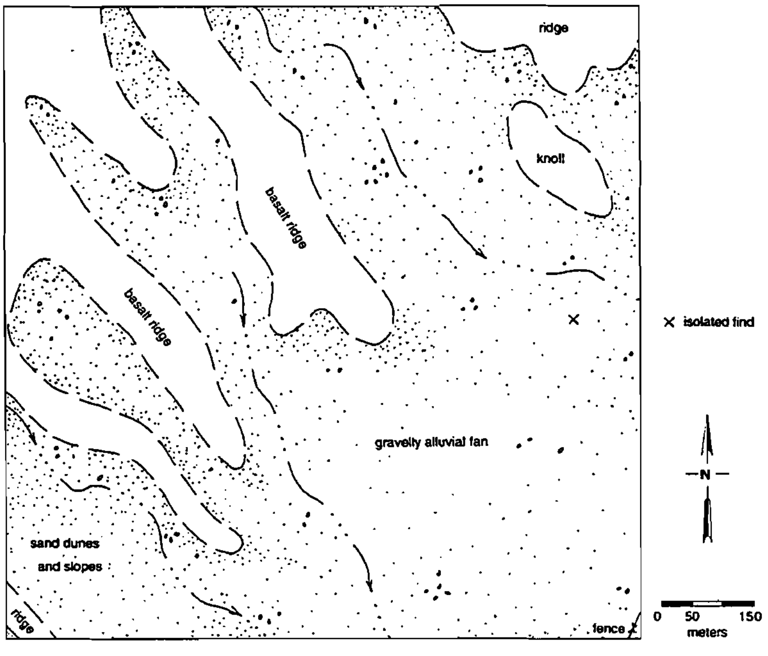
a. Surface view northwest.



b. Plan view.

Figure 102. Sample Unit 400/4369.

a. Surface view south.



b. Plan view.

Figure 103. Sample Unit 392/4360.

Habitat Type 29

Sample Unit 403/4382 is among the Dixie Valley parcels administered by NAS Fallon. It lies on the floor of Dixie Valley in the unchannelized Dixie Valley Wash floodplain. Elevations range only between 1096 and 1100 meters (3596 and 3609 ft amsl). Sediments are silts, frequently mounded in low dunes. The sample unit has sustained heavy agricultural activity. Russian thistle, halogeton, and tamarisk are common on disturbed areas; Bailey's greasewood, Russian thistle, and four-wing saltbush are present elsewhere. A large translucent chalcedony core reduction flake occurs within the unit.

Sample Unit 431/4423 (Figure 104) is also among the Dixie Valley parcels administered by NAS Fallon, occupying the floor of Dixie Valley. Sediments are loose sand sheets throughout. Elevations range only from 1054 meters to 1061 meters (3458 to 3481 ft amsl). The eastern four-fifths of the sample unit are plowed agricultural field, dissected by two east-west irrigation ditches and one north-south. Russian thistle and halogeton dominate this area. The western extreme of the unit is unplowed, and is dominated by Bailey's greasewood. Sandy alluvium dissected by well entrenched stream channels covers the area. The hydrology and geomorphology are a consequence of outwash from the irrigated field to the east. Two isolated finds were observed in the sample unit, both flakes of local chert. One is a primary decortication flake while the other is a middle stage bifacial thinning flake.

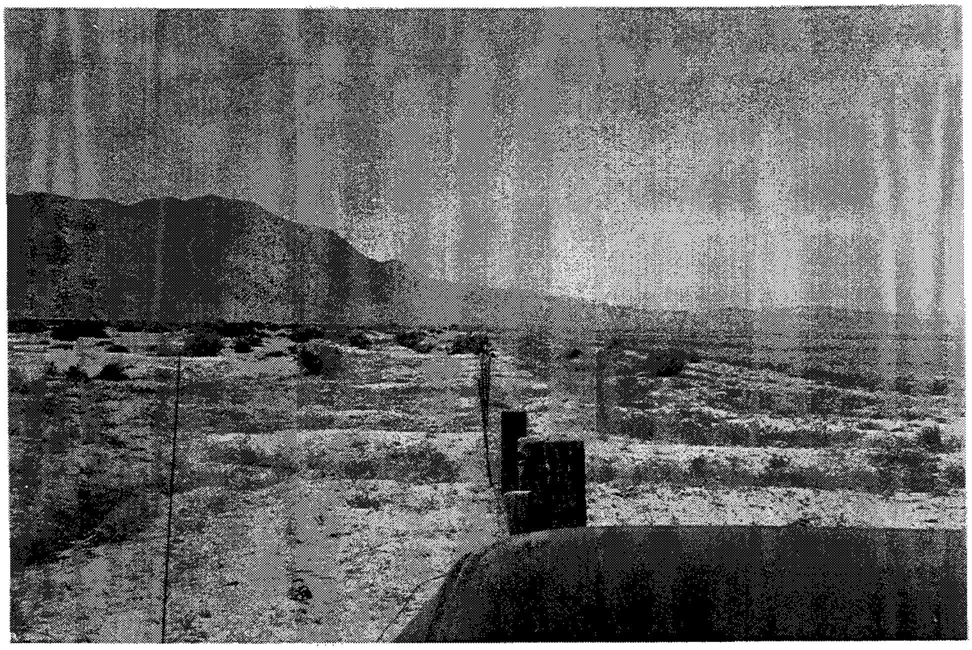
Habitat Types 37, 37c

Quadrat 364/4335 (Figure 105) is in the proposed eastern expansion of Bravo 19. It occupies the northern foothill slopes of the Barnett Hills. Elevations range from 1446 to 1554 meters (4744 to 5066 ft amsl). A north-trending ridge complex dominates the southern portion of the sample unit. Ephemeral washes flowing east and north drained and dissect the ridges. Colluvial talus and desert pavement armor ridges, loose gravelly loams occur on gentler surfaces to the northwest, and sandy alluvium occurs in wash bottoms. Bailey's greasewood and saltbush are dominant on colluvial slopes and desert pavements. Rabbitbrush and Indian ricegrass are common in drainages. Big sagebrush is restricted to north facing slopes. Gray and spiny horsebrush are common on sandy gravelly loams. Budsage, prince's plume, buckwheat, peppergrass, and cheatgrass were also observed.

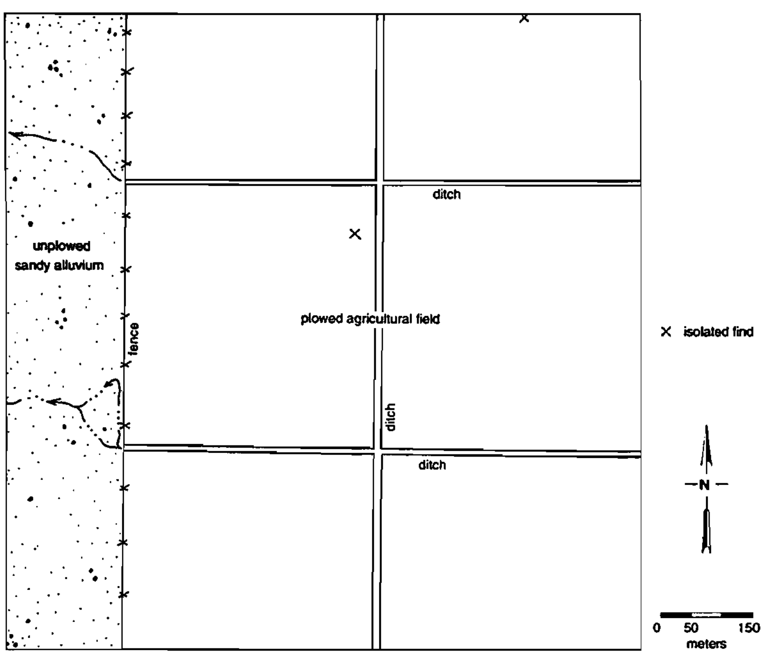
Three prehistoric isolates and one site appear in this sample unit. Of the three isolates, two are local chert bifacial thinning flakes and the third is a large obsidian Great Basin Stemmed projectile point fragment. The site is a small scatter of two cores and ca. 60 flakes representing assay of local fine-grained chert cobbles.

Sample Unit 394/4333 lies within the proposed southern expansion of Bravo 17, on the west flank of Slate Mountain overlooking Fairview Valley to the west and Bell Canyon to the north. West-trending ridges, separated by steeply entrenched intermittent drainages characterize the quadrat. A mountain knoll and saddle rise in the northeast corner of the quadrat to 1784 meters (5853 ft amsl) elevation, from drainage floors at 1621 meters (5319 ft amsl) on the west. Exposed basaltic bedrock, talus slopes, and loams capped by desert pavement occur in the unit. Big sagebrush, Bailey's greasewood, shadscale, spiny hopsage, Mormon tea, prickly pear, globemallow, Indian ricegrass, needlegrass, and bluegrass grow here. One chert biface fragment occurs within the sample unit.

Sample Unit 398/4333 is also located in the proposed southern expansion Bravo 17. Bell Canyon, a sandy-bottom wash, flows northeast through the southwest corner of the unit. Steep basaltic ridges and knolls separated by deep, southwest flowing intermittent drainages occupy the remainder of the sample unit. Elevations range from 1605 to 1730 meters (5266 to 5676 ft amsl). Colluvial talus and gravelly loams are the upland sediments. Isolated juniper trees grow on the highest northeast facing slopes. Dominant shrubs are big sagebrush, wolfberry, hopsage, and shadscale, with serviceberry,

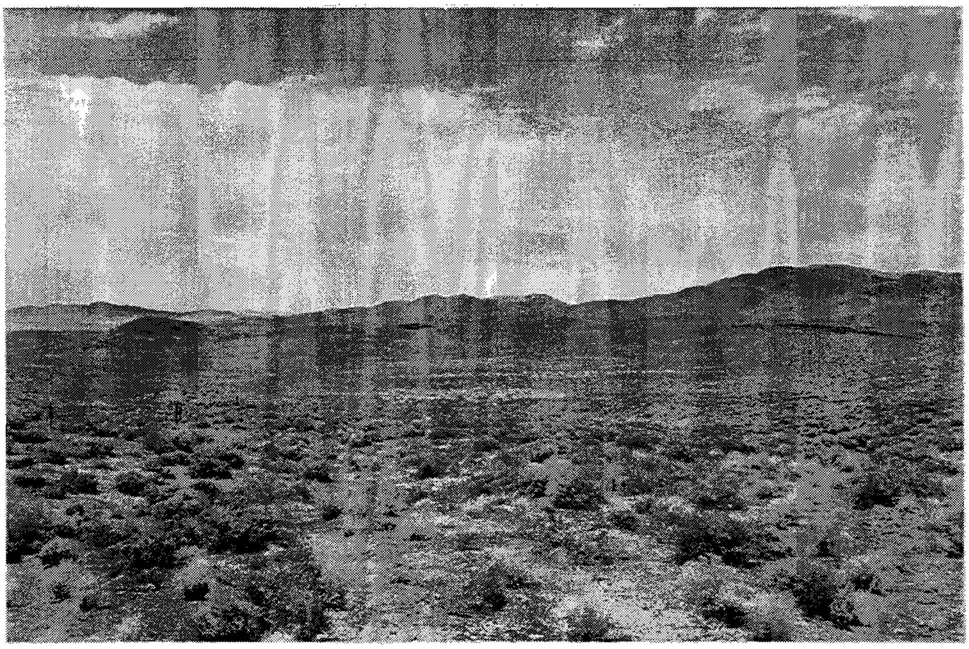


a. Surface view north.

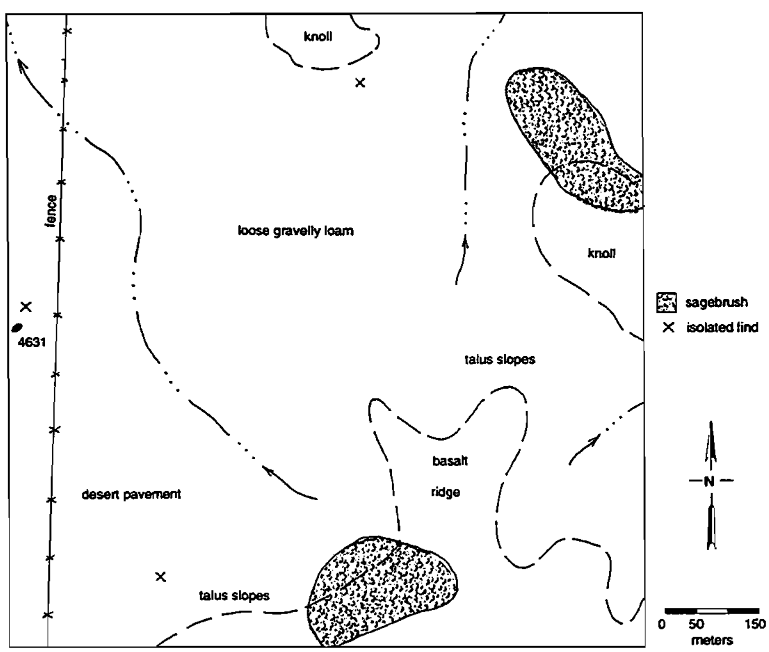


b. Plan view.

Figure 104. Sample Unit 431/4423.



a. Surface view north.



b. Plan view.

Figure 105. Sample Unit 364/4335.

milkweed, blazing star, globemallow, paintbrush, Indian ricegrass, cheatgrass, and bottlebrush squirreltail also present. An obsidian biface thinning flake and a chert biface fragment lie in this sample unit.

Habitat Type 38

Sample Unit 356/4334 (Figure 106) is within the southern portion of Bravo 19 at the base of the Blow Sand Mountains, overlooking Rawhide Flats to the southwest. Sand sheets and dunes cap the gradual slope but some exposed basaltic stripes appear in the northern extreme. Incipient drainages cross the quadrat, flowing southwest. Elevation ranges from 1225 meters (4020 ft amsl) at the northeast corner down to 1190 meters (3904 ft amsl) in the southwest. Heavy military bombardment has disturbed the sample unit. Bailey's and black greasewood, hopsage, seepweed, iodine bush, annual saltbush, and Russian thistle grow here. The sample unit contains two sparse lithic scatter sites and three isolated finds of which the latter include a biface fragment, a utilized flake tool, and a biface thinning flake, all of local chert. Both sites are sparse lithic scatters, with only 4723 containing formed tools. The tools include a basalt milling stone fragment, a quartzite hammerstone, a chert flake tool, and four biface fragments: one of basalt, one of obsidian, and two of chert. Site 4724 contains only local chert flakes.

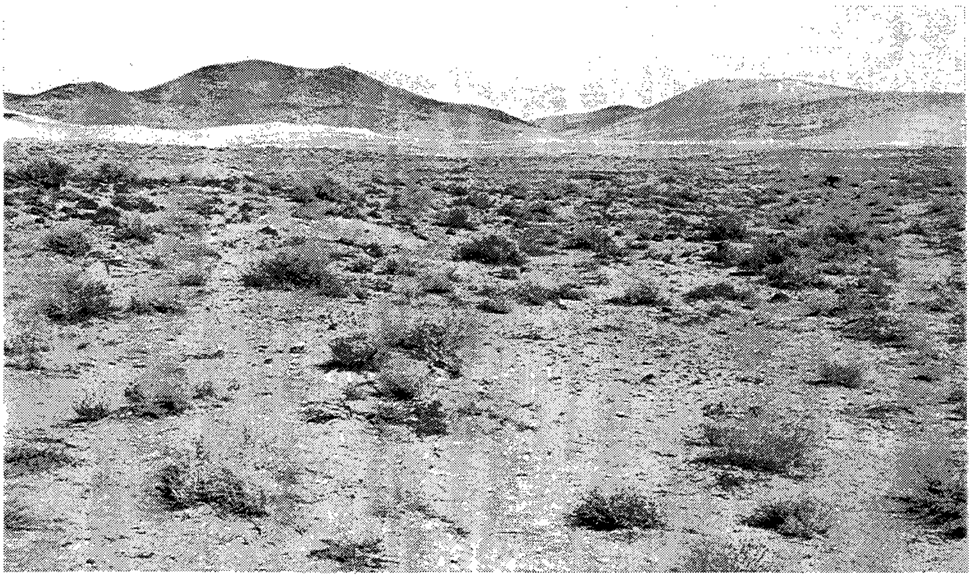
Habitat Types 56, 56c

Sample Unit 403/4367 is in the proposed northeastern expansion of Bravo 17, astride both steep peaks of Pirouette Mountain. With elevations ranging from 1527 meters (5010 ft amsl) in the west, down to 1402 meters (4600 ft amsl), and back up to 1546 meters (5072 ft amsl) on the eastern edge, this sample unit exhibited the steepest relief we encountered. Exposed basalt bedrock and boulders cap ridges and knolls, colluvial talus caps ridge slopes, and gravelly alluvium appears in steeply entrenched washes. Large, sandy aeolian dunes occur in the northern portion of the unit. Bailey's greasewood dominates slopes and ridges, while horsebrush and Indian ricegrass grow on dunes. A small patch of big sagebrush clings to the upper eastern slopes of Pirouette Mountain. Rabbitbrush, Mormon tea, spiny hopsage, budsage, snakeweed, prickly pear, buckwheat, Russian thistle, prince's plume, and cheatgrass were all observed but archaeological remains were not.

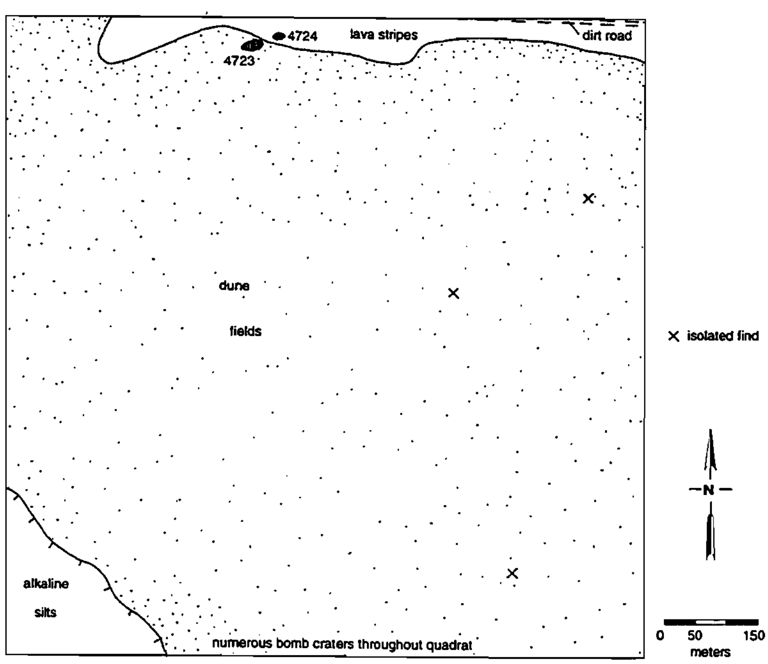
Sample Unit 403/4369 (Figure 107) is located on the proposed eastern expansion of Bravo 17. It lies on the west flank of the Louderback Mountains, north of Pirouette Mountain and east of Dixie Valley wash. Primary landforms are mountain ridges and knolls capped by basaltic bedrock. A broad intermittent wash and dissected alluvial fan occur in the southwest portion of the quad. Basaltic talus covers most slopes, a gravelly pavement armors alluvial fan surfaces, and sandy alluvium lines drainage bottoms. Elevations range from 1280 meters (4200 ft amsl) to 1408 meters (4620 ft amsl). Bailey's greasewood, shadscale, rabbitbrush, Mormon tea, horsebrush, prickly pear, globemallow, and Indian ricegrass grow in the sample unit. Two isolated projectile points fragments, both Elko Series, one of black obsidian and the second of white chalcedony, were recorded here.

Archaeological Site Types and Patterns

Here, for descriptive purposes, we characterize archaeological assemblages observed in the 1993 and 1994 samples. We rely on the set of site types devised by Raven (1990:89-95), having modified and clarified selected definitions and classificatory criteria. We distinguish four categories of sites based on the presence or absence of identifying attributes: sites with features, lithic scatters with ground stone artifacts, lithic scatters without ground stone, and isolated artifacts. Sites with features, of course, always contain evidence of features, lithic scatters with ground stone always contain ground stone artifacts associated with chipped stone remains but never exhibit features, and lithic scatters always

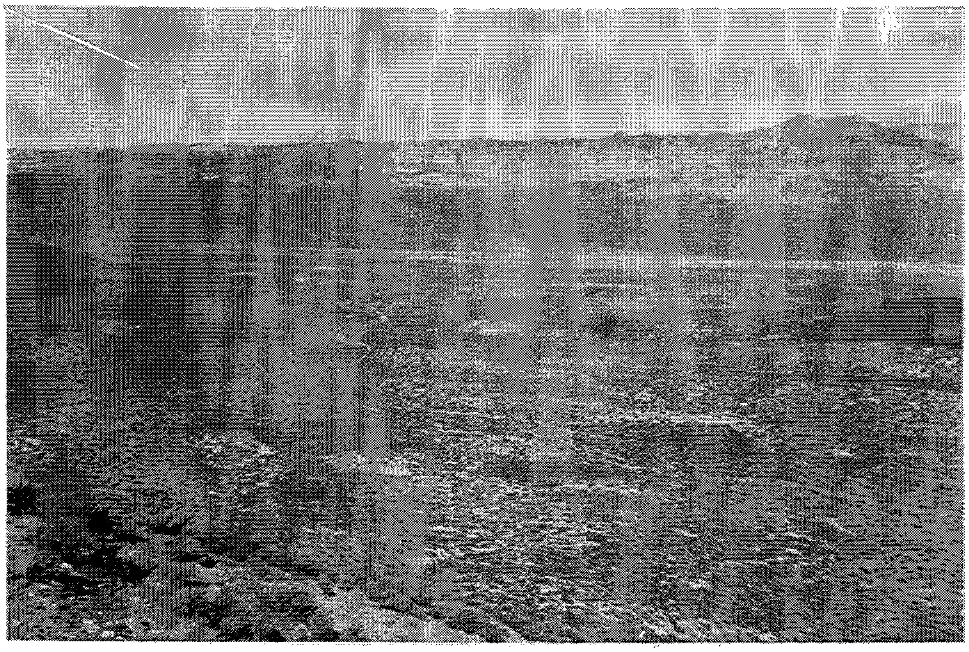


a. Surface view northeast.

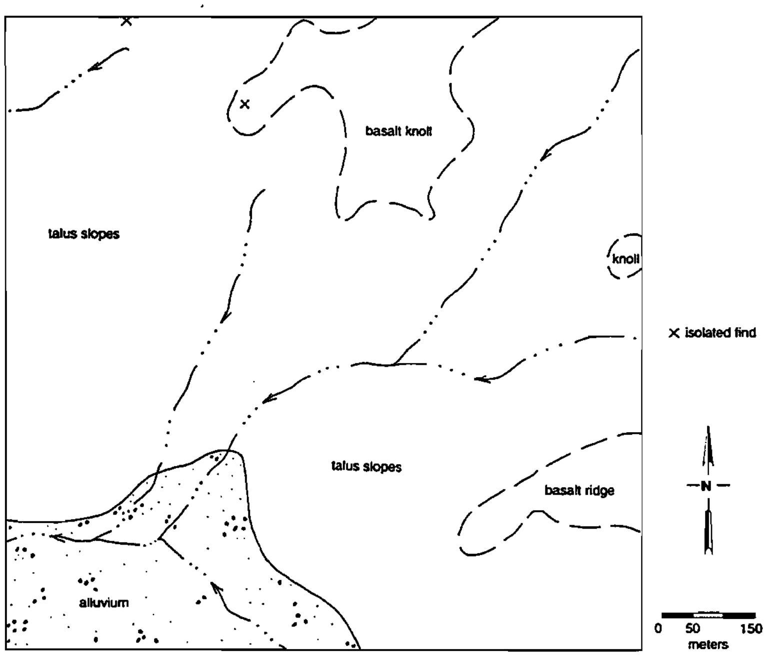


b. Plan view.

Figure 106. Sample Unit 356/4334.



a. Surface view west.



b. Plan view.

Figure 107. Sample Unit 403/4369.

have chipped stone artifacts but never features or ground stone tools. These three categories are subdivided into large and small variants based on the debitage assemblage size and on areal extent of the site. Sites with 25 or fewer flakes always are classified as small, while sites with 100 or more flakes are always large, regardless of areal site size. Cases with 26 to 100 flakes are classified small if they are 1000 square meters or less in area, large if otherwise. Isolates are subdivided to four types as exemplifying projectile points, chipped stone artifacts, ground stone tools, or debitage. (No examples of a 'storage facilities' site type containing circular pit features with few or no associated artifactual materials were found in the 1993/1994 sampling areas.)

Large Sites with Features

Features observed in the 1993 and 1994 surveys were concentrations of fire-altered rock or ground stone, or charcoal stains representing hearths with or without rock-lined firepits. Middens, storage pits, and burials observed in the earlier Stillwater sample (Raven 1990) were not apparent elsewhere. The features we encountered typically suggest long-term residential location.

We recorded five large sites with features (Table 45). The features range from a possible hearth at 4627 to more than 20 rock concentrations of ground stone or fire-altered rock and two charcoal stains at 4720. Lithic debris and formed tools are plentiful at these sites, as usually are a high frequency and diversity of ground stone tools. They often contain concentrations or clusters of artifacts or features, and artifacts such as beads or other items unrelated to subsistence; Figure 108 is examplary. All but 4627 contain diagnostic projectile points, bifaces and at least one other class of chipped stone tool, and both milling stones and manos. Other artifacts, such as shell beads at 4623, crystal manuports at 4721, and tule knives at 4720 and 4721, further illustrate the multifunctional assemblages typical of this site type. Site areas range from 3450 square meters at 4627 to 12250 square meters at 4619. Both 4619 and 4627 exhibit between 26 and 100 specimens of debitage, while the remaining three cases exhibit more than 500.

Small Sites with Features

All three small sites with features (Table 45) contain only one or two surface features and no more than 25 pieces of debitage, yet are larger than 2000 square meters in areal extent. Ground stone is present at all three, but scarce. We observed one projectile point at 4624 and chipped stone tools (two bifaces, a drill, and a uniface) only at 4645. A mano/hammerstone multipurpose tool at 3532 represents the only non-chipped stone tool recorded at these sites.

Large Lithic Scatters with Ground Stone

Lithic scatter sites with ground stone differ from large sites with features solely in their apparent lack of features and the requirement that they contain ground stone. While subsurface or destroyed surface features (products of site taphonomy and preservation) may be undiscovered elements of these sites, these sites may have functioned without hearth, burial, or storage facilities. Typically, ground stone is less frequent on these sites than on sites with features. Although chipped stone debris can be quite dense at these sites, there generally is less assemblage diversity than at feature sites. Of the five large lithic scatters with ground stone (Table 46), only one (4722) contained more than one piece of ground stone and more than a few bifaces only at 4655. Site 4655 (Figure 109), the second largest site we recorded, included 45 bifaces, a drill, six projectile points, a one non-portable milling stone set on a granitic boulder. Site 4646 yielded only two bifaces and a mano, with one mano and no lithic tools at all at 4652. Site 4722 contained nine milling stones and three biface fragments, and 4648 revealed a single ground chalcedony ornament.

Table 45. Sites with Residential Features.

Sample Unit	Site No.	Habitat No.	Projectile Points: Desert Series	Rosegate Series	Elko Series	Gatecliff Series	Large Side-Notched	Great Basin Stemmed	Humboldt Series	Other	Other Chipped Stone Tools: Biface	Drills/Perforators	Flake Tools	Scrapers	Unifaces	Cores	Debitage	Ground Stone: Manos	Milling Stones	Pestles	Mortars	Slab Metates	Non-Portable GST	Other GST	Other Tools: Hammerstones	Tule Knives	Shell Beads	Other Shell	Quartz Crystals	Features	Site Area (m2)
Large Sites with Features																															
340/4353	4619	3	0	0	0	1	0	0	0	0	1	0	1	0	0	0	25-100	3	7	0	0	0	0	2	0	0	0	0	0	5	12250
340/4353	4623	3	0	5	1	0	0	0	0	3	2	2	0	0	0	2	500+	2	2	0	0	0	0	0	0	0	12	0	0	5	49000
340/4361	4627	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25-100	0	3	0	0	0	0	0	0	0	0	0	0	1	3450
388/4346	4720	3a	0	1	2	0	0	0	0	0	3	0	12	0	0	0	500+	1	27	1	0	0	0	0	1	1	0	0	0	20+	52500
388/4346	4721	3a	0	1	2	0	0	0	1	6	45	1	28	2	2	1	500+	11	30	1	1	0	0	0	7	2	0	1	2	2	750000
	Total	0	7	5	1	0	0	1	9	51	3	41	2	2	3		17	69	2	1	0	0	2	8	3	12	1	2	33+		
Small Sites with Features																															
340/4361	4624	11	0	1	0	0	0	0	0	0	0	0	0	0	0	0	10-25	2	1	0	0	0	0	2	0	0	0	0	0	1	2240
349/4336	3532	20b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1-9	1*	2	0	0	0	0	0	0	0	0	0	0	2	9110
391/4349	4645	11	0	0	0	0	0	0	0	0	2	1	0	0	1	0	10-25	0	2	0	0	0	0	0	0	0	0	0	0	1	4000
	Total	0	1	0	0	0	0	0	0	2	1	0	0	1	0		3	5	0	0	0	0	2	0	0	0	0	0	4		

*Mano is end battered as if a hammerstone.

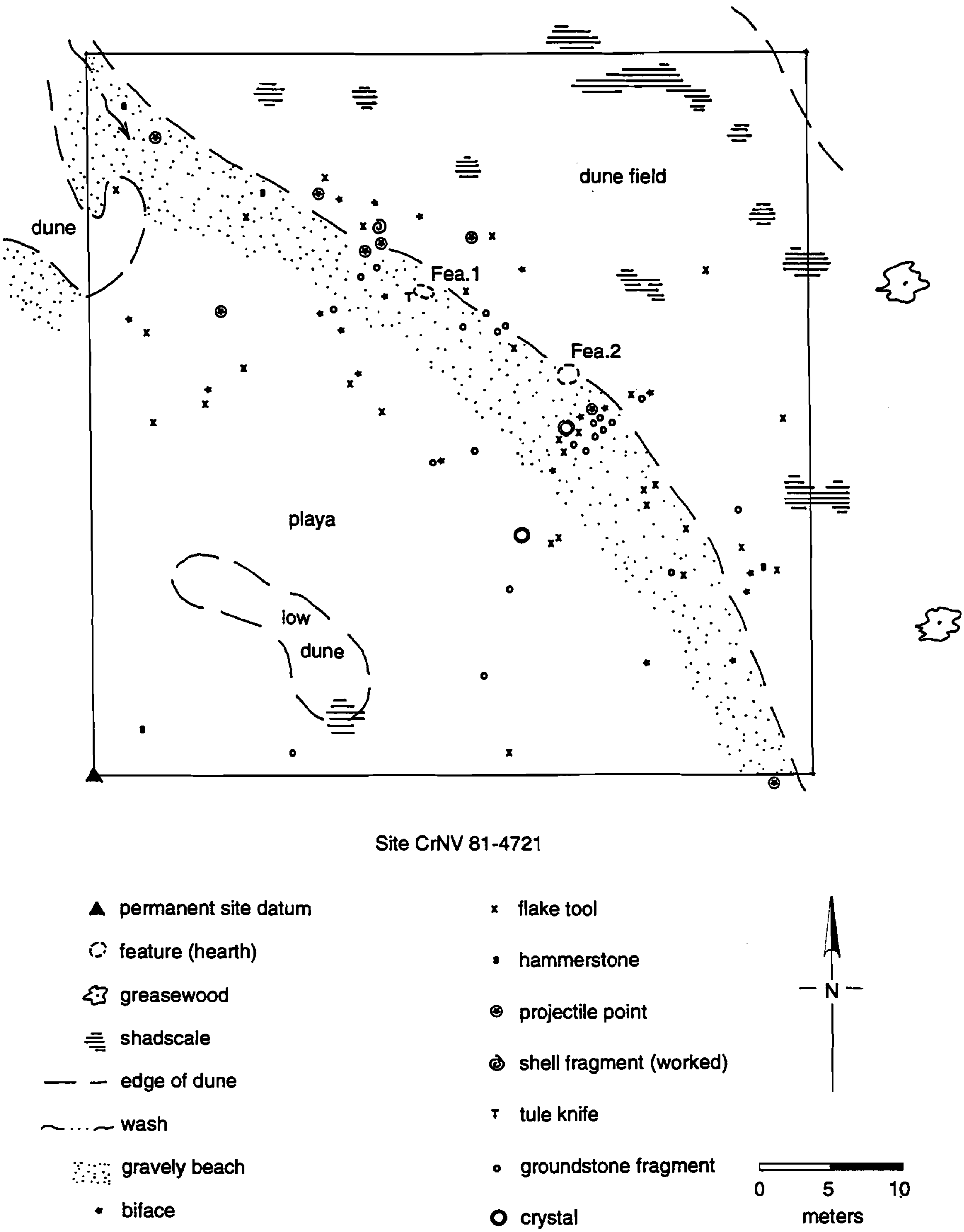


Figure 108. Map of a northeastern 50 meter by 50 meter area of feature and tool concentration at site 4621.

Table 46. Lithic Scatters with Ground Stone.

Large Lithic Scatters with Ground Stone

Sample Unit	Site No.	Habitat No.	Projectile Points: Desert Series	Rosegate Series	Elko Series	Other	Other Chipped Stone Tools: Biface	Drills/ Perforators	Scrapers	Unifaces	Cores	Debitage	Ground Stone: Manos	Milling Stones	Non-Portable GST	Other FST	Other: Hammer-stones	Site Area (m2)
388/4346	4722	3a	0	0	0	0	3	0	0	0	0	100-500	0	9	0	0	0	20000
391/4349	4646	11	0	0	0	0	2	0	0	0	0	25-100	1	0	0	0	0	1080
391/4349	4648	11	0	0	0	0	3	1	0	0	0	100-500	0	0	0	0	1*	15700
392/4331	4652	10b	0	0	0	0	0	0	0	0	0	500+	1	0	0	0	0	3000
392/4331	4655	10b	1	1	1	3	45	1	0	0	2	500+	0	0	1	0	0	290000
		Total	1	1	1	3	53	2	0	0	2		2	9	1	0	1	

Small Lithic Scatters with Groundstone

Sample Unit	Site No.	Habitat No.	Desert Series	Rosegate Series	Elko Series	Other	Biface	Drills/ Perforators	Scrapers	Unifaces	Cores	Debitage	Manos	Milling Stones	Non-Portable GST	Other FST	Hammer-stones	Site Area (m2)
340/4353	4618	3	0	0	0	0	3	0	0	0	1	1-9	1	1	0	1	0	11200
340/4353	4620	3	0	0	0	0	0	0	0	0	0	1-9	1	1	0	0	0	824
340/4353	4622	3	0	0	0	0	0	0	0	0	0	1-9	1	1	0	0	0	1
340/4361	4626	11	0	1	0	0	0	0	0	1	0	10-25	0	1	0	0	0	1400
356/4334	4723	38	0	0	0	0	2	0	2	1	0	10-25	0	1	0	0	1	500
		Total	0	1	0	0	5	0	2	2	1		3	5	0	1	1	

*chalcedony net weight/possible pendant

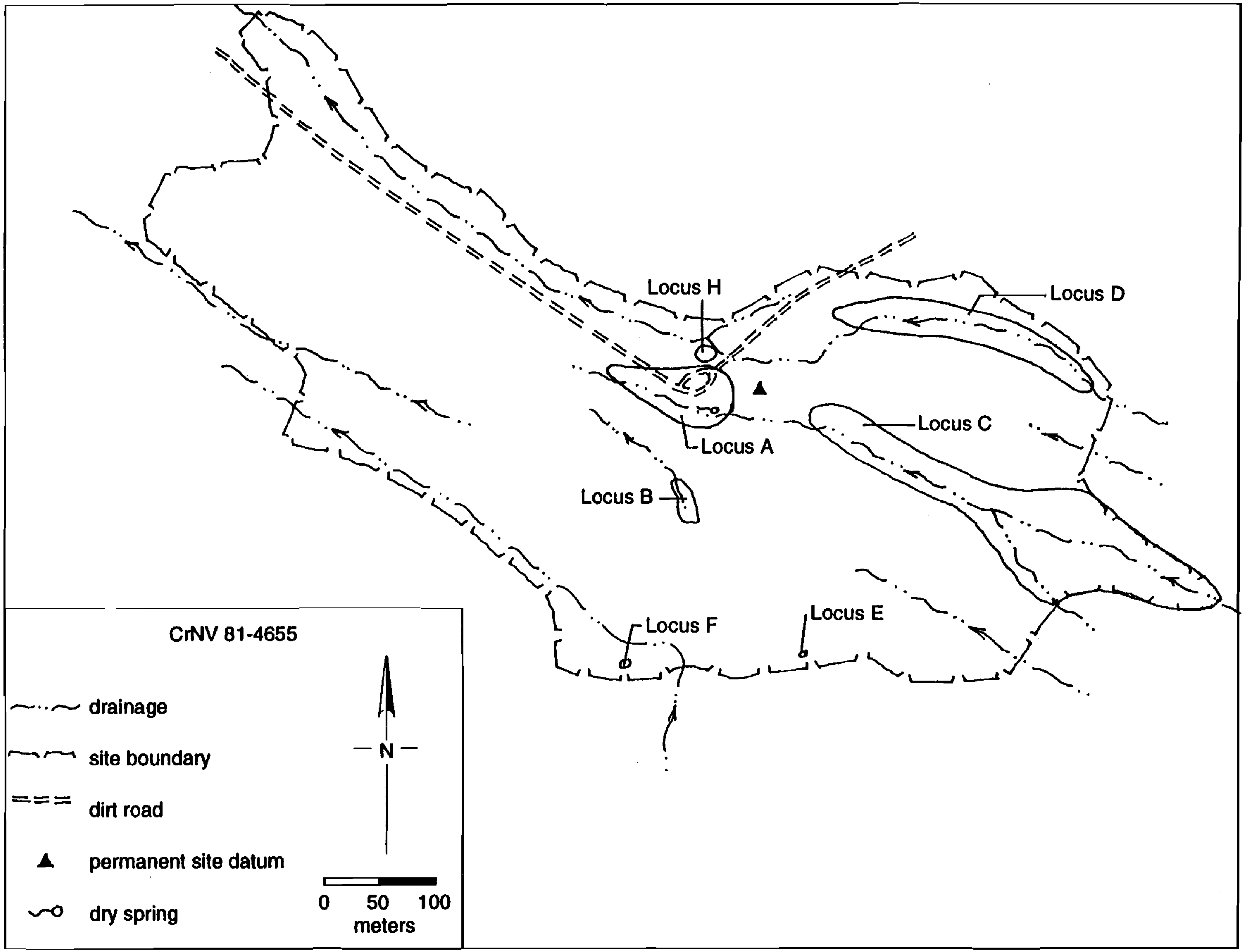
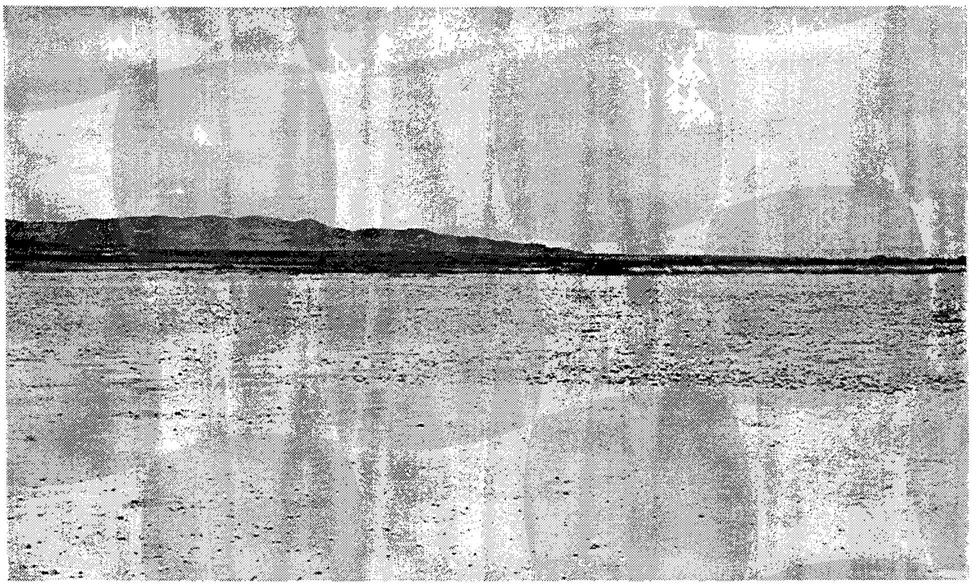
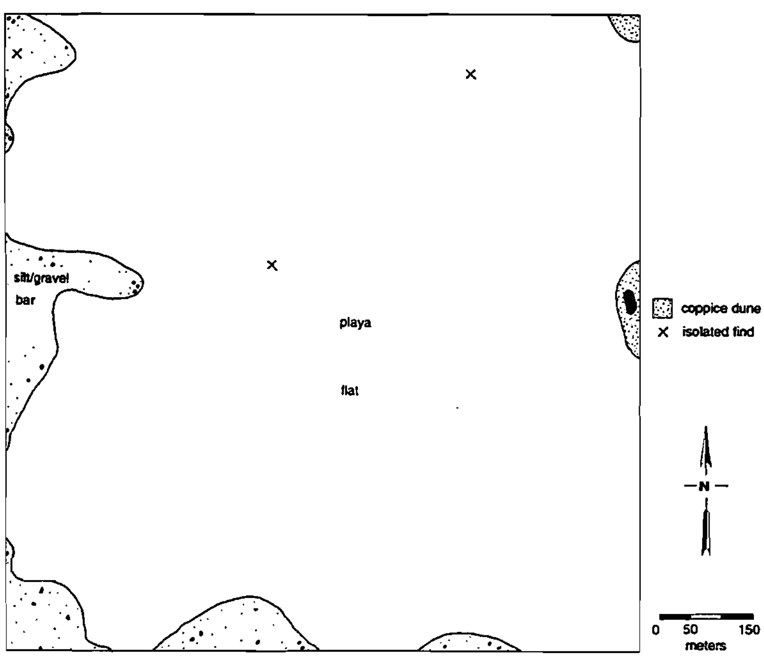


Figure 109. Map of site 4655.



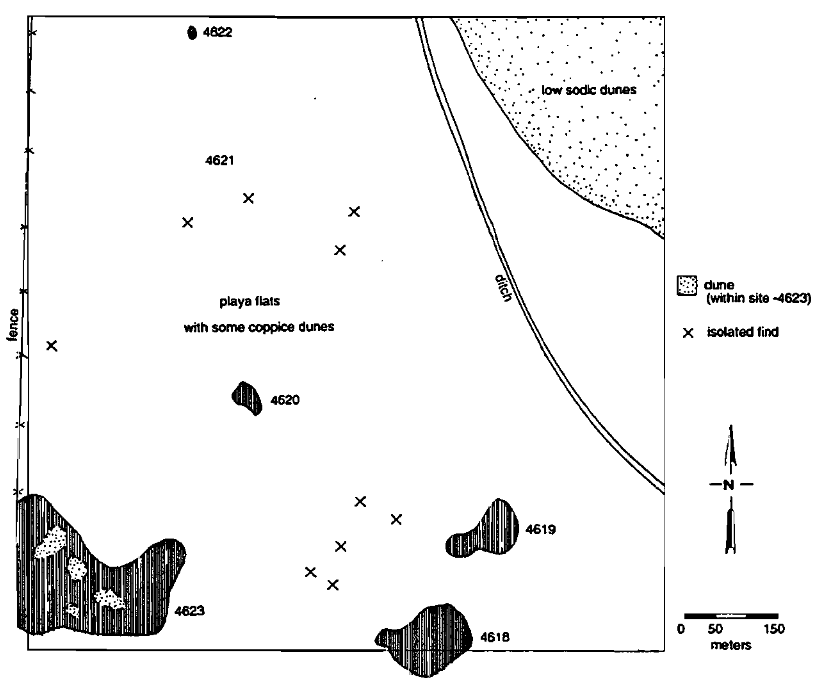
a. Surface view northwest.



b. Plan view.

Figure 84. Sample Unit 338/4352.

a. Surface view north.



b. Plan view.

Figure 85. Sample Unit 340/4353.

Small Lithic Sites with Ground Stone

These five sites (Table 46) contained from one to three pieces of ground stone. Only one projectile point, was observed, a Rosegate Series point at 4626. Sites 4618 and 4626 contained a few bifacally or unifacially formed tools. A couple of flakes, one mano, and one milling stone fragment define 4620 and 4622. 4723 revealed the most tool variety, including two bifaces, two scrapers, a uniface, and a hammerstone along with one milling stone fragment.

Large Lithic Scatters

Large lithic scatters consist of more than 25 chipped stone flakes in an area bigger than 1000 square meters. In two cases, however, we have classified as "large" sites with more than 100 pieces of debitage in an area slightly smaller than 1000 square meters.

We recorded 21 large lithic scatters (Table 47). Although formed artifacts can be common at these sites, most remain sparse in their assemblage diversity. Non-subsistence tools are rare. Cores are common, especially as expedient, locally abundant cobbles or at bedrock toolstone localities. Projectile points frequently are absent from the assemblage. Flake stages range from core reduction to late bifacial thinning, with pressure flakes very rare. The latter is probably due to both expedient tool reduction techniques, evident in cores without platforms and early-stage "clunky" bifaces common at these sites, and to the depositional environment that conceals small pressure flakes. All but three sites had more than 100 total flakes; five (4636, 4649, 4660, 4661 and 4662) evinced well over a thousand flakes scattered over expanses of 25,000 square meters or more. Most of the sites are quite large, with half larger than 7500 square meters. Cores occur at half the sites and bifaces or other formed tools at all but six (4616, 4647, 4651, 4656, 4661 and 4662). Other than bifaces, formed tools uncommon to most sites. Of the ten projectile points recorded at sites of this type, five are from 4636; seven of the nine flake tools were observed at 4731.

Three sites containing Great Basin Stemmed projectile points (4636, 4664 and 4665) are located on desert pavement surfaces with little or no potential for buried deposits. Site 4636 (Figure 110) extends over a pair of knolls immediately north of Diamond Field Jack Wash, a wide, sandy-bottom, entrenched drainage. Three typeable projectile points from this site include two Great Basin Stemmed and a concave-base Humboldt Series. Two point fragments with large collateral flake scars may represent additional stemmed points at this site. All except the Humboldt point are obsidian and debitage of this material dominates a southern portion of the northern knoll.

Sites 4664 and 4665 are on low ridges overlooking the northern end of Labou Flat just above the outflow of pluvial Lake Labou into Dixie Valley. Each site contains one Great Basin Stemmed projectile point. We recorded a scraper at the smaller 4664, and three scrapers, a flake tool, two unifaces, and eight bifaces at the larger 4665. Lithics at both sites include a variety of materials not common at other lithic scatters in our sample, including basalt, rhyolite, obsidian, and chalcedony, along with the cryptocrystalline silicates common at most sites.

Small Lithic Scatters

This site type comprises just over fifty-one percent (n=31) of all sites recorded, excluding isolated finds. Bifaces and cores occur at several, but are less common than at large lithic scatters. Projectile points, scrapers, and flake tools are all rare (Table 47). Various activities are likely have lead to creation of an archaeological record characteristic of small lithic scatter composition: butchering stations, hunting localities, loci of tool manufacture or expedient repair, or a briefly used campsite all could leave archaeological remnants fitting the definition of this site type.

Table 47. Lithic Scatters.

Large Lithic Scatters

Sample Unit	Site No.	Habitat No.	Projectile Points: Rosegate Series	Elko Series	Gatecliff Series	Great Basin Stemmed	Humboldt Series	Other	Other Chipped Stone Tools: Biface	Drills/ Perforators	Flake Tools	Scrapers	Unifaces	Cores	Debitage	Other Artifacts	Site Area (m^2)
338/4352	4731	3	0	0	0	0	0	0	2	0	7	0	0	4	25-100	0	1500
366/4336	4635	10	0	0	0	0	0	0	3	0	0	0	0	0	100-500	0	11000
366/4336	4636	10	0	0	0	2	1	2	17	0	0	0	0	3	500+	0	25500
389/4342	4712	10	0	1	0	0	0	0	1	0	0	1	0	0	25-100	0	1400
393/4355	4664	10	0	0	0	1	0	0	0	0	0	1	0	1	100-500	0	1300
393/4355	4665	10	0	0	0	1	0	0	8	0	1	3	2	5	500+	0	7500
392/4331	4651	10b	0	0	0	0	0	0	0	0	0	0	0	0	100-500	0	2000
392/4331	4654	10b	0	0	0	0	0	0	6	0	0	0	0	12	500+	0	23000
392/4331	4656	10b	0	0	0	0	0	0	0	0	0	0	0	0	100-500	0	3500
392/4331	4658	10b	0	0	1	0	0	0	0	0	0	0	0	0	100-500	0	13000
392/4331	4660	10b	0	0	0	0	0	0	4	0	0	0	0	3	500+	0	30000
392/4331	4661	10b	0	0	0	0	0	0	0	0	0	0	0	2	500+	0	50000
392/4331	4662	10b	0	0	0	0	0	0	0	0	0	0	0	1	500+	0	33000
334/4362	4615	11	0	0	0	0	0	0	2	0	0	0	0	2	100-500	0	5670
334/4362	4616	11	0	0	0	0	0	0	0	0	0	0	0	3	100-500	0	7460
334/4362	4617	11	0	0	0	0	0	0	4	0	0	0	0	5	100-500	0	22460
340/4361	4628	11	0	0	0	0	0	0	0	0	1	0	0	0	100-500	0	3200
389/4341	4718	11	0	0	0	0	0	0	7	0	0	0	0	0	100-500	0	880
391/4349	4647	11	0	0	0	0	0	0	0	0	0	0	0	0	25-100	0	5675
391/4349	4649	11	1	0	0	0	0	0	10	0	0	0	0	0	500+	0	102000
395/4350	4666	16	0	0	0	0	0	0	1	0	0	0	0	0	100-500	0	785
		Total	1	1	1	4	1	2	65	0	9	5	2	41		0	

*chalcedony net weight/possible pendant

Table 47. Lithic Scatters, continued.

Small Lithic Scatters

			Projectile Points						Other Chipped Stone Tools								
Sample Unit	Site No.	Habitat No.	Rosegate Series	Elko Series	Gatecliff Series	Great Basin Stemmed	Humboldt Series	Other	Biface	Drills/ Perforators	Flake Tools	Scrapers	Unifaces	Cores	Debitage	Other Artifacts	Site Area (m²)
336/4353	4725	3	0	0	0	0	0	0	0	0	2	0	0	1	10-25	0	700
366/4336	4632	10	0	0	0	0	0	0	0	0	0	0	0	3	25-100	0	11
366/4336	4633	10	0	0	0	0	0	0	0	0	0	0	0	0	25-100	0	410
366/4336	4634	10	0	0	0	0	0	0	0	0	0	0	0	0	10-25	0	140
366/4336	4638	10	0	0	0	0	0	0	0	0	0	0	0	1	10-25	0	4
388/4335	4640	10	0	0	0	0	0	0	0	0	0	0	0	0	10-25	0	400
390/4342	4713	10	0	0	0	0	0	0	3	0	0	0	0	0	1-9	0	150
390/4342	4716	10	0	0	0	0	0	0	1	0	1	0	0	0	25-100	0	200
390/4334	4641	10	0	1	0	0	0	0	1	0	0	0	0	0	10-25	0	12950
392/4331	4653	10b	0	0	0	0	0	0	1	0	0	0	0	0	10-25	0	1800
392/4331	4657	10b	0	0	0	0	0	0	0	0	0	0	0	0	25-100	0	900
392/4331	4659	10b	0	0	0	0	0	0	1	0	0	0	0	1	10-25	0	2
334/4362	4613	11	0	0	0	0	0	0	0	0	0	0	0	0	10-25	0	830
334/4362	4614	11	0	0	0	0	0	0	1	0	0	0	0	1	10-25	0	1570
335/4356	4726	11	0	0	0	0	0	0	0	0	0	0	0	1	10-25	0	3535
335/4356	4727	11	0	0	0	0	0	0	1	0	0	0	0	0	10-25	0	375
335/4356	4728	11	0	0	0	0	0	0	0	0	0	0	0	3	25-100	0	210
335/4356	4729	11	0	0	0	0	0	0	2	0	0	0	0	0	10-25	0	17
335/4356	4730	11	0	0	0	0	0	0	3	0	2	0	0	6	10-25	0	6090
340/4361	4625	11	0	0	0	0	0	0	2	0	1	0	0	0	1-9	0	785
389/4341	4717	11	0	0	0	0	0	0	0	0	0	0	0	0	25-100	0	85
389/4341	4719	11	0	0	0	0	0	0	1	0	0	0	0	0	25-100	0	115
391/4349	4644	11	1	0	0	0	0	0	0	0	0	0	0	0	1-9	0	450
391/4349	4650	11	1	0	0	0	0	0	1	0	0	0	0	0	1-9	0	440
392/4355	4663	16	0	1	0	0	0	0	2	0	0	0	0	0	10-25	0	295
395/4350	4667	16	0	0	0	0	0	0	0	0	0	0	0	0	25-100	0	188
395/4350	4668	16	0	0	0	0	0	0	1	0	0	0	0	0	25-100	0	280
395/4350	4669	16	0	0	0	0	0	0	2	0	0	1	0	0	25-100	0	188
400/4369	4672	21	0	0	0	0	0	0	0	0	0	0	0	0	10-25	0	390
364/4335	4631	37	0	0	0	0	0	0	0	0	0	0	0	2	25-100	0	8
356/4334	4724	38	0	0	0	0	0	0	0	0	0	0	0	0	10-25	0	200
		Total	2	2	0	0	0	0	23	0	6	1	0	19		0	

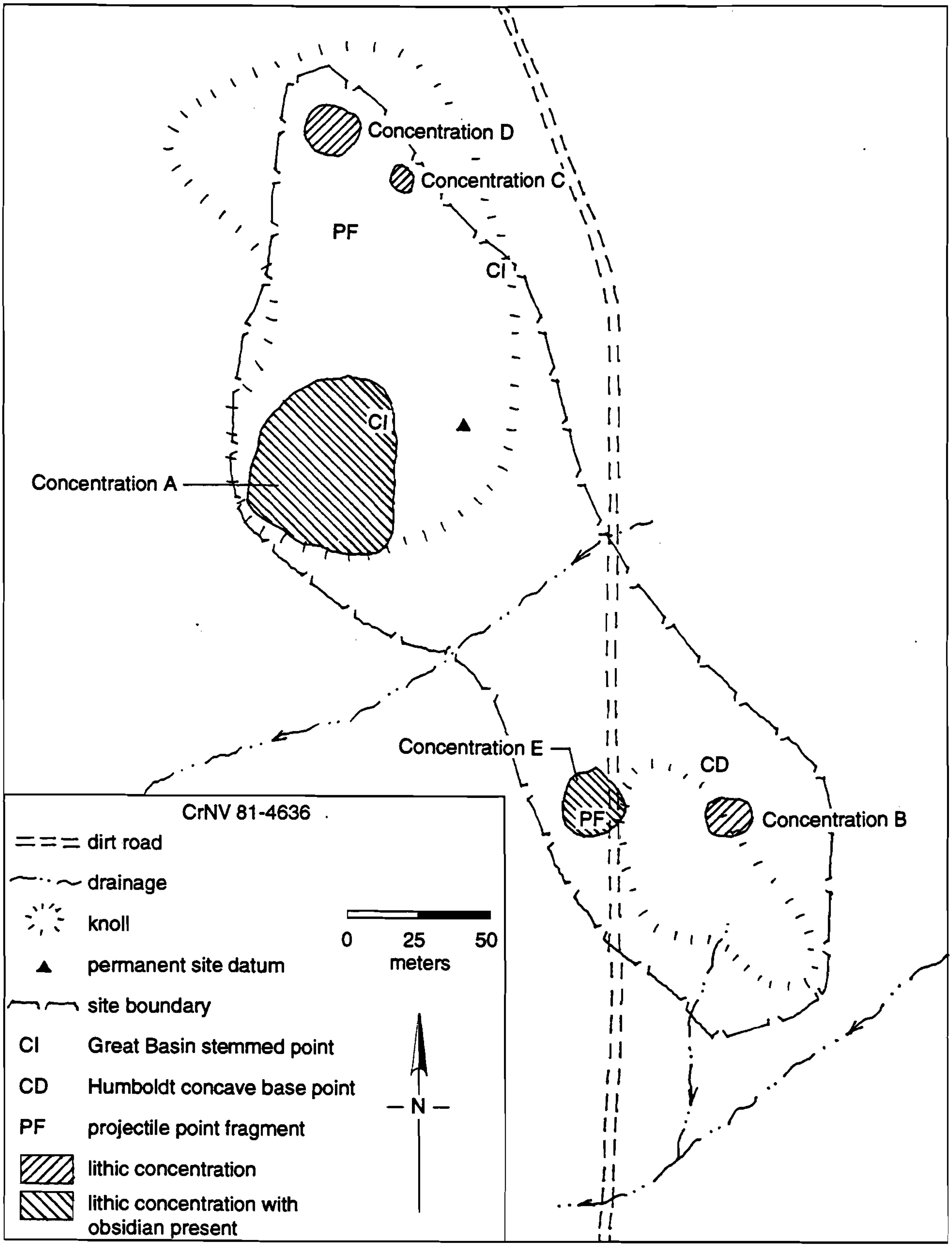


Figure 110. Map of site 4636.

Isolated Projectile Points

We recorded five projectile points (Table 48) isolated from other cultural material, finding them anywhere from barren playa to mountaintops. Two projectiles, a Desert Series and an Elko Series, were recorded on the south side of Lone Rock in the center of the Carson Sink. They apparently were exposed by modern munitions explosion. Farther away, among the historic remains of the Wonder Mining District, field crews recorded two isolated Elko Series points on ridges above steep, dissected slopes. Finally, one Great Basin Stemmed point was recorded far to the south on a gravel armored piedmont slope.

Table 48. Isolated Projectile Points.

Sample Unit	Site No.	Habitat No.	Projectile Points: Desert Series	Elko Series	Great Basin Stemmed	Site Area(m^2)
385/4412	16-1(i)	2	1	0	0	1
385/4412	16-2(i)	2	0	1	0	1
364/4335	10-5(i)	37	0	0	1	1
403/4369	43-2(i)	56	0	1	0	1
403/4369	43-1(i)	56	0	1	0	1
		Total	1	3	1	

Isolated Formed Chipped Stone Tools

The discard or loss of other types of formed chipped stone tools appears in higher frequency than for projectile points; of 25 isolated tools (Table 49), including a hammerstone, nearly half were observed in three quadrats (388/4346, 336/4353, 340/4353). Bifaces are by far the most common isolated formed tool, representing 60 percent of all isolated formed tools including projectile points, the converse of a higher frequency of projectile point loss recorded in the Stillwater sample area (Raven 1990:94). Of the total 415 formed tools recorded on sites in the 1993/1994 sample, about 60 percent are bifaces (including projectile points). Thus, isolated artifact loss or discard in our sample roughly parallels on-site tool disposal or loss.

Table 49. Isolated Formed Chipped Stone Tools.

Sample Unit	Site No.	Habitat No.	Bifaces	Flake Tools	Cores	Hammerstones	Site Area (m^2)
336/4353	10-1(i)	3	0	1	0	0	1
336/4353	10-3(i)	3	0	0	1	0	1
336/4353	10-9(i)	3	0	1	0	0	1
338/4352	12-2(i)	3	1	0	0	0	1
340/4353	4-2(i)	3	0	0	1	0	1
340/4353	4-6(i)	3	1	0	0	0	1
340/4353	4-8(i)	3	0	1	0	0	1
340/4353	4-9(i)	3	1	0	0	0	1
388/4346	3-4(i)	3a	1	0	0	0	1
388/4346	3-5(i)	3a	1	0	0	0	1
388/4346	3-7(i)	3a	1	0	0	0	1
388/4346	3-1(i)	3a	1	0	0	0	1
388/4346	3-2(i)	3a	0	0	0	1	1
393/4356	28-1(i)	10	1	0	0	0	1
334/4362	3-14(i)	11	1	0	0	0	1
335/4356	11-4(i)	11	1	0	0	0	1
340/4361	5-3(i)	11	1	0	0	0	1
389/4341	2-3(i)	11	1	0	0	0	1
391/4349	24-4(i)	11	1	0	0	0	1
350/4334	7-3(i)	16	0	0	1	0	1
395/4350	30-1(i)	16	1	0	0	0	1
394/4333	29-1(i)	37c	1	0	0	0	1
398/4333	34-3(i)	37c	1	0	0	0	1
356/4334	8-1(i)	38	1	0	0	0	1
356/4334	8-2(i)	38	0	1	0	0	1
		Total	17	4	3	1	

Isolated Ground Stone

Isolated occurrences of ground stone (Table 50), considered here to be three or fewer total artifacts, are rare at 11 occurrences in five quadrats. Two sample units contain most (n=8), of which both also contain three or more sites with ground stone. The three remaining pieces of ground stone were from sample units of various habitats, all with dunes or gravelly beaches. No upland ground stone was recorded.

Table 50. Isolated Ground Stone.

				Ground Stone				
Sample Unit	Site No.	Habitat No.	Debitage	Manos	Milling Stones	Mortars	Slab Metates	Site Area
338/4352	12-1i	3	1	1	0	0	0	1
340/4354	4621	3	0	1	1	1	0	390
340/4354	4-1(i)	3	0	1	0	0	0	1
340/4354	4-3(i)	3	0	0	1	0	0	1
340/4354	4-4(i)	3	0	0	1	0	0	1
340/4354	4-5(i)	3	0	1	0	0	0	1
340/4354	4-7(i)	3	0	1	0	0	0	1
340/4354	4-10(i)	3	0	0	1	0	0	1
388/4346	3-6(i)	3a	0	1	0	0	0	1
340/4361	5-5(i)	11	0	0	1	0	0	1
352/4338	6-1(i)	20	0	0	0	0	1	1
		Total	1	6	5	1	1	

Isolated Chipped Stone Debitage

This isolate type includes occurrences of nine or fewer pieces of chipped stone debris and no tools. We recorded 86 observations, scattered throughout numerous sample units in a variety of habitats. Nearly all manifestations are of locally available cryptocrystalline silicate material; obsidian, basalt, and chalcedony isolates are rare.

It should be noted that we did not record isolated debitage in Sample Units 388/4346 and 340/4353 due to the ubiquity of lithic debris throughout both; here only isolated formed tools and ground stone were recorded.

Temporally Diagnostic Artifacts

Securely dating occupations of surface sites is always problematic in the absence of stratigraphic associations of chronometric assays. Of necessity, temporal assignments must be made from time-sensitive, non-perishable artifacts such as projectile points (Figures 111-113) and shell beads (Figure 114), which are present on only a few sites representing a small portion of habitats we investigated. We rely on the sequence proposed for the Stillwater area of Toedokado territory (Elston, Katzer, and Currey 1988:376-377) in following discussions.

We recorded a total of 50 projectile points, of which 35 are typeable to one of six series: Great Basin Stemmed (Figure 111a-e), Humboldt (Figure 111f, g), Gatecliff (Figure 112a, b), Elko (Figure 112c-m), Rosegate (Figure 113e-q), or Desert (Figure 113a, b). Of the remaining 15 point fragments, most are considered non-diagnostic pieces rather than projectile point bases or entire specimens that fail to fit into objective, or even subjective, classifications. All points were drawn in the field and the illustrations used to type the points according to the Thomas (1981:11-13) key. Examples of typed points appearing in the 1993/1994 sample are shown in Figures 111, 112, and 113).

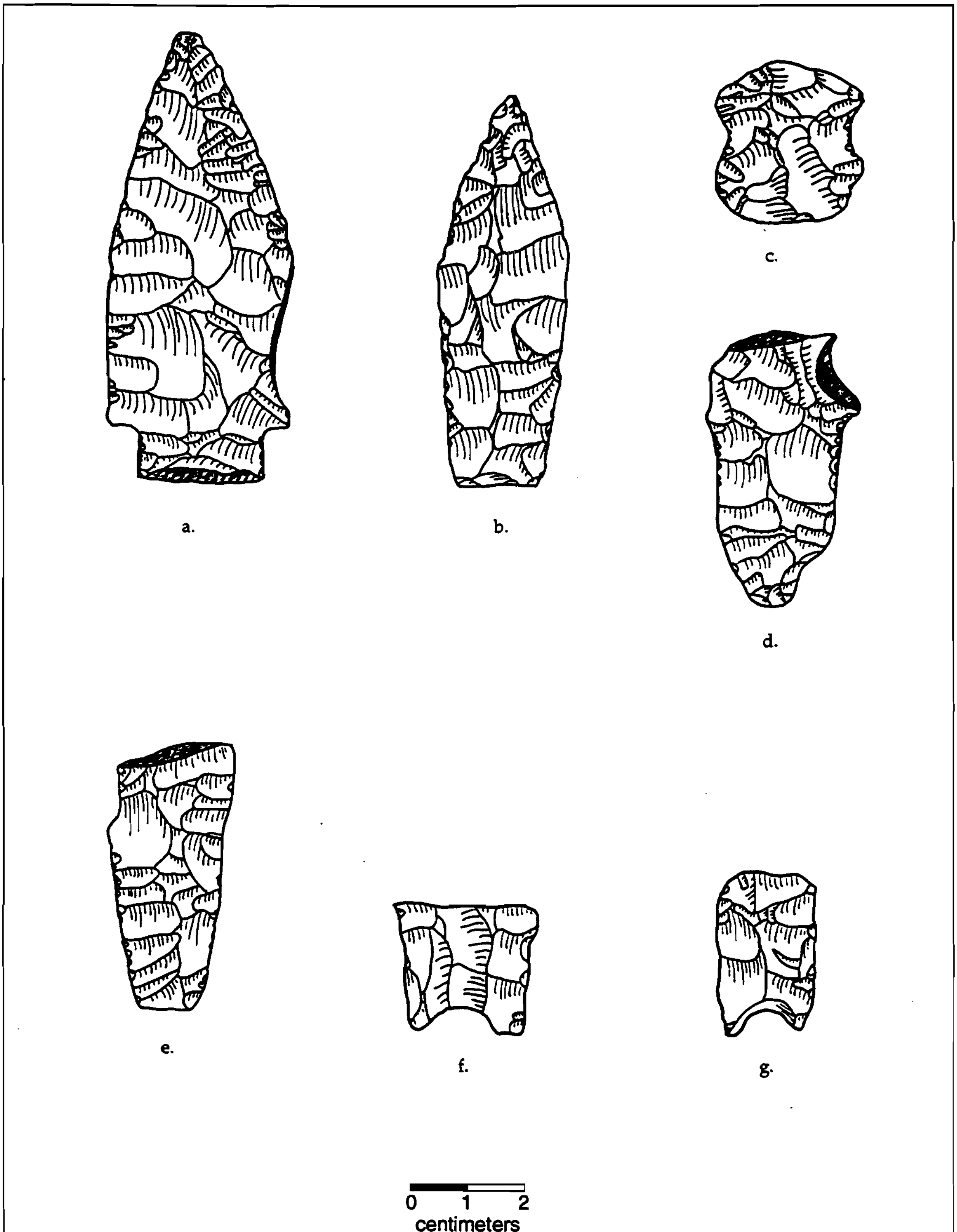


Figure 111. Great Basin Stemmed and Humboldt Series projectile points recorded in 1993 and 1994. a-f. Great Basin Stemmed; g. Humboldt Series.

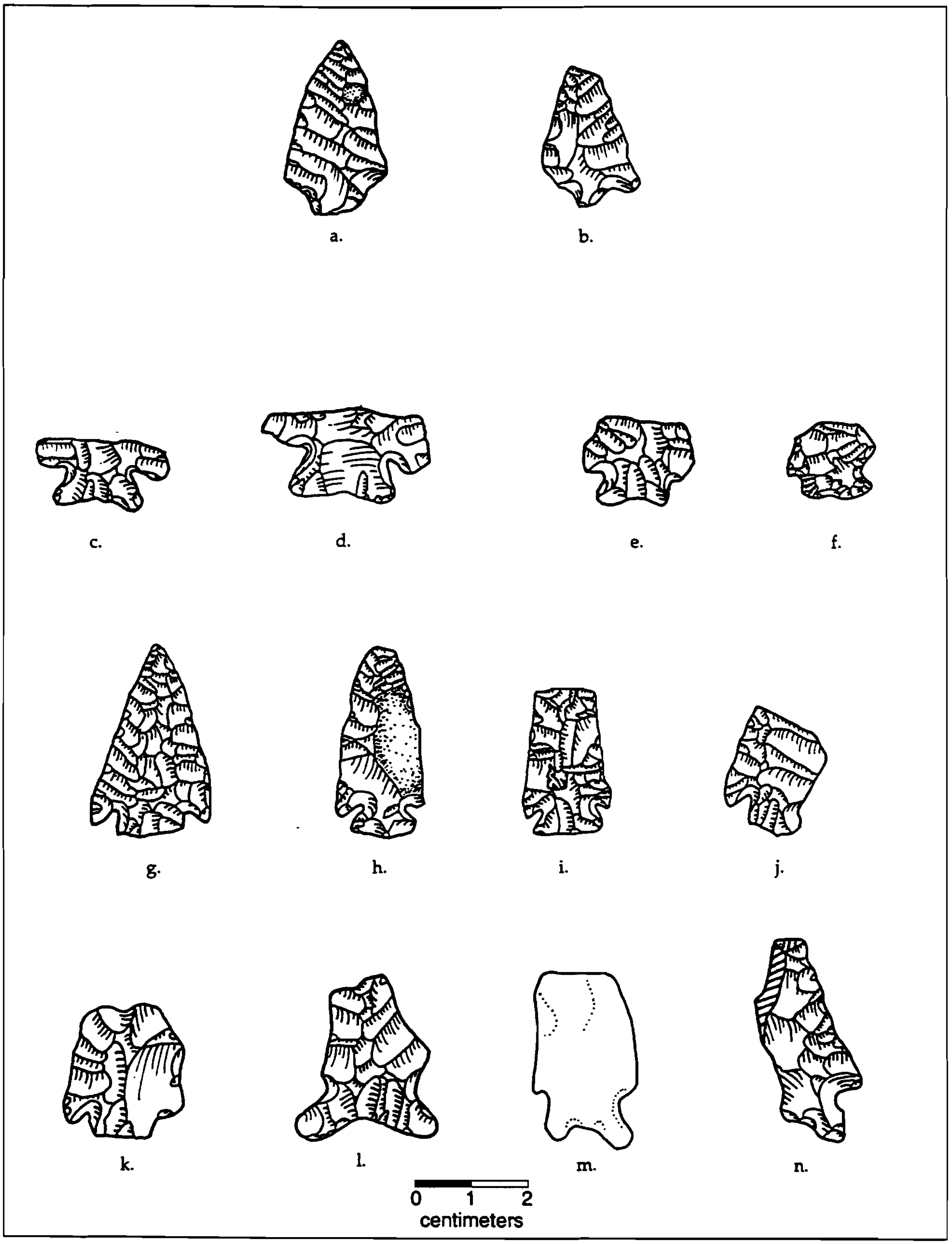


Figure 112. Gatecliff and Elko Series projectile points recorded in 1993 and 1994. a-b. Gatecliff Series; c-n. Elko Series.

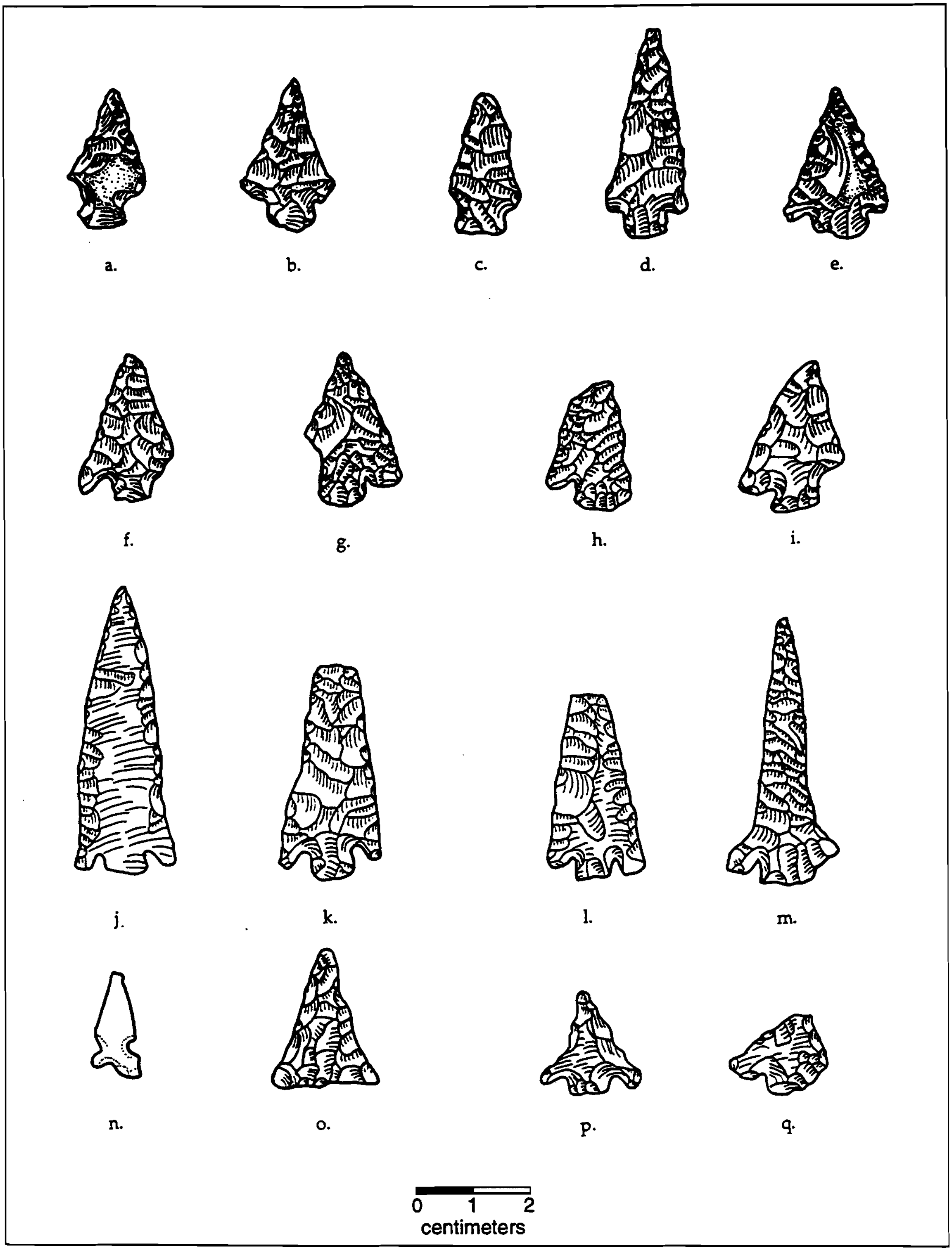
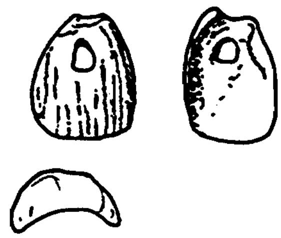
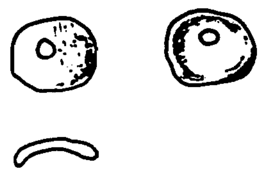


Figure 113. Rosegate and Desert Series projectile points recorded in 1993-1994. a-l. Rosegate Series; m. Rosegate point reworked into a drill; n. Desert Side-Notched; o. Cottonwood Triangular; p-q. out-of-key (Carson variants).



a. Type C5 scoop Olivella pendant (one of seven).



b. Type C2 split drill bead (one of five).

c. Chalcedony pendant (or possible netweight).

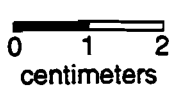


Figure 114. Shell beads and possible chalcedony pendant recorded in 1994.

Projectile Points

Among the points observed during the survey are two specimens (Figure 113c, d) morphologically resembling those in the Rosespring Series, but much smaller (<1.8 cm in length). Such points frequently are encountered in the Carson Desert (Kelly 1983b, 1985; Raven 1990; Gedney 1994) and are referred to as the Carson Variant (Kelly 1983:33-36). Since we do not know the temporal significance of this point style, these points were not included among Rosegate Series.

The 1989 and 1993/1994 surveys were conducted in different sets of habitats. In 1989, most habitats were riparian and marsh, while in 1993/1994, most habitats were located in dry lowlands, particularly on gravelly alluvial fans. We anticipated the possibility that differences between the proportions of points in these two samples (Table 51) might suggest temporal differences in foraging preferences that may not show up in an analysis of habitats because of small sample size.

Table 51. Projectile Points per Type from All Toedokado Samples.

Sample Year	Great Basin Stemmed	Humboldt Series	Large Side-notched	Gatecliff Series	Elko Series	Rosegate Series	Desert Series	Other
1989	0	17	7	22	20	30	30	97
1993/1994	5	2	0	2	11	13	2	15

Cumulative percentages of each temporally sensitive point series were calculated for each sample. These are shown graphically as ogives in Figure 115. The major differences between the two samples are that more Great Basin Stemmed Series and fewer Desert Series points were observed in 1993/1994 than in 1989. However, the samples are statistically indistinguishable at the 0.05 level. This was confirmed using the Komolgorov-Smirnov two sample test (critical value D = 0.272 observed value = 0.234) and chi-squared approximation (critical value x^2 = 5.991; observed value = 5.438).

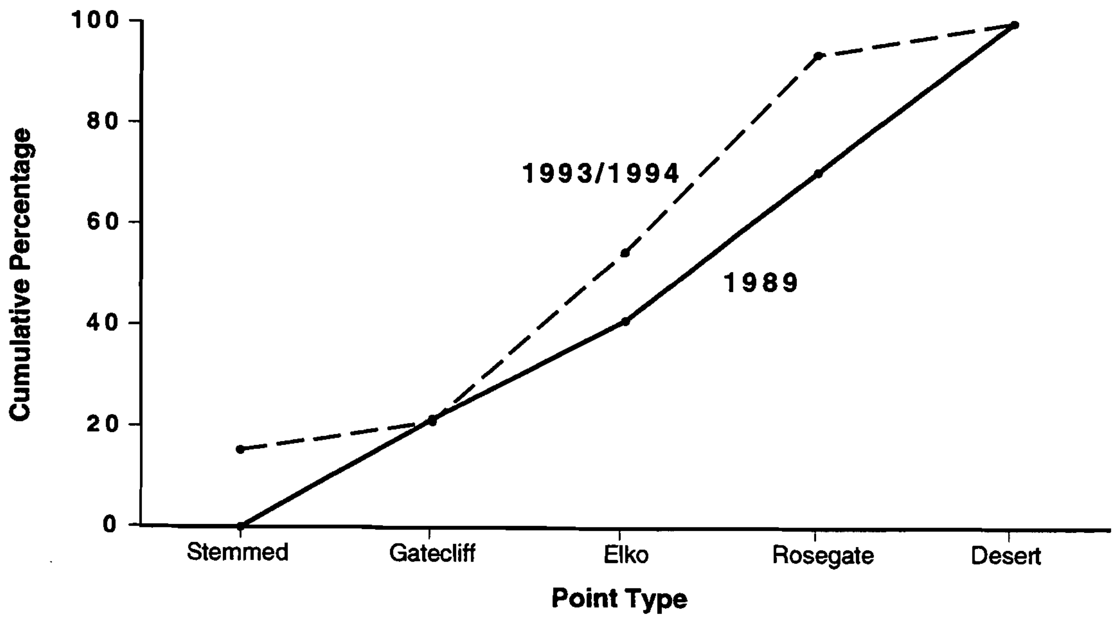


Figure 115. Time-sensitive projectile points from 1989 and 1993/1994 samples.

Because the thirty-five time-sensitive points observed in 1993/1994 are spread over twenty-one sites located in seven habitats, samples of points per habitat are too small for meaningful analysis. Only five sites contained three or more diagnostic points (Table 52). Elko-Rosegate time of occupation is indicated for sites 4623, 4720, and 4721, while points from site 4655 suggests a later span between Elko and Desert periods. Site 4636 appears to represent Stemmed Period occupancy.

Sites 4623, 4720, and 4721 occupy low dunes adjacent vast playa expanses in Habitat Types 3 and 3a. With projectile points limited to Elko and Rosegate Series, the features, ground stone, and plethora of flaked stone tools at these three sites suggests that resources in Habitat Types 3 and 3a during the early portion of the Late Holocene were worthy of considerable energy investment.

The occurrence of such a large and diverse site as 4636 in Habitat Type 10 is also a deviation from expectations of our model. What this site may indicate, along with two sites with Great Basin Stemmed points in Sample Unit 355/313 (also Habitat Type 10), and a single isolated Stemmed point from desert pavement/piedmont in Sample Unit 364/335 (Habitat Type 37), is considerably better resource availability in these habitats during the early Holocene than presently available there.

Table 52. Sites with Three or More Time-Sensitive Projectile Points.

Site Number	Habitat Type	Stemmed	Humboldt	Elko	Rosegate	Desert	Other	Total
4623	3	0	0	1	5	0	3	9
4720	3a	0	0	2	1	0	0	3
4721	3a	0	1	2	1	0	6	10
4636	10	2	1	0	0	0	2	5
4655	10b	0	0	1	1	1	3	6

Shell Beads

The utility of marine shell bead styles as a chronological time-marker in the Great Basin and California has been demonstrated by James Bennyhoff (Bennyhoff and Heizer 1958; Hughes and Bennyhoff 1986; Bennyhoff and Hughes 1987). Shell beads made in California are common in the Humboldt and Carson Sinks (Bennyhoff and Hughes 1987:148). Shell beads present on site 4623, independently confirm the dates suggested by projectile points.

As discussed above, this site is located within Habitat Type 3 at approximately 1298 meters (4259 ft amsl) elevation in playa flats and low coppice dunes several kilometers west of Carson Lake. We recorded a total of 12 *Olivella* sp. shell beads of two varieties (Figure 114a, b) were observed eroding out of a dune, in the company of several pieces of ground stone, and three projectile points: one each of Rosegate, Elko and Carson Variant types.

Five of the beads are typeable as oval split drilled Type C2 while the remaining seven are a scoop pendant Type C5 (Bennyhoff and Hughes 1987:123). These bead types were in use during the terminal Middle Period of California (circa 1450 to 1250 B.P.) fitting well with the Elko and Rosegate Period projectile points from this site.

Chapter 8. ASSESSMENT OF THE TOEDOKADO MODEL

David W. Zeanah and Robert G. Elston

How well does the habitat model anticipate the archaeological record of Toedokado territory? Unlike Raven (1990), whose mission was to sample at a consistent rate his entire study area, we are confined to a 5% sampling of selected portions of Toedokado territory, not of its entirety. Since the parcels representing the survey sample universe are administrative selections, they fail to represent the range of habitat types comprising the modeled area. Thus, we can assess how well the archaeology of our sample units corresponds to expectations generated by the Toedokado model, but an adequate test of the utility of the model to predict the complexity and distribution of archaeological remains throughout Toedokado territory must await representative sampling of the entire territory.

We base archaeological expectations on a seven-point archaeological complexity scale which addresses human behavior, but we organized and describe survey results in terms of physical criteria. Clearly, our first task in the present model assessment is to explore patterning in the composition and diversity of archaeological assemblages in the sample so that we may infer the hunter-gatherer behavior that produced them. Then we can assign predictive ranks (*sensu* Table 39) to each sample unit according to habitat type. This done, we can evaluate how well the model predicted the observed archaeological record of each sample unit surveyed.

Since the present study expands and elaborates the earlier Stillwater model (Raven and Elston 1989; Raven 1990), the following analyses combine the earlier Stillwater survey data with the present data (cf. Chapter 7). This allows us to take more advantage of the regional perspective offered by the Toedokado territory habitat model, to increase the sample size of sites and quadrats, and to increase the variety of habitat types sampled. We have reclassified to present categories the entire 1989 site and quadrat sample to ensure their comparability with the 1993/1994 sample (Table 53).

Excluded from further analysis are the two sample units (353/4367, and 356/4363) on the NAS Fallon Main Station because we cannot ensure data comparability, to the bulk of our data set, and the isolated debitage because it was recorded differentially over the three field seasons. In total, we have survey data available from 94 square kilometer units (39 sampled in 1989, 55 sampled in 1993 and 1994) and from 339 archaeological sites (228 recorded in 1989 and 111 recorded in 1993 and 1994; Table 54).

Interpreting the Archaeological Record

Earlier (cf. Chapter 5:Table 39), we used the habitat model to assess the foraging potential of individual habitats for Toedokado hunter-gatherers, and we made general assumptions about how central place foraging, sexual division of labor, and technology influence the formation of the archaeological record. From these observations, we devised a seven-point scale that forecasts the relative likelihood of residential occupation and the profitability of men's and women's subsistence activities within each habitat type.

We described archaeological sites observed in 1993 and 1994 sample units by classifying them according to assemblage size and to the presence or absence of particular artifact categories (cf. Chapter 7). Before we can ascertain how well the predictions of Chapter 5 fare against the observed archaeological record, we must link descriptive site categories to foraging and settlement behaviors by analyzing the assemblage composition and diversity of the combined sample of archaeological sites. Our objective is to learn how to interpret descriptive site categories (i.e., sites with features, lithic and ground stone scatters, lithic scatters, and isolates) as functional entities (i.e., residential occupation sites, logistic camps, or foraging sites).

Table 53. Distribution of Site Types by Sample Unit, 1989 Survey Data.

Sample Unit	Habitat	Large Sites w/Features	Small Sites w/Features	Large Lithic Scatters w/Ground Stone	Small Lithic Scatters w/Ground Stone	Large Lithic Scatters	Small Lithic Scatters	Isolated Projectile Points	Isolated Ground Stone Tools	Isolated Chipped Stone Tools	Isolated Debitage	Total
1	1a	0	0	0	1	0	0	0	0	0	0	1
2	53	0	0	0	0	0	0	0	0	0	0	0
3	53	3	2	0	2	0	0	1	2	1	0	11
4	53	1	0	2	0	0	3	0	0	2	1	9
5	2	0	2	1	0	1	1	1	0	1	3	10
6	2b	0	0	0	0	0	0	0	0	0	0	0
7	2a	0	0	0	0	0	0	0	0	0	0	0
8	2b	0	0	0	1	0	2	0	1	0	0	4
9	2a	0	0	1	0	0	0	0	0	0	0	1
10	2a	0	0	1	0	0	0	0	0	0	0	1
11	2a	0	0	0	0	0	0	0	0	0	0	0
12	3	0	0	0	0	0	2	2	0	2	1	7
13	3b	0	0	1	2	1	4	1	1	4	2	16
14	53	2	0	1	2	1	4	2	0	0	11	23
15	3	0	1	0	4	0	1	2	11	1	0	20
16	3b	1	1	0	2	0	0	0	0	0	0	4
17	5	0	1	0	2	0	0	0	0	0	0	3
18	5b	0	1	0	0	0	0	1	0	0	2	4
19	6	1	6	0	2	1	1	0	1	2	1	15
20	6b	0	2	0	1	0	0	0	0	1	0	4
21	7	1	0	1	1	0	1	2	4	2	0	12
22	7b	0	1	2	1	0	0	1	3	0	0	8
23	9	0	0	0	0	0	0	0	0	1	0	1
24	9b	0	0	0	2	0	1	3	0	1	0	7
25	9b	1	1	0	2	0	1	0	1	0	0	6
26	9	0	0	0	0	0	0	0	0	0	1	1
27	9	0	0	2	1	0	1	2	2	3	0	11
28	9	3	1	1	3	2	3	1	1	1	1	17
29	9b	0	4	0	1	0	0	0	1	0	0	6
30	9a	0	1	3	2	0	1	1	2	5	1	16
31	14	0	0	0	0	0	1	0	0	0	0	1
32	11	0	0	0	0	1	2	0	0	1	1	5
33	10	0	0	0	0	0	6	0	0	0	2	8
34	13	0	0	0	0	0	0	0	0	0	0	0
35	7	0	0	0	0	0	0	2	0	0	0	2
36	3	0	1	0	1	0	1	0	1	0	1	5
37	3	1	0	0	0	1	2	1	0	0	1	6
38	3b	0	0	0	0	0	0	0	0	0	0	0
39	3a	0	0	2	0	1	7	0	0	2	3	15
Total		14	25	18	33	9	45	23	31	30	32	259

Table 54. Site Type Distributions by Survey Sample.

Site Type	1989	1993/1994
Large Sites with Features	14	5
Small Sites with Features	25	3
Large Lithic and Ground Stone Scatters	18	5
Small Lithic and Ground Stone Scatters	33	5
Large Lithic Scatters	9	21
Small Lithic Scatters	45	31
Isolated Projectile Points	23	5
Isolated Ground Stone Tools	31	11
Isolated Chipped Stone Tools	30	25
Total	228	111

Assemblage Diversity

It should be possible to deduce archaeological site function from assemblage diversity (i.e., number of artifact types); tool diversity should reflect the diversity of activities represented on a site. Thus, since durable residential bases are loci of a broad range of subsistence, manufacture, maintenance, refuse disposal, and leisure activities, diverse archaeological assemblages should represent long term occupation sites. Conversely, considering that short term bases, logistic field camps, and procurement locations are arenas for particularized sets of tasks, homogeneous assemblages should represent specialized site types (see Binford 1980 for site type definitions and Thomas 1983:72-83, 1989 for discussion of the expected diversity and composition of the assemblages of these types in the Great Basin).

This approach is problematic to the extent that diversity strongly correlates with sample size (Jones, Grayson, and Beck 1983). That is, as sample size increases diversity also increases, independent of site function. Diverse assemblages that could be classified as base camps may be diverse simply because they are fortuitously large. In contrast, sites that seem to have specialized functions because of their homogeneous assemblages, may not be diverse merely because the observed assemblages happen to be small.

Figure 116 is a scattergram of the number of artifacts and number of artifact types for 143 archaeological sites in the sample, excluding from consideration 196 sites that contain no more than one tool; the chart distinguishes sites with features (n=36), lithic scatters with ground stone (n=58), and lithic scatters (n=49), collapsing large and small variants of these categories. The figure indicates that there is a relationship between assemblage size and assemblage diversity, although it clearly is curvilinear (r=.855, 142 d.f., p=.001); as assemblage size increases, the probability of adding new classes declines. The figure also shows that the three descriptive categories of sites have different size-diversity relationships. Sites with features tend to be represented by the largest assemblages with the most artifact types in the sample, while lithic scatters are represented by the smallest, least diverse assemblages.

Figure 117 log-transforms the number of tools and tool categories for the 143 assemblages, straightening the relationship between assemblage size and number of tool types (Rhode 1988). The figure presents the linear regression line for the combined set of sites; as expected, sample size and sample diversity are significantly correlated among the 143 sites (r= 0.74, d.f. =142, p= .0001), suggesting that artifact quantity accounts for 55% of all variability in number of artifact types. Considering that the three descriptive site types tend to be represented by different assemblage sizes (sites with features are large, lithic scatters are small, and lithic scatters with ground stone are intermediate), we must take this correlation into account if we are to tease site function from assemblage diversity.

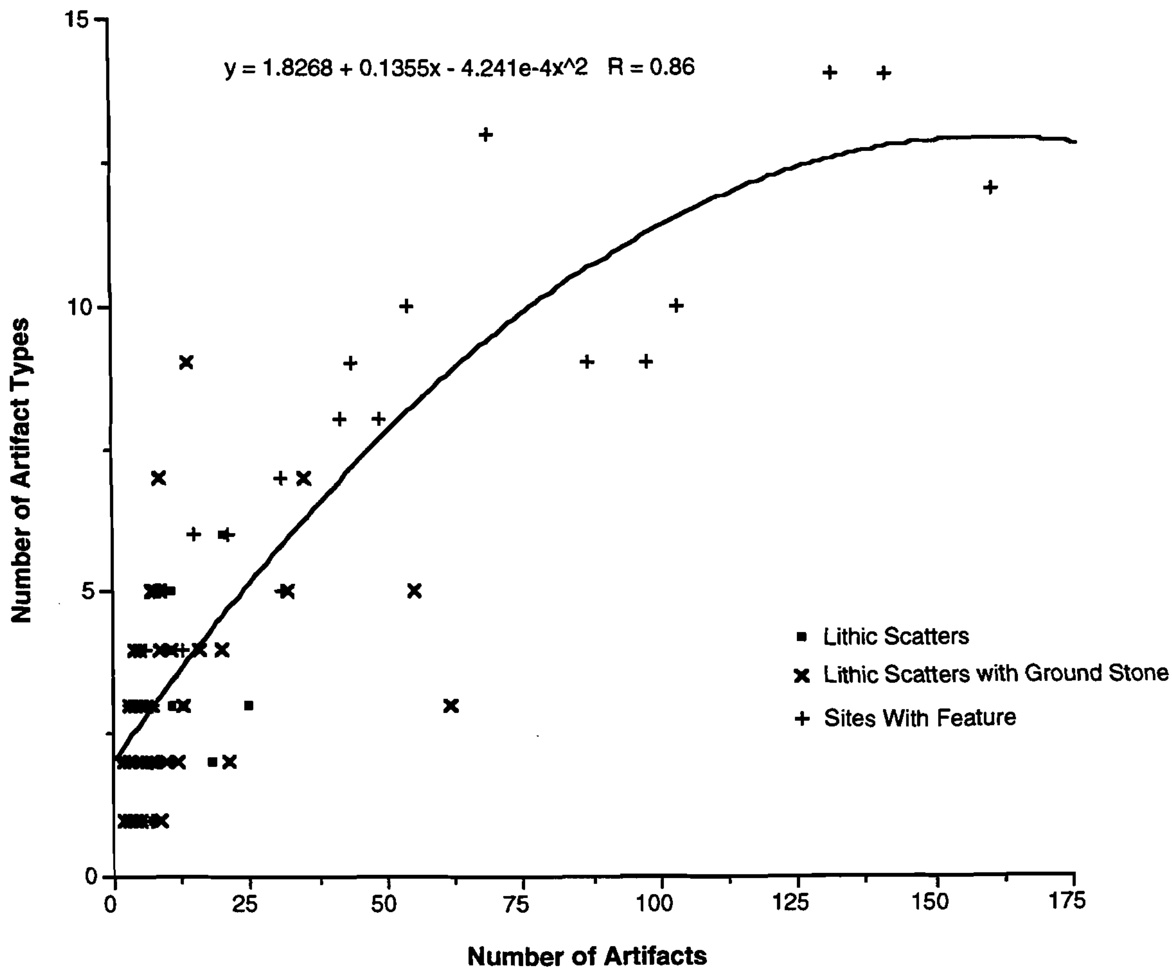


Figure 116. Number of artifacts and artifact types at sites with features, lithic scatters, and lithic scatters with ground stone.

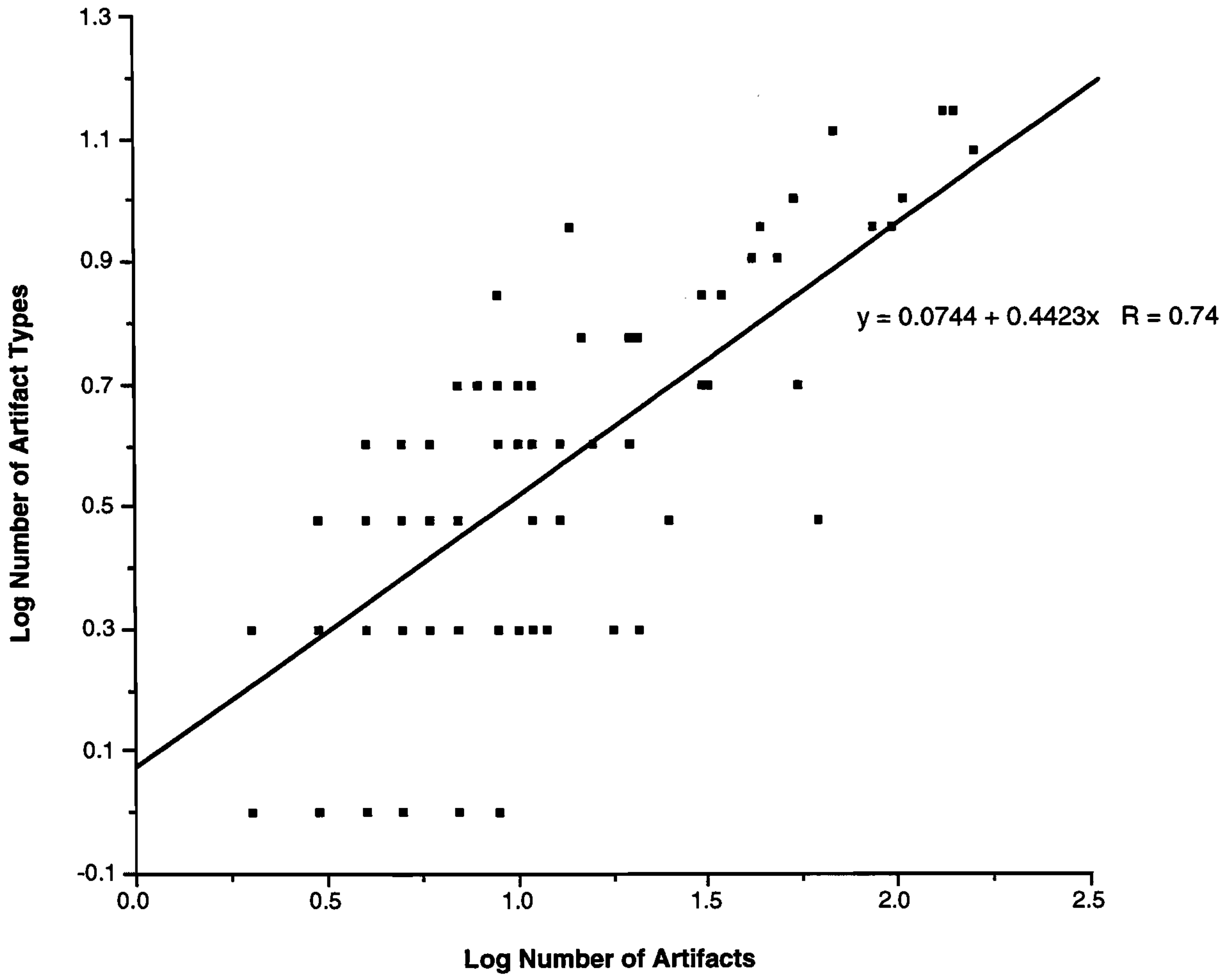


Figure 117. Log sample size versus log sample diversity among combined set of site types.

One way to distinguish functional assemblage diversity from diversity induced by sample size effect is to look at diversification *rates* (Kelly 1985; Thomas 1989; Ingbar 1992). For example, since residential sites demonstrate more behavioral diversity than other site types, the diversity of those assemblages should increase rapidly as sample size increases. In contrast, sites with more particularized functions should add new tool categories less frequently as assemblage size increases. The slope of regression lines plotted for sample size and number of classes should be steeper for residential sites than for specialized site types.

We are tempted to interpret sites with features as long term base camps because their hearths, burials, pits and middens suggest long duration residential occupation (Thomas 1983:76). In contrast, we suspect that lithic scatters with and without ground stone tools tend to represent short term foraging camps, specialized logistic camps, and procurement sites. If we are correct, the assemblages of sites with features should exhibit more diversity with each increment of sample size than should lithic scatters with and without ground stone.

Figure 118 charts the relationships between log assemblage size and log assemblage diversity for sites with features and for lithic scatters with and without ground stone. We combine the latter two categories to ensure that the descriptive definitions of the site types do not force them to be more or less diverse than sites with features. Lithic scatters intuitively may seem less diverse than sites with features simply because, by definition, they cannot contain ground stone tools. Similarly, lithic scatters with ground stone may be fortuitously more diverse than sites with features since we define them as always containing ground stone, which may or may not appear in sites with features. Combining lithic scatters with and without ground stone ensures that we are comparing site categories capable of the containing the same range of assemblage diversity.

Assemblage size and assemblage diversity are significantly correlated for sites both without features ($r=.525$, $p=.0001$) and sites with features ($r=.897$, $p=.0001$). However, the regression line for the 107 lithic scatters with and without ground stone tools has a lower slope ($m=0.336$) than the 36 sites with features ($m=0.472$). Assemblages without features diversify much more slowly than those with features although both site categories potentially contain the same range of tool classes. We believe that the differences in slope between sites with and without features reflect site function. Sites with features diversify more rapidly, consistent with our expectation that these sites represent long term occupation sites. Lithic scatters with and without ground stone diversify more slowly, suggesting that they represent task-specific logistic camps, procurement locations, and short term base camps.

Assemblage Composition

In the previous analysis, we demonstrated a significant correlation between sample size and sample diversity, showing that rates of diversification vary between sites with features and other sites in a manner consistent with our expectations of site function. We pointed out that sites with features diversify at relative rates typical of residential bases, but that other site types could encompass a variety of functions. Analysis of diversity cannot further distinguish site function in either category because it assumes that assemblage variation is a function of assemblage size. But, if the activities of hunter-gatherers vary according to functional site type, then the artifact type composition of assemblages should reflect those activities regardless of assemblage size. Thus the representation of individual artifact categories should vary significantly among site types, and between large and small variants of site types, reflecting site function (cf. Bettinger et al. 1994).

Table 55 presents the counts of tool types by site type for all 339 sites in the sample. In this analysis we distinguish large and small variants of sites with features, lithic and ground stone scatters, and lithic scatters. Further, we have included the combined set of isolates as an additional category. We have grouped artifacts into categories to minimize the number of empty cells in the table. Chipped stone artifact types that occur abundantly in the sample, such as projectile points, bifaces, utilized flakes and cores, are tallied as individual categories in Table 55. In contrast, we have combined all ground stone tools, including relatively common manos, slab milling stones, basin milling stones, and indeterminate ground stone fragments, as well as occasional nonportable milling stones, mortars, and

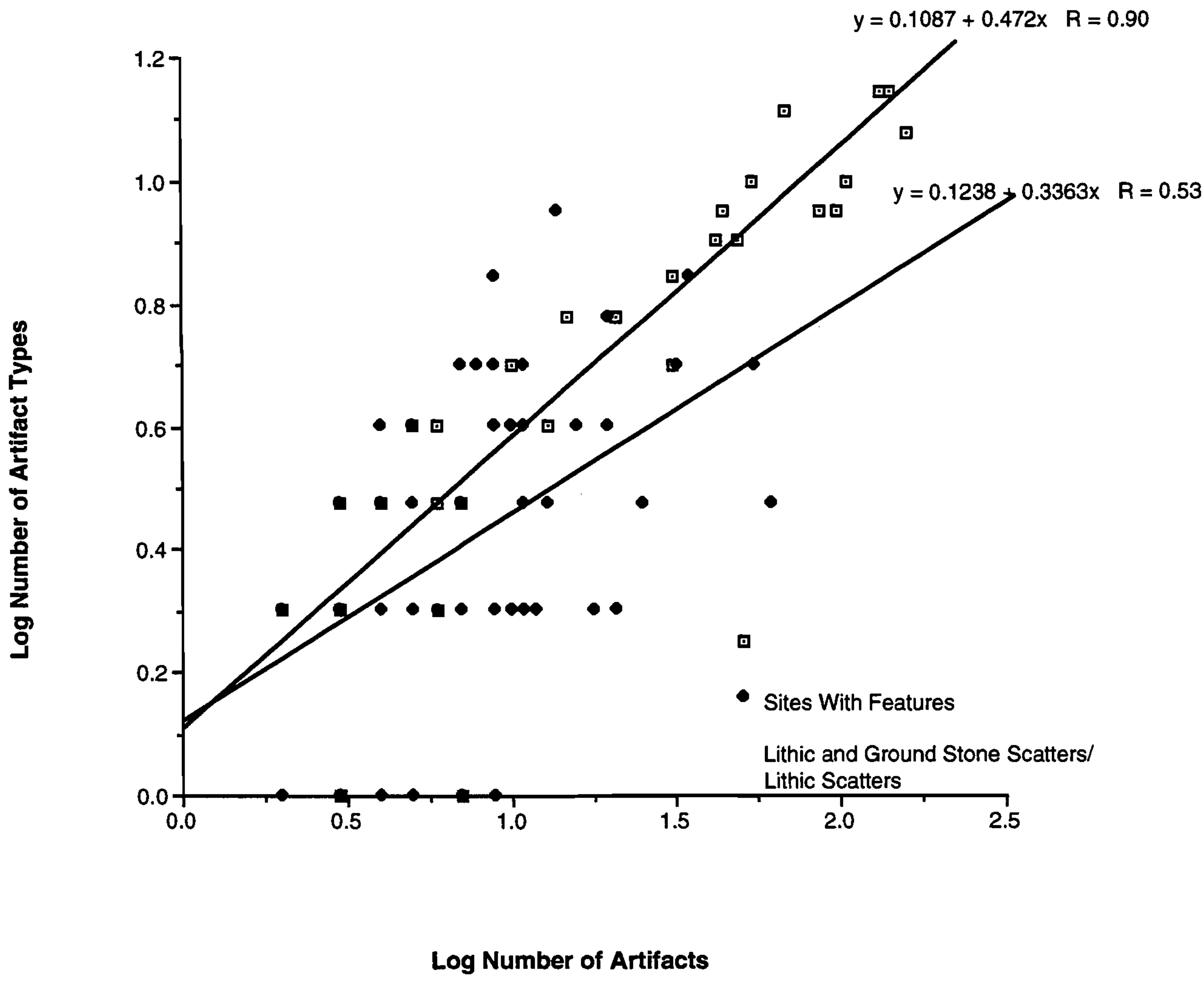


Figure 118. Log sample size versus log sample diversity among sites with and without features.

Table 55. Distribution of Artifact Type According to Site Type.

Site Type	Projectile Points	Bifaces	Other Fabrication Tools	Utilized Flakes	General Other Utility Tools	Cores	Ground Stone Tools	Ornaments	Total
Large Sites w/Features	104	129	29	116	57	147	439	21	1042
Small Sites w/Features	17	8	4	4	0	5	91	0	129
Large Lithic Scatters w/Ground Stone	57	83	9	17	5	28	72	2	273
Small Lithic Scatters w/Ground Stone	20	11	6	7	5	9	178	0	236
Large Lithic Scatters	17	74	15	9	5	51	0	0	171
Small Lithic Scatters	30	36	2	13	0	36	0	0	117
Isolates	28	30	2	10	3	13	56	1	143
Total	273	371	67	176	75	289	836	24	2111

pestles, into a single class. We have combined uncommon artifact types into three functional categories (cf. Winter 1969, Thomas 1983) to bolster the small sample sizes of these rare tools. Fabrication tools are items used to manufacture other tools such as drills, scrapers, unifaces, bone tools, and abraders. General utility tools (i.e., hammerstones, choppers, and battered cobbles) are artifacts suitable for a variety of tasks. Finally, ornaments include glass and shell beads, quartz crystals, and ground stone pendants.

We subjected the data to chi-square analysis as an eight column by seven row contingency table to learn if particular tool types are associated significantly (or not associated) with particular site types. Eighteen percent of the cells have expected values lower than five items and no cell is expected to contain less than a single item; thus, the distribution satisfies sample size requirements for the chi-square test (Thomas 1986:298). The distribution is significant (chi-square = 604.609, 42 d.f., p=.0001). Transforming artifact counts into standardized adjusted residuals (following Bettinger 1989:312-313) detected which tool classes are associated significantly (or dissociated) with which site types. Table 56 presents the adjusted residual values; those greater than 1.96 or less than -1.96 are significant at the .05 level.

Table 56. Adjusted Residuals for Artifact Types by Site Type.

Site Type	Projectile Points	Bifaces	Other Fabrication Tools	Utilized Flakes	General Other Utility Tools	Cores	Ground Stone Tools	Ornaments
Large Sites with Features	-3.99	-6.19	-1.01	4.587	4.699	0.551	2.345	3.759
Small Sites w/Features	0.086	-3.5	-0.05	-2.22	-2.25	-3.35	7.416	-1.26
Large Lithic Scatters w/Ground Stone	4.194	5.968	0.124	-1.35	-1.65	-1.77	-4.79	-0.68
Small Lithic Scatters w/Ground Stone	-2.17	-5.53	-0.59	-3.17	-1.26	-4.68	11.94	-1.75
Large Lithic Scatters	-1.22	9.211	4.356	-1.52	-0.46	6.403	-11	-1.46
Small Lithic Scatters	4.215	3.858	-0.93	1.117	-2.14	5.53	-9.01	-1.19
Isolates	2.454	1.108	-1.25	-0.6	-0.97	-1.66	-0.11	-0.51

As can be seen, utilized flakes, general utility tools, ground stone tools, and ornaments are significantly present on large sites with features while projectile points and bifaces are proportionally underrepresented on this site type. Small sites with features contain more ground stone than expected, but cores, general utility tools, utilized flakes, and bifaces are underrepresented. Large lithic scatters with ground stone have significant representations of bifaces and projectile points but, surprisingly, ground stone tools occur in lower than expected frequencies. Small lithic scatters with ground stone, on the other hand, have significant representations of ground stone tools but not of points, bifaces, utilized flakes, or cores. More bifaces, fabrication tools, and cores than expected occur in large lithic scatters. Small lithic scatters significantly contain projectile points, bifaces, cores, but general utility tools are underrepresented. Finally, projectile points occur in significant frequencies as isolates.

On the basis of these associations, we can make some general interpretations about the kinds of activities performed on the seven site types. Women's subsistence activities, as reflected by ground stone food processing implements are represented strongly in large and small sites with features, small lithic scatters with ground stone, and, we presume, isolated ground stone artifacts (we suggest that these are simply small examples of small lithic scatters with ground stone). Projectile points and bifaces in large lithic scatters with ground stone, large and small lithic scatters, and isolated projectile points and chipped stone tools strongly suggest men's subsistence activities.

The strong association of ground stone tools and ornaments with large sites with features is consistent with our earlier inference that such kinds of sites represent long term occupation sites because we expect such artifacts to occur at residential bases (Thomas 1983:78). The association of utilized flakes and other general utility tools does not contradict this interpretation because of the diversity of tasks conducted at residential camps (Thomas 1983:76-77). Since we also interpret small sites with features as long term residential sites (or perhaps shorter duration foraging base camps) based on the presence of features, the strong representation of ground stone tools at these sites should reflect women's food processing at hearthside after short term foraging forays within the immediate catchment of the camp.

Large lithic scatters with ground stone are more difficult to interpret. The strong association of points and bifaces, and statistically negative association with ground stone tools, suggests that these sites reflect hunting more strongly than seed gathering and processing. But, by definition, large lithic scatters with ground stone do contain ground stone tools, suggesting that plant food processing occurred to some extent at these sites. We suggest that large lithic scatters with ground stone may represent short term base camps, where plant food gathering and processing were minor subsistence activities compared to hunting or small animal procurement. As such, these sites may represent short term residential occupation supporting both men's and women's subsistence strategies. However, it also is possible that such sites represent specialized hunting camps for men, and the minor proportions of ground stone were used for processing dried meat (Robert Bettinger, personal communication, 1995).

We interpret large and small lithic scatters as logistic hunting sites based on their strong association with projectile points, bifaces, and cores, and on lack of ground stone. It also is likely that these site types include short-term foraging bases of which the assemblages do not reflect women's activities. In either case, the assemblages of these site types strongly suggest male subsistence strategies while providing no evidence for the conduct of female subsistence activities. The significant occurrence of large lithic scatters with fabrication tools is expected of residential sites, and is consistent with logistical camps (Thomas 1983:77). The representation of bifaces and cores in their assemblages suggests that lithic toolstone procurement and processing played a large role in their creation. Isolated projectile points and chipped stone tools, we suspect, represent men's foraging locations.

Conversely, small lithic scatters with ground stone and isolated ground stone tools may represent short term foraging sites where male subsistence activities were unimportant. We suspect that these sites are foraging locations, field processing stations, and logistic field camps for female task groups.

Predicting the Archaeology of Sample Units

The foregoing analyses detected significant differences in the diversity and composition of site types between the 1989 and 1993/1994 site samples. Using these differences we infer the function of site types in prehistoric subsistence-settlement patterns. Large and small sites with features represent long term residential sites, because they evince residential facilities and more assemblage diversity than other site types, and significantly contain artifact categories suggesting residential occupation. Sites with features also contain significant quantities of ground stone tools consistent with our expectation that residential sites will be closely associated with women's subsistence activities.

In contrast, large lithic scatters with ground stone tools are associated significantly with projectile points and bifaces despite the presence of ground stone tools, and thus suggest men's subsistence activities. It is possible that these sites represent specialized hunting camps, but we infer from the presence of ground stone that they are short term residential bases where women did not process plant food intensively.

Small lithic scatters with ground stone are associated strongly with ground stone tools, and we infer that these sites, along with isolated ground stone tools, represent field camps, field processing stations, and gathering locations strongly associated with women's subsistence strategies. Lithic scatters and isolated chipped stone tools and projectile points reflect male subsistence activities as indicated by significant quantities of points, bifaces, and fabrication tools. Lithic toolstone procurement and field processing (as indicated by cores) probably are inducing variability unrelated to subsistence pursuits in these categories.

Based on these inferences, we now can assign expected archaeological correlates to the behavioral expectations cast in Chapter 5. Table 57 states these expectations.

Table 57. Expected Site Type Correlates of Archaeological Complexity Ranks.

Archaeological Complexity Rank	Behavioral Prediction	Expected Behavioral Site Types	Expected Archaeological Site Types
7	Highly profitable for men's and women's foraging. High potential for residential occupation.	Men's and women's foraging and logistic sites. Residential base camps abundant.	Sites abundant. All site types present. Strong representation of large and small sites with features.
6	Profitable for men's and women's foraging. Good potential for residential occupation.	Men's and women's foraging and logistic sites. Residential base camps likely.	Sites abundant, all site types present, strong representation of sites with features.
5	Moderately profitable for men's and women's foraging. Moderate potential for residential occupation.	Men's and women's foraging and logistic sites. Residential base camps common.	Sites common, all site types present, small sites with features and large lithic scatters with ground stone may be common.
4	Low profitability for men's and women's foraging. Low potential for residential occupation.	Men's and women's foraging and logistic sites. Residential base camps rare.	Sites, common, large lithic scatters with ground stone and large and small sites with features may be present, all other site types common.
3	Profitable for men's foraging only. No potential for residential occupation.	Men's foraging and logistic sites only. No residential base camps.	Sites may be absent. When sites are present, large lithic scatters with ground stone, large and small lithic scatters, and isolated projectile points and chipped stone tools should dominate. No sites with features or large lithic scatters with ground stone are present.
2	Profitable for women's foraging only. No potential for residential occupation	Women's foraging and logistic sites only. No residential base camps.	Sites may be absent, when sites are present small lithic and ground stone scatters, and isolated ground stone tools stone tools should dominate.No sites with features or large lithic scatters with ground stone.
1	Unprofitable for men's and women's foraging. No potential for residential occupation	Few or no men's and women's foraging and logistic sites. No residential base camps.	Sites should be absent or rare. No sites with features or large lithic scatters with ground stone.

Table 58 lists 1989, 1993, and 1994 survey sample units and ranks each according to expected archaeological complexity. With the exception of irregularly inundated sample units, complexity assignments are taken directly from Table 39. We ranked irregularly inundated sample units according to observed environmental (but not archaeological) characteristics of the unit. Those irregularly inundated sample units with topographic irregularities likely to form shorelines and islands when marshes are present were assigned a value of seven. Those lacking suitable topographic relief were assigned a score based on habitat type.

Table 58. Predicted Archaeological Complexity Ranks for 1989, 1993 and 1994 Sample Units.

Sample Year	Sample Unit	Habitat Type	Expected Archaeological Complexity Rank	Comment
1989	358/4395	1a	4	No marsh islands or shorelines
1989	359/4398	53	7	
1989	374/4389	53	7	
1989	372/4391	53	7	
1989	382/4389	2	7	Irregularly inundated with potential for marsh islands and shorelines
1989	358/4406	2a	1	No potential for marsh islands or shorelines when inundated
1989	379/4391	2a	1	No potential for marsh islands or shorelines when inundated
1989	351/4407	2b	6	Assigned because of water source
1989	352/4397	2	1	
1989	370/4396	2a	1	No potential for marsh islands or shorelines when inundated
1989	353/4402	2a	1	No potential for marsh islands or shorelines when inundated
1989	367/4371	3	5	
1989	371/4378	3b	6	Assigned because of water source
1989	371/4380	53	7	
1989	365/4385	3	5	
1989	362/4382	3b	6	Assigned because of water source
1989	353/4382	5	6	
1989	352/4383	5b	6	Assigned because of water source
1989	359/4389	6	6	
1989	358/4390	6b	6	Assigned because of water source
1989	359/4382	7	5	
1989	358/4384	7b	6	Assigned because of water source
1989	348/4385	9	3	
1989	352/4390	9b	6	Assigned because of water source
1989	376/4384	9b	6	Assigned because of water source
1989	377/4380	9	3	
1989	366/4389	9	3	
1989	359/4391	9	3	
1989	353/4384	9b	6	Assigned because of water source
1989	364/4392	9a	7	Dunes indicate potential for marsh islands and shorelines when inundated
1989	347/4388	14	2	
1989	371/4371	11	4	
1989	373/4374	10	2	
1989	378/4380	13	3	
1989	348/4389	7	5	
1989	373/4396	3	5	
1989	355/4410	3	5	
1989	377/4394	3b	6	Assigned because of water source
1989	370/4394	3a	1	No potential for marsh islands or shorelines when inundated
1993	390/4342	10	2	
1993	389/4341	11	4	
1993	388/4346	3a	7	Dunes indicate potential for marsh islands and shorelines when inundated
1993	394/4346	10	2	
1993	397/4346	10	2	
1993	352/4338	20	2	

Table 58, continued.

Sample Year	Sample Unit	Habitat Type	Expected Archaeological Complexity Rank	Comment
1993	350/4334	16	4	
1993	356/4334	38	1	
1993	357/4335	15	2	
1993	336/4353	3	5	
1993	335/4356	11	4	
1993	338/4352	3	5	
1993	334/4352	10	2	
1994	331/4362	18	1	
1994	333/4369	11	4	
1994	334/4362	11	4	
1994	340/4353	3	5	
1994	340/4361	11	4	
1994	346/4335	20	2	
1994	349/4336	20b	6	Assigned because of water source
1994	364/4335	37	3	
1994	366/4336	10	2	
1994	377/4413	2a	1	No potential for marsh islands or shorelines when inundated
1994	378/4416	2	1	
1994	382/4420	2	1	
1994	384/4410	2	1	
1994	385/4412	2	1	
1994	385/4418	2	1	
1994	386/4411	2	1	
1994	388/4335	10	2	
1994	388/4354	16	4	
1994	388/4409	2	1	
1994	390/4334	10	2	
1994	390/4365	18	1	
1994	391/4349	11	4	
1994	392/4331	10b	6	
1994	392/4355	16	4	
1994	392/4360	26	2	
1994	393/4356	10	2	
1994	394/4333	37c	3	
1994	395/4350	16	4	
1994	396/4353	16	4	
1994	396/4365	10	2	
1994	397/4368	21	2	
1994	398/4333	37c	3	
1994	398/4359	21	2	
1994	399/4364	10	2	
1994	399/4370	21	2	
1994	400/4360	11	4	
1994	400/4369	21	2	
1994	402/4364	26	2	
1994	403/4367	56c	1	
1994	403/4382	29	5	
1994	403/4369	56	1	
1994	431/4423	29	5	

Rank 1 Sample Units

We sampled eighteen Rank 1 sample units, including eight units in biotically sterile playas (Habitat Type 2) and five irregularly inundated playas (Habitat Type 2a) lacking landforms conducive to the formation of marsh shorelines and islands. Also sampled were two examples of Habitat Type 18 (Barren Gravelly Slope, 4"-8" p.z.), one example of Habitat Type 38 (Sodic Dunes/ Sodic Flat), one example of Habitat Type 56, and one case of Habitat Type 56c (Loamy Slope 8"-10" p.z./ Gravelly Loam 4"-8" p.z./ Stony Slope 4"-8" p.z./ Barren Gravelly Slope 4"-8" p.z.).

We evaluate Rank 1 habitats as unproductive for either men's or women's subsistence resources and with no potential for residential occupation. We predict that all site types should be absent or rare and that no sites with features or large lithic scatters with ground stone ever should occur on these quadrats. As can be seen on Table 59, fourteen of the sampled units bear no archaeological remains and two contain two isolated projectile points apiece. These sample units correspond well with our expectations.

Of the remaining two sample units, 370/4396 contains a large lithic scatter with ground stone contrary to expectations. Possibly the irregularly inundated playa once hosted a marsh after all. If so, reconsideration of ranking to 4 or 7 would be indicated. Finally, sample unit 356/4334 contains a small lithic scatter with ground stone, a small lithic scatter, and two isolated chipped stone tools. Even though the unit lacks evidence of residential occupation, the diversity of sites here does not accord with our expectations.

Rank 2 Sample Units

We assessed habitat types of Rank 2 as moderately profitable for women's foraging, with low potential for men's foraging or residential occupation. These habitat types contain resources that occasionally should draw the attention of women, such as Indian ricegrass, annual forbs, saltbushes, berries, roots, and small mammals. However, the habitats should be unattractive to medium and large game because of their remoteness from water and generally poor forage. Since we expect women's subsistence activities to be less visible and since these habitats are comparatively unproductive, we expect sites to be rare or absent in these habitats. When sites are present, we anticipate that small lithic scatters with ground stone and isolated ground stone tools will dominate the archaeological record.

We sampled 21 Rank 2 sample units. These included eleven examples of Habitat Type 10 (Gravelly Loam 4"-8" p.z.), four examples of Habitat Type 21 (Gravelly Loam 4"-8" p.z./ Valley Wash 4"-8" p.z.), two cases apiece of Habitat Types 20 (Sandy 5"-8"/ Gravelly Loam 4-8"/Dunes 4"-8") and Habitat Type 26 (Gravelly Loam 4"-8"/ Barren Gravelly Slope 4"-8"), and one each of Habitat Type 14 (Sodic Terrace) and Habitat Type 15 (Dunes and Sodic Dunes). Distributions of site types in these sample units appear in Table 60.

Twelve sample units contain no archaeological remains at all, consistent with our assessment of the low foraging potential of these habitats. Five contain a small lithic scatter or isolated tools, but only quadrat 352/4338 conforms to the expected site type configuration, possessing one isolated ground stone tool; the other four contain site types more suggestive of men's subsistence. The paucity of archaeological remains in these sample units, however, is consistent with our estimate of the low productivity of rank two habitats. Four sample units of Habitat Type 10 possess between three to six examples of large and small lithic scatters, isolated chipped stone artifacts, and isolated projectile points. The bias toward site types associated with male foraging activities suggests that we may have underestimated the hunting potential of Type Habitat 10. On the other hand, all six sites in sample units 373/4374 cluster in the northwest corner of the unit on a small patch of Habitat Type 3 (Raven 1990:17-18) which offers much greater hunting potential than Habitat Type 10. This suggests that the error here lies in our sampling procedure rather than in our assessment of the foraging potential of Habitat Type 10. Rank 2 sample units, as expected, exhibit no evidence of residentiality.

Table 59. Site Types in Rank 1 Sample Units.

Sample Unit	352/	378/	382/	384/	385/	385/	386/	388/	358/	379/	370/	353/	377/	331/	390/	356/	403/	403/
Coordinates	4397	4416	4420	4410	4412	4418	4411	4409	4406	4391	4396	4402	4413	4362	4365	4334	4369	4367
Habitat Type	2	2	2	2	2	2	2	2	2a	2a	2a	2a	2a	18	18	38	56	56c
Large Sites w/Features	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Sites w/Features	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Large Lithic Scatters w/Ground Stone	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Small Lithic Scatters w/Ground Stone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Large Lithic Scatters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Lithic Scatters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Isolated Projectile Points	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0
Isolated Ground Stone Tools	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolated Chipped Stone Tools	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Total	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	4	2	0

Table 60. Site Types in Rank 2 Sample Units.

Sample Unit	394/	397/	334/	396/	399/	388/	390/	390/	393/	373/	366/	347/	357/	346/	352/	397/	398/	399/	400/	392/	402/
Coordinates	4346	4346	4352	4365	4364	4335	4334	4342	4356	4374	4336	4388	4335	4335	4338	4368	4359	4370	4369	4360	4364
Habitat Type	10	10	10	10	10	10	10	10	10	10	10	14	15	20	20	21	21	21	21	26	26
Large Sites With Features	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small SItes w/ Features	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Large Lithic Scatter w/Ground Stone s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Lithic Scatter w/Ground Stone s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Large Lithic Scatters	0	0	0	0	0	0	0	1	2	0	2	0	0	0	0	0	0	0	0	0	0
Small Lithic Scatters	0	0	0	0	0	1	1	2	0	6	4	1	0	0	0	0	0	0	1	0	0
Isolated Projectile Points	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolated Ground Stone Tool	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Isolated Chipped Stone Tools	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	1	1	3	3	6	6	1	0	0	1	0	0	0	1	0	0

Rank 3 Sample Units

Habitat types in this category contain low ranked plants such as bluegrass, bottlebrush squirreltail, and needlegrass; consequently, these habitats should be worthwhile for women's foraging only when the diet breadth was exceptionally broad and other habitats were unproductive. Rank 3 habitat types contain moderate quantities of forage of sheep, deer, antelope, woodrat, and marmot forage; therefore, hunters occasionally may use these patches. We estimate that Rank 3 habitat types are moderately productive patches for men hunting but are unproductive for women gathering; residential occupation is unlikely. Lithic scatters, isolated projectile points, and isolated chipped stone tools should dominate the archaeological record of these habitats. Sites with features, small lithic scatters with ground stone, and isolated ground stone artifacts should be rare or absent. The productivity of class three habitats is sufficiently low that we expect frequent archaeologically barren quadrats.

We sampled eight Rank 3 habitats: four examples of Habitat Type 9 (Sandy fans and sheets, sodic fans - sodic flats 4"-8" p.z./ sodic flats 3"-8" p.z.), two examples of Habitat Type 37c, and one example each of Habitat Type 37 (Loamy Slope 8"-10" p.z.) and of Habitat Type 13 (Sodic Flat 8" - 10"/ Gravelly Loam 4" - 8" p.z.). Of these (Table 61), two yielded no remains, three contained only isolated chipped stone tools, and a sixth sample unit contained a small lithic scatter and an isolated projectile point. These six examples are consistent with expectations, contrary to which the two remaining quadrats contained high site densities (11 and 16 sites per sample unit) and evidence of residential occupation. Although most sites conformed to configuration expectation, both contained examples of small ground stone scatters or isolated ground stone artifacts more indicative of women's foraging. In addition, sample unit 359/4391 contained four examples of sites with features, while sample unit 366/4389 contained two large lithic scatters with ground stone. Sites in sample unit 359/4391 are associated closely with minor pockets of habitats more productive than Habitat Type 9 (Raven 1990:63-65), suggesting that habitat variability within the square kilometer sample unit may account for the deviation from the expected pattern in this case.

Table 61. Site Types in Rank 3 Sample Units.

Sample Unit Coordinates Habitat Type	348/ 4385 9	377/ 4380 9	366/ 4389 9	359/ 4391 9	378/ 4380 13	364/ 4335 37	394/ 4333 37c	398/ 4333 37c
Large Sites w/Features	0	0	0	3	0	0	0	0
Small Sites w/Features	0	0	0	1	0	0	0	0
Large Lithic Scatters w/Ground Stone	0	0	2	1	0	0	0	0
Small Lithic Scatters w/Ground Stone	0	0	1	3	0	0	0	0
Large Lithic Scatters	0	0	0	2	0	0	0	0
Small Lithic Scatters	0	0	1	3	0	1	0	0
Isolated Projectile Points	0	0	2	1	0	1	0	0
Isolated Ground Stone Tool	0	0	2	1	0	0	0	0
Isolated Chipped Stone Tools	1	0	3	1	0	0	1	1
Total	1	0	11	16	0	2	1	1

Rank 4 Sample Units

These habitat types typically are sand dunes and sheets that are productive for a variety of game and that foster abundant small mammals, annual forbs, and Indian ricegrass for a brief period in late spring and early summer. They have good potential for both men's and women's foraging, but since they are most attractive to women only briefly during the year, they have low potential for residential occupation. Rank 4 habitat types also contain marshes lacking islands or shorelines. These are highly attractive for men's and women's foraging but are unsuitable camp locations. Sites with features may occur in rank 4 habitat types and all other site types should be common. We always expect archaeological remains in these sample units.

We sampled 14 rank four sample units (Table 62), including eight examples of Habitat Type 11 (Sandy Fans and Sheets, Gravelly Loam 4" - 8" p.z.), five examples of Habitat Type 16 (Sandy 5" - 8" p.z.), and one case of Habitat Type 1 (Marsh without shorelines or islands). Four sample units lack any archaeological remains and three contain only one site or only isolates, results that are inconsistent with our expectations. The remaining seven sample units each are represented by four to eight sites. Two sample units, 334/4361 and 391/4349, contain sites with features and large lithic scatters with ground stone as well as examples of most other site types. Five sample units contain large and small lithic scatters and isolated chipped stone artifacts. These cases seem consistent with expectations although sites indicative of women's foraging seem underrepresented on the five sample units with lithic scatters, while occupation sites seem overrepresented on the two units bearing sites with features.

Rank 5 Sample Units

Habitat types ranked fifth are profitable for both men's and women's foraging activities. They are rich in moderately high ranked plant resources such as seepweed, saltbush, and wildrye, and they should represent relatively attractive territory for hunting a variety of mammals. These habitat types are moderately capacious for residential occupation in middle summer and late autumn. Consequently, we expect all site types in these sample units and all units should contain archaeological sites.

We selected twelve sample units representing Rank 5 habitat types (Table 63). Seven are Habitat Type 3 (Sodic Flat, 4"-8"). An irregularly inundated example of Sodic Flat (Habitat Type 3a), lacking landforms that would form islands or beaches when flooded, appears in the sample of Rank 5 habitats. Two examples are Habitat Type 7 (Sodic Flat/Sodic Terrace - Sandy Fans and Sheets/Sodic Sands/ Deep Sodic Sands), and two units are represented by Habitat Type 29 (Sodic Flat/Deep Sodic Fan).

The sample units of Habitat Type 29 lack archaeological remains and one case of Habitat Type 7 contains only two isolated projectile points. Two examples of Habitat Type 3 each contain only one lithic scatter accompanied by two isolates. A third sample units contains two small lithic scatters and four isolates. The paucity of archaeological remains in these six units is inconsistent with our expectations for these habitat types.

The remaining six sample units each contain between four and 20 sites. Sites with features appear in five cases, consistent with our expectations of residentiality in these habitat types. The remaining unit lacks sites with features but contains two large lithic scatters with ground stone, one large lithic scatter, seven small lithic scatters, and two isolated tools. All six cases conform to our expectations for this habitat type rank.

Rank 6 Sample Units

Sample units assigned a rank of six are highly productive of men's and women's foraging opportunities and residential suitability. These typically are riparian habitats or contain minor areas of wetland vegetation associated with perennial water sources. Available water and high densities of forage species should attract game animals. In addition, these habitat types support abundant plant foods. We expect sample units in these habitat types to contain many examples of all site types, and that sites with features and large lithic scatters with ground stone will be particularly common.

Two of our fourteen Rank 6 sample units (Table 64) are Habitat Type 5 (Moist Floodplain/Wet Sodic Bottom/Sodic Flat) and two are Habitat Type 6 (Moist Floodplain/Wet Sodic Bottom). The remainder are unproductive dryland habitats, but contain a perennial water source with associated

Table 62. Site Types in Rank 4 Sample Units.

Sample Unit	358/	371/	389/	335/	333/	334/	340/	391/	400/	350/	388/	392/	395/	396/
Coordinates	4395	4371	4341	4356	4369	4362	4361	4349	4360	4334	4354	4355	4350	4353
Habitat Type	1a	11	11	11	11	11	11	11	11	16	16	16	16	16
Large Sites w/Features	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Small Sites w/Features	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Large Lithic Scatters w/Ground Stone	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Small Lithic Scatters w/Ground Stone	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Large Lithic Scatters	0	1	1	0	0	3	1	2	0	0	0	0	1	0
Small Lithic Scatters	0	2	2	5	0	2	1	2	0	0	0	1	3	0
Isolated Projectile Points	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolated Ground Stone Tools	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Isolated Chipped Stone Tools	0	1	2	1	0	1	1	1	0	1	0	0	1	0
Total	1	4	5	6	0	6	7	8	0	1	0	1	5	0

Table 63. Site Types in Rank 5 Sample Units.

Sample Unit	367/	365/	359/	348/	373/	355/	370/	336/	338/	340/	403/	431/
Coordinates	4371	4385	4382	4389	4396	4410	4394	4353	4352	4353	4382	4423
Habitat Type	3	3	7	7	3	3	3a	3	3	3	29	29
Large Sites w/Features	0	0	1	0	0	1	0	0	0	2	0	0
Small Sites w/Features	0	1	0	0	1	0	0	0	0	0	0	0
Large Lithic Scatters w/Ground Ston	0	0	1	0	0	0	2	0	0	0	0	0
Small Lithic Scatters w/Ground Stone	0	4	1	0	1	0	0	0	0	3	0	0
Large Lithic Scatters	0	0	0	0	0	1	1	0	1	0	0	0
Small Lithic Scatters	2	1	1	0	1	2	7	1	0	0	0	0
Isolated Projectile Points	2	2	2	2	0	1	0	0	0	0	0	0
Isolated Ground Stone Tools	0	11	4	0	1	0	0	0	1	7	0	0
Isolated Chipped Stone Tools	2	1	2	0	0	0	2	3	1	4	0	0
Total	6	20	12	2	4	5	12	4	3	16	0	0

Table 64. Site Types in Rank 6 Sample Units.

Sample Unit	351/	352/	371/	362/	377/	353/	352/	359/	358/	358/	376/	353/	392/	349/
Coordinates	4407	4390	4378	4382	4394	4382	4383	4389	4390	4384	4384	4384	4331	4336
Habitat Type	2b	9b	3b	3b	3b	5	5b	6	6b	7b	9b	9b	10b	20b
Large Sites w/Features	0	0	0	1	0	0	0	1	0	0	1	0	0	0
Small Sites w/Features	0	0	0	1	0	1	1	6	2	1	1	4	0	1
Large Lithic Scatters w/Ground Stone	0	0	1	0	0	0	0	0	0	2	0	0	2	0
Small Lithic Scatters w/Ground Stone	1	2	2	2	0	2	0	2	1	1	2	1	0	0
Large Lithic Scatters	0	0	1	0	0	0	0	1	0	0	0	0	7	0
Small Lithic Scatters	2	1	4	0	0	0	0	1	0	0	1	0	3	0
Isolated Projectile Points	0	3	1	0	0	0	1	0	0	1	0	0	0	0
Isolated Ground Stone Tools	1	0	1	0	0	0	0	1	0	3	1	1	0	0
Isolated Chipped Stone Tools	0	1	4	0	0	0	0	2	1	0	0	0	0	0
Total	4	7	14	4	0	3	2	14	4	8	6	6	12	1

minor areas of wetland. Humboldt Slough crosses one sample unit (351/4407) and the Carson River delta flows through another (353/4384). Five contain small patches of marsh habitat (358/4384, 362/4382, 371/4378, 376/4384, 377/4394) and three (352/4390, 392/4331, 349/4336) contain springs.

Only one sample unit (377/4382) contains no sites at all, contrary to expectation. Nine contain sites with features, consistent with our anticipation of residential occupation of these habitat types. Two of the remaining sample units (392/4331, 371/4378) lack sites with features but contain, respectively, 12 and 14 examples of almost all other site types, including two examples each of large lithic scatters with ground stone. The final two examples (351/4407 and 352/4390) contain small lithic scatters with ground stone, small lithic scatters, and isolated artifacts. The lack of evidence for residential occupation of these two units is inconsistent with our expectations.

Rank 7 Sample Units

Rank 7 habitat types are most productive for men's and women's foraging and have the greatest likelihood of residential occupation. These habitat types should maintain high site densities and occupation sites should be abundant. All seven of the sampled units are marshes with islands and shorelines (359/4398, 374/4389, 372/4391, 371/4380) or are irregularly inundated quadrats that would form marsh islands and shorelines when flooded (382/4389, 388/4346, 364/4392).

One sample unit (359/4398) lacks archaeological remains, contrary to expectation; however, the remaining six cases have between seven and 15 sites each and all six contain at least one site with features, as well as lithic scatters with ground stone (Table 65).

Table 65. Site Types in Rank 7 Sample Units.

Sample Unit Coordinates Habitat Type	382/ 4389 2a	388/ 4346 3a	364/ 4392 9a	359/ 4398 53	374/ 4389 53	372/ 4391 53	371/ 4380 53
Large Sites w/Features	0	2	0	0	3	1	2
Small Sites w/Features	2	0	1	0	2	0	0
Large Lithic Scatters w/Ground Stone	1	1	3	0	0	2	1
Small Lithic Scatters w/Ground Stone	0	0	2	0	2	0	2
Large Lithic Scatters	1	0	0	0	0	0	1
Small Lithic Scatters	1	0	1	0	0	3	4
Isolated Projectile Points	1	0	1	0	1	0	2
Isolated Ground Stone Tools	0	1	2	0	2	0	0
Isolated Chipped Stone Tools	1	5	5	0	1	2	0
Total	7	9	15	0	11	8	12

Discussion

Table 66 summarizes the distribution of site types by expected archaeological complexity for all samples. Sixty-three of the 94 sample units considered seem well accommodated by predictions of the habitat model, nine are ambiguously served by both accurate and inaccurate predictions, and 22 are unaccommodated by model expectations. Thus, the model successfully predicted the archaeological manifestations of 67% to 77% of the sample units.

Table 66. Summary Distribution of Site Types by Archaeological Complexity Rank.

Complexity Rank	1	2	3	4	5	6	7	Total
Large Sites w/Features	0	0	3	1	4	3	8	19
Small Sites w/Features	0	0	1	2	2	18	5	28
Large Lithic Scatters w/Ground Stone	1	0	3	2	3	5	8	22
Small Lithic Scatters w/Ground Stone	1	0	4	2	9	16	6	38
Large Lithic Scatters	0	5	2	9	3	9	2	30
Small Lithic Scatters	1	16	5	18	15	12	9	76
Isolated Projectile Points	4	0	4	0	9	6	5	28
Isolated Ground Stone Artifacts	0	1	3	1	24	8	5	42
Isolated Chipped Stone Artifacts	2	1	7	9	15	8	14	56
Total	9	23	32	44	84	85	62	339
Number of Empty Sample Units	14	12	2	4	2	1	1	36
Number of Sample Units With Sites	4	9	6	10	10	13	6	58
Mean Sites per Sample Unit with Sites	2.3	2.6	5.3	4.4	8.4	6.5	10.3	5.8
Number of Sample Units with Occupations Sites	1	0	2	2	6	11	6	28
Number of Sample Units Conforming to Expectations	16	13	6	5	6	11	6	63
Number of Ambiguous Sample Units	1	4	0	2	0	2	0	9
Number of Quadrats Contradicting Expectations	1	4	2	7	6	1	1	22

The model successfully predicts presence or absence of sites in sample units. Table 67 arrays the number of units containing and lacking sites against ranks predicted to have none (Ranks 1 to 3) and always to contain them (Ranks 4 to 7). The distribution is significant in the direction expected. The model is similarly successful at predicting presence or absence of residential sites (sites with features and large lithic and ground stone scatters), as demonstrated in Table 68.

Table 67. Number of Sample Units with and without Sites by Ranks Predicted to Contain or Lack Sites.

	Sample Units With Sites	Sample Units Without Sites	Total
Ranks 1-3 (no sites)	19	28	47
Ranks 4-7 (sites)	39	8	47
Total	58	36	94
		Chi-square =18.008 1 d.f., p=.0001	

Table 68. Number of Sample Units with and without Residential Sites by Ranks Predicted to Contain or Lack Residential Sites (Sample Units without sites excluded).

	Sample Units Without Residential Sites	Sample Units With Residential Sites	Total
Ranks 1-3 (no occupation)	16	3	19
Ranks 4-7 (occupation)	14	25	39
Total	30	28	58
		Chi-square = 11.943 1 d.f., p=.0005	

The model was most successful in consideration of Ranks 1, 2, and 3 habitat types, in which 35 of 47 sample units (74%) firmly followed expectations, and of Ranks 6 and 7, in which 17 of 21 quadrats (81%) were consistent with expectations. For example, site densities in sample units with sites are lowest in ranks one and two sample units, while high site densities occur in ranks six and seven sample units. In contrast, the model is less successful at predicting Ranks 4 and 5 habitats. Here, 11 of 26 sample units (42%) conformed to predicted variability. Site densities in sample units with archaeological sites drop from 4.4 sites per unit in Rank 3 habitats to 3.7 sites per unit in Rank 4 habitats, but rise again to 7 sites per unit in Rank 5 habitats.

Considering that the available sample is drawn from an administratively disparate geography which does not represent Toedokado territory entire, we cannot know whether the disparity between prediction and actuality in Rank 4 and 5 sample units reflects inaccuracies in the soil and range database used to construct the model, error in our assessment of the foraging potential or archaeological record of these habitats, or sampling problems induced by the small clustered nature of the sample. The question can be resolved, but only in light of an adequate regional test.

Sample problems notwithstanding, review of the combined distribution of sites by complexity rank produces insights. Table 69 presents the distribution of site types by expected archaeological complexity rank for all 94 sample units in the sample. To minimize the number of cells with expected values of less than five, we collapsed site types into three functional categories: residential sites, sites associated with female subsistence strategies, and sites associated with male subsistence strategies. Residential sites include large and small sites with features and large lithic scatters with ground stone. Sites associated with females subsistence strategies comprise small lithic scatters with ground stone and isolated ground stone artifacts, while sites associated with male subsistence activities include large and small lithic scatters, as well as isolated projectile points and chipped stone tools. We subjected this distribution to chi-square analysis as a seven column by three row contingency table. The distribution is significant (chi-square = 57.509, 12 d.f. p=.0001). We transformed the nominal values of artifact counts to adjusted residuals, presented in Table 70. Recall that values greater than 1.96 or less than -1.96 are significant at the .05 level. Figure 119 presents the distribution of these three categories by predicted archaeological complexity as an ogive.

Residential sites occur significantly in Ranks 6 and 7 habitats, which are most likely to contain residential bases. They are significantly underrepresented in Rank 5 habitat types, in which we suggested potential would be moderate. At the same time, female subsistence sites are significantly abundant in Rank 5 habitat types. In contrast, male subsistence sites are proportionately overrepresented on Rank 4 sample units, but female subsistence sites occur less often than expected. Residential sites are rare in Rank 2 habitat types, consistent with expectations of low potential for residential occupation. Female subsistence sites are rare in Rank 2 habitat types while male subsistence sites are common, reversing our expectations of the foraging potential of these habitats.

Summarizing these patterns, three discordances between our expectations and the observed archaeological record are apparent in Table 70. First, residential sites occur in significantly lower than expected frequencies in Rank 5 habitat types, which we thought to have moderate potential for residentiality. Second, female subsistence sites are abundant in Rank 5 habitat types, which we thought productive for women's foraging, but are rare in Ranks 4 and 2 habitat types, which we also thought productive for women's foraging. Third, male subsistence sites occur significantly in Rank 4 habitat types, which we thought productive for men's foraging, but they are also significantly present in Rank 2 habitat types, which we believed unproductive hunting patches.

Table 69. Summary Distribution of Site Functions
by Archaeological Complexity Rank.

Expected Archaeological Complexity Rank	Residential Sites	Female Subsistence Sites	Male Subsistence Sites	Total
1	1	1	7	19
2	0	1	22	23
3	7	7	18	32
4	5	3	36	44
5	9	33	42	84
6	26	24	35	85
7	21	11	30	62
Total	69	80	190	339

Table 70. Adjusted Standardized Residuals of Site Functions
by Archaeological Complexity Rank.

Archaeological Complexity Rank	Occupation Sites	Female Subsistence Sites	Male Subsistence Sites
1	-0.7	-0.89	1.331
2	-2.51	-2.25	3.964
3	0.25	-0.24	-0.024
4	-1.59	-2.81	3.692
5	-2.53	3.904	-1.229
6	2.707	1.163	-3.139
7	2.924	-1.2	-1.234

Chi-square= 57.509, p=.0001

It is possible that the underrepresentation of residential sites and overrepresentation of women's subsistence sites in Rank 5 habitat types is a function of our misidentification of small lithic scatters with ground stone and isolated ground stone tools as specialized field camps, processing stations, and harvesting locations, when they actually represent small residential sites. If so, then site distributions correspond to expectations, with the size and diversity of residential site assemblages diminishing parallel to the relative ranks of the habitat types. Considering, however, the significant differences in diversity and composition of small lithic scatters with ground stone from sites with features and large lithic scatters with ground stone, it seems more likely that Rank 5 habitats have less capacity for residential occupation than we thought. Recall that these habitat types contain dry shrub communities that periodically are rich in seeds and berries, but that lack water sources.It may be that hunter-gatherers could best access these habitats from residential camps positioned on water sources in areas nearby.

Similarly, the overrepresentation of male subsistence sites in Rank 4 habitat types may represent our misinterpretation of lithic scatters as specialized site types when they are nondiverse occupation

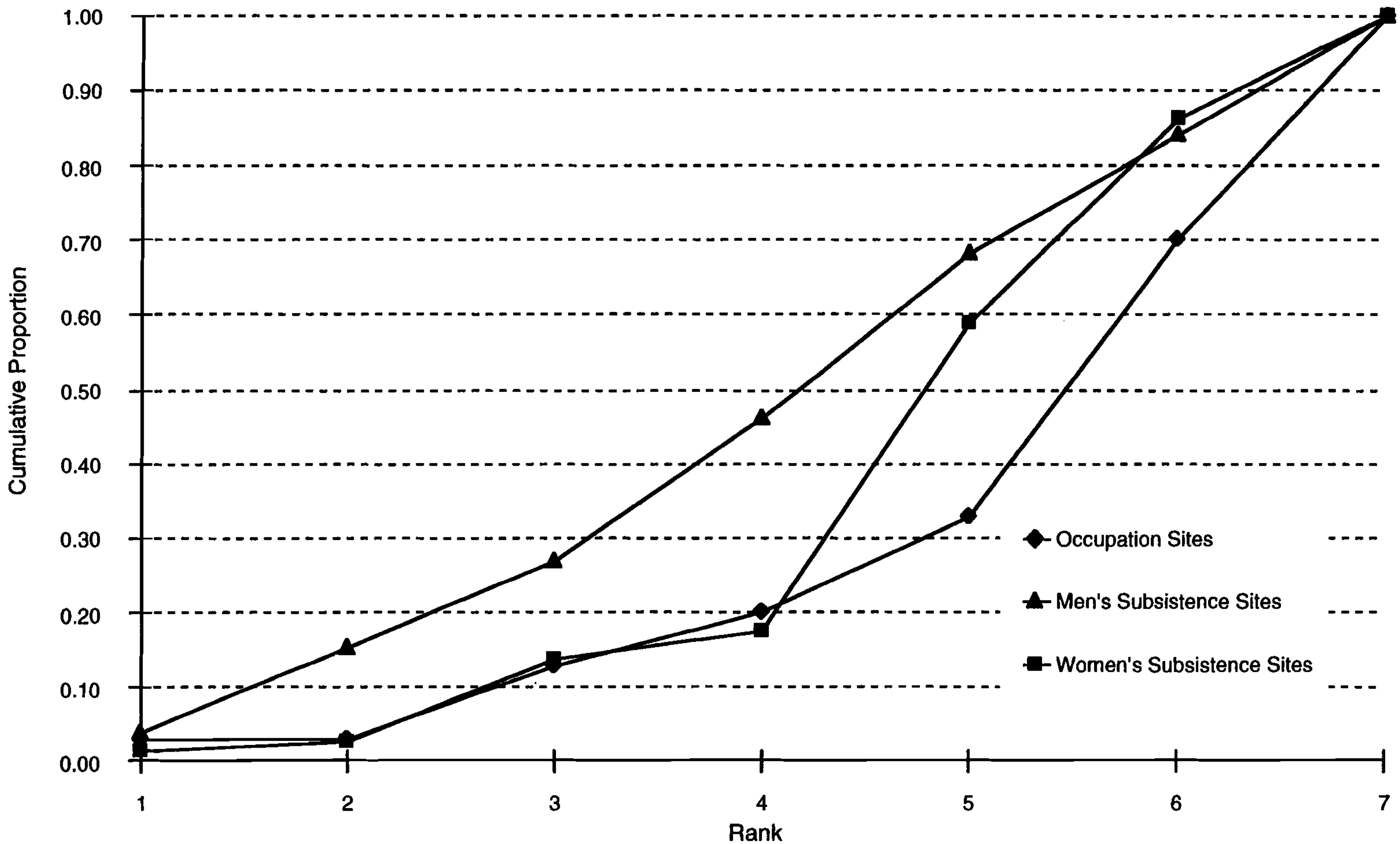


Figure 119. Cumulative distribution of residential sites, men's subsistence sites, and women's subsistence sites by expected archaeological complexity rank.

sites (perhaps where women emphasized the procurement of small mammals rather than seeds). But, it seems more likely that the bias reflects the productivity of dry sand dunes and sheets as hunting territories for a variety of game.

Finally, the dominance of male subsistence sites and lack of female subsistence sites in quadrats of Rank 2 habitat types warrants comment. The lack of evidence for plant food procurement and processing in these quadrats probably demonstrates that the sparse or low ranked seeds, roots, and berries available in rank two quadrats were simply too unprofitable to have attracted the attention of prehistoric gatherers very often. However, even though these habitat types should also be unproductive hunting territories, they contain more lithic scatters and isolated lithic tools than expected. Two factors may explain the bias toward male subsistence activity here: first, all but one of the 21 Rank 2 quadrats sampled contain gravelly sediments along lower alluvial fans. These deposits offer potential toolstone sources near toolstone-poor valley floor habitats. Thus, lithic toolstone procurement and processing may inflate the representation of lithic scatters in these otherwise impoverished habitats. In support, we note that bifaces and cores comprise 69% of all artifacts in Rank 2 habitats (n=76), more than in any other set of quadrats sampled. This suggests, as we expected in Chapter 5, that lithic toolstone procurement and processing can have tremendous influence on the archaeological record because of the high visibility of lithic debris and discards. Thus, habitat types that have poor foraging potential but contain toolstone sources can have significantly more complex archaeological records than predicted by the habitat type model. Specifically, these instances should contain abundant large and small lithic scatters dominated by cores and bifaces (see Elston 1988:155-160 for a formal model of lithic assemblage variability relative to toolstone source distributions in Toedokado territory).

Although toolstone sources cannot be calculated into the habitat model (because we cannot calculate caloric cost benefits for toolstone), predictions of the habitat model can be modified to accommodate toolstone sources. This requires systematic review of geological data to pinpoint and cross-stratify habitat types likely to contain toolstone. Absent this, specific toolstone sources can be noted as they are discovered, and the predictions of those specific quadrats modified to reflect the toolstone source.

Second, the heavy representation of lithic scatters in quadrats with Rank 2 habitats may reflect past environmental circumstances that are too ancient for the Toedokado model to reflect adequately. Two sample units (392/4356 and 366/4336) are associated almost exclusively with Great Basin Stemmed points, suggesting that the presence of these sites is attributable to environmental characteristics pertinent only to the early Holocene.

As is discussed in Chapter 9, the landscape comprising the habitat model refers to conditions of the mid-nineteenth century, yet we know that climate and landscape have varied considerably since the end of the Pleistocene, when people first entered the Great Basin (cf. Elston 1986). This suggests that the predictive ability of the habitat model should decline with increasing time depth, perhaps accounting for some of the unpredicted variability in the survey data.

Conclusions

Comparison of site types in 94 sample quadrats indicates that the habitat model successfully anticipated the archaeological record of 67% to 77% of the sample units. Greatest predictive success was among the highest (ranks six and seven) and lowest (ranks one, two, and three) ranked habitat types. The match between expected and observed archaeological records was less satisfactory for quadrats with rank four and five habitat types; these contained lower frequencies of residential sites than ranks six and seven habitats and lower percentages of empty quadrats than ranks one, two, and three quadrats. Since the model is most successful at predicting quadrats totally lacking archaeological remains and quadrats containing residential sites (i.e., sites likely to have subsurface features), the utility of the model as a planning tool for land managers is evident.

Because the present sample is derived from an administrative geography of parcels that does not represent adequately the entire Toedokado territory, it is presently impossible to determine if predictive failures reflect inaccuracies in the soil, vegetation, topographic, and hydrological data on which the model is built, or errors in the cost-benefit data used to rank habitat types, or errors in site type assignment based on surface survey data, or sampling error. We do observe that, since this assessment was based on surface observations, the burial or deflation of sites and features likely affects the successful prediction rate of the model. Too, our exclusion from consideration of sites and isolates containing only debitage probably affects predictive success rates as well. Further studies involving subsurface testing and more intensive surface assemblage inventory may achieve higher prediction success.

We suspect that some of the predictive errors reflect paleoenvironmental variability but presently available data are insufficient to evaluate this possibility. Available data do suggest these three modifications to the predicted archaeological complexity of habitat types. First, we reassess rank five habitats as having low potential for residential occupation because of the lack of water sources in these habitats. Second, ranks three and four habitats are only moderately profitable for women's substance activities, while rank two habitats are unprofitable for women's foraging. Third, expectations for the archaeological record of rank two habitats should be modified to account for the availability of toolstones on lower alluvial fan sediments.

Chapter 9. PALEOENVIRONMENTAL VARIATION AND HUMAN LAND USE IN TOEDOKADO TERRITORY

Robert G. Elston, David W. Zeanah, James A. Carter, and Daniel P. Dugas

The ethnographic Toedokado habitat model provides an economic framework from which to interpret site distribution as well as a basis for generating expectations about where sites should be located. In preceding chapters, we modeled the resource landscape of ethnographic Toedokado territory and assessed the economic costs and benefits of using its resources. Assessments of the model against the archaeological record produced good results, but some deviation of the archaeological record from modelled expectations may be a function of paleoenvironmental variability in the resource structure of the model area.

Investigation of temporal variability in subsistence strategies responding to paleoenvironmental change is a primary research endeavor among western Great Basin archaeologists. Several investigators propose that hunter-gatherer adaptations have changed significantly in Toedokado territory over the last 10,000 years (Elston 1982, 1986; Kelly 1985). Temporally patterned deviations of the archaeological record from Toedokado model predictions are likely to reflect this variability; if we can alter the parameters of the habitat model to account for changes indicated by the paleoenvironmental record, then the habitat model should usefully predict what the responses of hunter-gatherers to that variability should have been.

Temporal variability in the performance of the model was anticipated in Chapter 2. We guessed that the model would perform best with reference to the most recent past and with decreasing precision with increasing time depth because our understanding of landscapes and human diet breadth becomes less perfect as we go farther and farther back in time. For example, climate (Figure 120), has varied considerably during the twelve to eleven thousand years the Great Basin has been occupied by humans (cf. Elston 1986), with concomitant changes among plants and animals (Tausch et al. 1993; Grayson 1993). Thus, the landscape nearest to us in time (such as that incorporated in the Toedokado model) is the one we are most likely to approximate with the fewest errors.

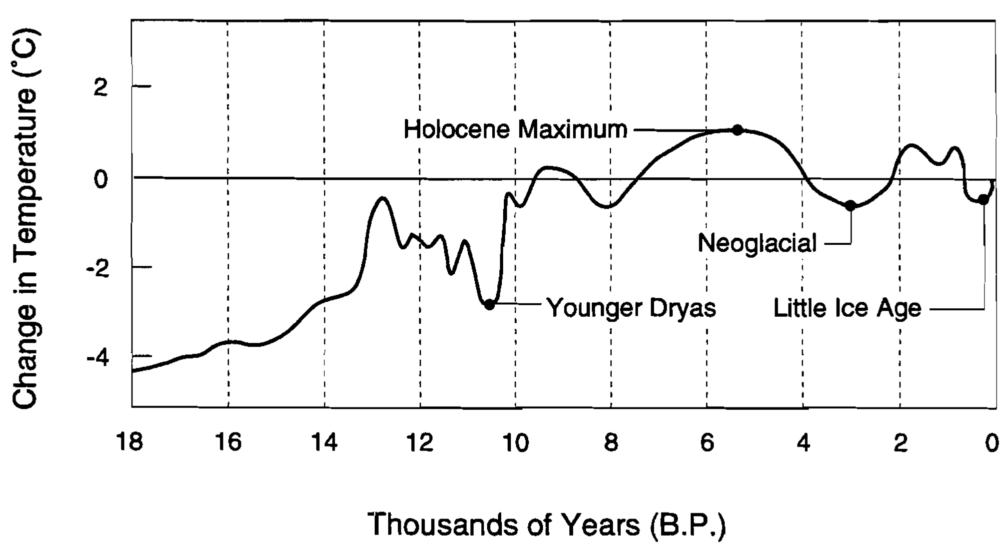


Figure 120. Global temperature variation during the Late Pleistocene and Holocene (after Eddy and Bradley 1991).

It follows that no single iteration of the model landscape can account for the entire archaeological record. Optimal model performance can be achieved only with a model incorporating several landscapes, each reflecting the environment of a particular period. Eventually, we will have a fine-grained paleoenvironmental record developed from studies of tree rings, pollen, and pack rat middens (cf. Bradley 1985). However, the number of landscapes it is practical to model for archaeological research or management in the Carson Desert is limited by our ability to distinguish between time periods using time sensitive artifacts (i.e., projectile points and shell beads) that are likely to be observed on the surface. Moreover, such artifacts mark relatively broad (several hundred to two or three thousand years) periods, within which there may be considerable paleoenvironmental variation. This suggests that we must be content with model landscapes that "average" the environment for any particular prehistoric period; the longer the period, the less precision we can expect.

But development of fully operational landscape models for each prehistoric period is beyond the scope of the present study. What we can do is consider major paleoenvironmental changes known to have occurred in the region occupied by the ethnographic Toedokado, and evaluate their effects on paleolandscapes. This will give us a better idea of how the basic model might be revised to improve its predictive power for any particular prehistoric period. Thus, the goal of this chapter is to assess how far back in time we can project the habitat model with confidence, how paleoenvironmental variability is likely to affect the structure of the resource landscape portrayed by the habitat model, and how that variability would have affected foraging strategy.

We consider Great Basin paleoenvironmental history divided into three large intervals: Pleistocene-Holocene transition (11,500-7,000 B.P.), middle Holocene (7,000-4,500 B.P.) and late Holocene (4,500 B.P. to present). First we outline landscapes in the Pleistocene-Holocene transition (PHT). The dates of 11,500 B.P. and 7,000 B.P. bound an interval utterly unlike anything in the middle or late Holocene. The climate was generally more cool and moist that at present (cf. Figure 120), the Carson Desert maintained standing lakes for long periods (probably with the contribution of the Walker River), and vegetation was dominated by an *Artemisia* steppe. Moreover, the starting date of 11,500 B.P. coincides with the most likely earliest human occupation in the Great Basin, and with the pause in the recession of Lake Lahontan at the 1203 m Russell shoreline. The magnitude of these climatic and hydrological differences suggest that the resource landscape of the Pleistocene-Holocene transition must have been quite different from that of the habitat model. Therefore, we decline to attempt to project the model back so far in time. However, working from a thin paleoenvironmental record, we have estimated what the resource landscape should have looked like; descriptions of PHT habitats are broadly conceived, and are likely to be wrong in many details. Nevertheless, we believe that we have captured many of the salient features of economic importance to foragers of the Pleistocene-Holocene transition.

Next, we address the middle Holocene interval between 7,000 B.P. and 4,500 B.P. when the warming trend peaked (cf. Figure 120), and vegetation communities (including the saltbush zone) seen in historic times were established. There is no evidence for lakes in the Carson Desert at this time, but paleoenvironmental records are scarce. Because this interval lacks known time-marking artifact types altogether (Elston 1986; Grayson 1993), we consider it here only in passing. Moreover, because available paleoenvironmental data suggest that the climatic parameters of this interval differed so much from the present, we do not project the habitat model into this interval.

Then we consider the late Holocene, when vegetation zones occurred in roughly the same positions we see them now, and contained virtually the same plant species observed historically, with the exception of pinyon pine. Thus, it is in this interval that the resource landscape portrayed by the habitat model came into being. We discuss effects of, and evidence for, the extremes of late Holocene climatic variation: mesic intervals and extended droughts. We then assess the effects of these variations on relative habitat productivity and resource structure as portrayed in the habitat model.

Finally, we model how paleoenvironmental changes to the habitat type landscape should have affected hunter-gatherer subsistence and settlement decisions. First we model autumn foraging returns for ethnographic Toedokado from two ethnographically recorded camp locations. This simulation serves as a baseline by which foraging responses to the resource landscape under ethnographic conditions can be compared to changes in resource distributions inferred from the paleoenvironmental record. Then we alter the resource structure to accommodate the habitat type landscape as it occurred during the early Late Holocene and restructure the simulation accordingly. Finally, we conduct a foraging simulation for hunter-gatherers of the Pleistocene-Holocene transition in a hypothetical habitat landscape deduced from the paleoenvironmental record.

Landscapes of the Pleistocene-Holocene Transition

By convention (Hopkins 1975; Grayson 1993:46-47), the last glacial epoch of the Pleistocene ended and the Holocene interglacial interval began at 10,000 B.P. In reality, the Pleistocene-Holocene boundary is less clear-cut, since changes occur at different rates in extent of glaciers, elevations of lakes, and distributions of plants.

Late Pleistocene Climate and Vegetation

During the late Pleistocene (ca. 22,000 to 13,000 BP), the Great Basin witnessed the resurgence of mountain glaciers and high stands of valley lakes. Climate was influenced by the position of the polar jet stream, forced far to south by the thick Laurentide ice sheet. This greatly increased the number and severity of winter storms (Kutzbach and Wright 1985; Kutzbach 1987; Kutzbach et al. 1993). During much of this interval, however, storm tracks apparently were depressed so far south that the Lahontan Basin while very cold, was relatively dry. Under these conditions, between 24,000 and 16,000 B.P., glaciers formed above 3048 m (10,000 ft amsl) in the Sierra Nevada and higher ranges of the Great Basin (Grayson 1993:102-103; Thompson et al. 1993:484). Since the highest mountain valleys of the Clan Alpine and Stillwater Ranges reach only 3038 and 2678 m (9967 and 8787 ft amsl) respectively, upper slopes in Toedokado territory must have been ice free, even during the glacial maximum. At this time, Lake Lahontan seems to have maintained itself between 1260 m (4134 ft) and 1270 m (4167 ft), connecting the western and Carson Desert subbasins across Darwin Pass (Benson and Thompson 1987a; Benson et al. 1990:248).

Around 16,000 B.P., the polar front began to move northward and more winter storms crossed the Lahontan Basin. Because lakes rose while glaciers retreated, climate during this time seems to have been both wetter and warmer than during the earlier glacial maximum. Compared to today, it was perhaps 5° to 7° C cooler, with 1.8 times greater annual precipitation (Benson and Thompson 1987b:254-255; Hostetler and Benson 1990). Effective precipitation reached its maximum between approximately 14,200 B.P. and 13,800 B.P., when Lake Lahontan reached its maximum elevation (1330 m [4364 ft amsl]). This increase was short lived. The rapid decline of Lake Lahontan (over 130 m) in the next two thousand years suggests a warming climate that was only arrested between 11,500 B.P. and 10,500 B.P. (cf. Figure 120) during a global return to glacial conditions known as the Younger Dryas Period (Benson et al. 1992).

Plant macrofossils from dated woodrat middens (Wigand and Nowak 1992; Nowak et al. 1994a) the pollen record from Hidden Cave (Wigand and Mehringer 1985), and lacustrine deposits from Pyramid Lake (Davis and Elston 1972) indicate that between 23,000 and 11,500 B.P., whitebark pine (*Pinus albicaulis*) grew in the Virginia Mountains at 1,380 m (4,530 ft), 1,120 m (3,75 ft) lower than it now occurs, restricted to the Carson Range west of Reno (Wigand and Nowak 1992:45). Rocky slopes of the

Stillwater and Clan Alpine Ranges, and probably the Desert, Cocoon, Sand Spring, Fairview and West Humboldt ranges above 1800 m (5906 ft amsl) likely harbored stands of Utah juniper (*Juniperus osteosperma*) and pine (most likely limber pine or whitebark pine) during this period. Brushy steppe extended from lake shores into the surrounding mountain ranges (Wigand and Mehringer 1985:122; Wigand and Nowak 1992:50; Nowak et al. 1994a). Although greasewood and saltbush were present, the zonal communities we now see in valley bottoms and fringing playas were absent. Much of the present saltbush habitat was occupied by lakes and marshes, and soil moisture may have been too great to sustain large communities of these plants on alluvial fans at higher elevations.

Late Pleistocene Lakes

Recession of Lake Lahontan continued until, in the Carson Desert possibly falling below 1203 m (3947 ft amsl) for a brief time, it stabilized at the 1203 m Russell shoreline between about 11,500 B.P. and 10,500 B.P. (Elston, Katzer and Currey 1988; Currey 1988, 1989), during the Younger Dryas Period (Benson et al. 1992). At this elevation, the lake filled both Carson Sink and Humboldt Sink, and covered the area of Naval Air Station Fallon and Carson Lake. The Salt Wells Basin possibly was connected with this lake through a narrow arm at Salt Wells (Davis 1982:Figure 6); if so, the putative connection did not last long enough for a 1203 m shoreline to develop in Salt Wells Basin (Morrison 1964:Table 7).

The Russell Shoreline and Fallon Lakes

The 1203 m shoreline originally was interpreted as the oldest of five "Fallon Lakes" thought to date from about 4,000 B.P; younger stands occurred at 1198 m (3931 ft amsl), 1193 m (3914 ft amsl), and 1186 m (3891 ft amsl) (Morrison 1964:79-90; Table 7). However, tephrochronology suggested some of these lakes were at least early Holocene in age (Davis 1978, 1982:67). Later, radiocarbon assays of tufa and marl in deposits originally described by Morrison (1964:80, Plate 11, Figure 32) as First or Second Fallon Lake, yielded dates of 11,300 B.P. and 11,100 BP (Elston, Katzer and Currey 1988; Currey 1988, 1989), demonstrating the age of the 1203 m "First Fallon Lake" shoreline as Late Pleistocene. More recently, *Anadonta* shell obtained from the north side of the Humboldt Bar at an elevation of 1198 m dated to 10,380 B.P. (Benson et al. 1992). This indicates that Morrison's (1964) 1198 m "Second Fallon Lake" also dates to the Late Pleistocene. We think it likely that the 1198 m shoreline is a recessional stand in the decline of the 1203 m lake.

Lake Dixie and Lake Labou

Although there are no dates for the Late Pleistocene stands of Lake Dixie, we speculate that one or more of the three sets of large shoreline features (in sections 29 through 32 of T. 22 N., R. 36 E) lying at elevations near 1080 m (3543 ft amsl), 1073 m (3520 ft amsl), and 1064 m (3491 ft amsl) are correlated with the 1203 m Russell shoreline in the Carson Desert basin (D. Dugas, personal communication, June 1993). Because of its relatively small size and shallow (ca. 10 m) depth, shorelines of Lake Labou are more difficult to see; in any case, Lake Labou has received even less attention from geomorphologists than Lake Dixie (but cf. Nials 1994). Lake Labou spilled to the northeast into Dixie Valley Wash when it reached 1,274 meters (4180 ft amsl). This channel is topographically obvious on the USGS Drumm Summit, Nev., 1:24,000 (1972) quadrangle, and is also delineated in part by soil and vegetation on the Drumm Summit vegetation inventory (USDI BLM 1982) map. It is possible that the climate was cool and moist enough to keep the lake at this elevation most of the time during the Late Pleistocene, but we suspect that Lake Labou was more variable than the larger Dixie and Lahontan lakes.

Late Pleistocene Marshes

Most of the extant pollen records provide little information about marsh vegetation during the late PHT. Between 1203 m and 1198 m, much of the lake shoreline in the Carson Desert south of the West Humboldt Range would have been steep and subject to considerable wave action, particularly on the (lee) eastern and northern margins. Likely locations for marshes would have been more shallow and protected places, as for example, in the arms extending westward up Massie Slough west of Upsal Hogback and northeast into what is now the Humboldt Sink, in the flats west of what is now Carson Lake, and on margins of the Salt Wells Basin. Extensive riparian marshes probably were present upstream of the lake on both the Humboldt and Carson rivers. Flatter, poorly drained areas such as that between Sheckler Reservoir and Carson Lake, and between Massie Slough and Soda Lake, may have contained numerous interdunal basins and eolian depressions holding ponds and small lakes with marshes.

The stratigraphy of Leonard Rockshelter also may provide some clues about the location and duration of marshes (Heizer 1951). The shelter stands at 1,275 m (4175 ft) on the north side of the West Humboldt Range, overlooking the Humboldt Sink. The lowest stratum in the shelter is beach gravel, overlain with angular fragments of tufa spalled off the shelter wall after the water retreated, in turn overlain with a layer of bat guano that accumulated between 11,199 B.P. and 7038 B.P. (Heizer 1951; Byrne, Busby and Heizer 1979). Since bats eat insects, we assume a plentiful supply of insects near the shelter. And because marshy habitats are among the most buggy, perhaps it is not going to far to assume fairly extensive marshes around the margins of the Late Pleistocene (1203-1198 m) lake extending up the Humboldt drainage.

There are no dates for the Late Pleistocene stands of Lake Dixie and Lake Labou, but we speculate that Lake Dixie supported marshes at its northeastern and southwestern margins below 1064 m. Moreover, if relatively shallow Lake Labou was maintained at about its maximum (1,274 m) through much of the Late Pleistocene, extensive marshes could be expected to form around its north and south margins, and along the drainage spilling into Dixie Valley.

Subaerial Deposits in the Pleistocene/Holocene Transition

Dunes probably were prominent features of the Late Pleistocene landscape anywhere that sand was plentiful. Dune formation in the Lahontan Basin is likely to have accelerated as soon as the receding lake exposed supplies of sand in beaches, deltas, and extensive subaerial (Wyemaha) deposits from the last interglacial period. If the lake did decline briefly below the Russell shoreline before 11,500 B.P., it is possible that any sand dunes accumulated below 1203 m later formed islands in the 1203-1198 m lake. There is, however, no firm geological evidence of such dune islands, which in any case would have been planed off quickly by wave action and ice (Dugas 1993). The extensive belt of silt and sand dunes now present on the eastern and northern margins of Carson Sink probably did not begin to form until the complete desiccation of the Carson Sink after Mazama time.

Fauna in the Pleistocene-Holocene Transition

Grayson (1993:159, Table 7-2) reports that of the thirty-five genera of mammals that became extinct at the end of the Pleistocene, sixteen were native to the Great Basin. These included ground sloth, short-faced bear, large cat, horse, camel, muskox, mastodon, and mammoth. None of these, however, has ever been found in undisputed association with humans in the Great Basin, and the majority of reliable radiocarbon dates for extinct mammals are no younger than 13,500 to 11,500 B.P. This suggests that these animals were on the wane during the initial warming trend of the Late

Pleistocene, but some may have been present at the appearance of human hunters around 11,500 B.P. (Nelson and Madsen 1980). All of the large mammals present in the Great Basin throughout the Holocene (bison, elk, deer, antelope, and mountain sheep) were also here in the Late Pleistocene, but there presently is no way to estimate accurately their numbers or distribution (Donald Grayson, personal communication, December 1994). Still, higher biodiversity and relative abundance of shrubs and herbaceous species during the PHT (Table 71) is likely to have offered good forage for large animals of modern species, so we can speculate that they were abundant then, perhaps more abundant than in modern times. Small mammals now resident in the Great Basin (ground squirrel, pack rat, marmot, hare, rabbit, pika) were present in the Late Pleistocene, although in different distribution (Grayson 1993:177-182). Climate and vegetation also may have fostered a larger population of these animals in the PHT than later in the Holocene.

Table 71. Forage Plants Present in a Fossil Woodrat Nest Near the Western Margin of Toedokado Territory (after Nowak et al. 1994a).

Forage for:	**a**	**b**	**c**
	taxa in fossil and modern records	taxa only in fossil record or in modern flora at higher elevation	taxa only in modern vegetation
Antelope	*Chrysothamnus* sp. *Crepis* sp. *Eriogonum* sp. *Graya spinosa* *Lupinus* sp. *Poa* sp *Sitanion hystrix* *Stipa* sp.	*Oenothera* sp. *Oryzopsis hymenoides* *Prunus andersonii* *Purshia tridentata* *Rosa* sp.	*Phlox* sp.
Mule Deer	*Artemisia tridentata* *Astragalus* sp. *Atriplex canescens* Crepis sp. *Eriogonum* sp. *Juniperus osteosperma* *Lupinus* sp. *Poa* sp. *Sitanion hystrix* *Stipa* sp.	*Agropyron* sp. *Balsamorhiza sagittata* *Cercocarpus ledifolius* *Ephedra viridis* *Oryzopsis hymenoides* *Prunus andersonii* *Purshia tridentata* *Ribes* sp. *Rosa* sp.	
Mountain Sheep	*Artemisia tridentata* *Astragalus* sp. *Atriplex canescens* *Atriplex confertifolia* *Crysothamnus* sp. *Crepis* sp. *Eriogonum* sp. *Juniperus osteosperma* *Lupinus* sp. *Poa secunda* *Sitanion hystrix* *Stipa* sp.	*Agropyron* sp. *Balsamorhiza sagitta* *Ephedra viridis* *Oryzopsis hymenoides* *Prunus andersonii* *Ribes* sp. *Rosa* sp. *Trifolium* sp.	

Table 71, continued.

Forage for:	**a**	**b**	**c**
Rabbits/Hares	*Artemisia tridentata* *Astragalus* sp. *Atriplex canescens* *Atriplex confertifolia* *Crysothamnus nauseosus* *Crysothamnus viscidiflorus* *Graya spinosa* *Kochia americana* *Lupinus* sp. *Poa* sp. *Stipa comata* *Stipa thurberiana* *Tetradymia glabrata*	*Eleocharis* sp. *Ephedra viridis* *Oryzopsis hymenoides* *Prunus andersonii* *Purshia tridentata* *Rosa woodsii*	*Gilia* sp.
Ground Squirrels	*Artemisia* sp. *Astragalus* sp. *Atriplex* sp. *Lupinus* sp. *Poa* sp. *Sitanion hystrix* *Stipa* sp.	*Agropyron* sp. *Balsamorhiza sagitta* *Ephedra* sp. *Oryzopsis hymenoides* *Purshia tridentata* *Ribes* sp.	
Woodrats/Marmots	*Artemisia* sp. *Astragalus* sp. *Juniperus osteosperma*	*Ephedra* sp. *Ribes* sp.	

Environments of the Early Holocene

Early Holocene seasonality was quite different than at present. The shrinking Laurentide ice sheet still forced the jet stream and winter storms to the south, but fewer passed directly over the Lahontan Basin (Kutzbach et al. 1993:Figure 4.16). According to Kutzbach and Webb (1993:5-6), at 9,000 years ago the orbital geometry of the earth around the sun was such that perihelion (the point at which earth is closest to the sun) fell in July (it now is in January), and the axial tilt of the earth relative to the sun was greater then (24.5°) than now (23.5°). Solar radiation was high, summer insolation about eight percent greater than today, and summer continental temperatures about 5°C higher than at present; summers in the Great Basin were also probably warmer than at present, although precise temperatures are unknown (Thompson et al. 1993:489). However, winters were colder than at present and average temperatures were cooler than today. Paleoclimate models and increased hydrogen-deuterium ratios from packrat middens suggest the possibility of a strong summer monsoon (and greater summer precipitation) under these conditions (Thompson et al. 1993:491, 495), but increased southerly flow does not correlate well with other paleobiotic data (Thompson et al. 1993:495). Rapid climatic changes resulted in corresponding rapid changes in vegetation assemblages, high species turnover, and high biodiversity (Nowak et al. 1994a). Abundant perennial forbs and brushy species likely offered better forage for both large and small animals, perhaps increasing this abundance.

Although the ensuing Early Holocene climate was warmer and dryer than previously, it was on average cooler and more moist than at present. While marshes in eastern Oregon, Ruby Valley, and Las Vegas Valley seem to have gone dry by 7,500 B.P. (Grayson 1993:197), valleys (including the Carson Desert) in western and central Nevada contained lakes at the time of the Mazama eruption about 6,900 B.P. (Davis 1982:65).

Benson et al. (1992) show that lakes in the western arm of Lake Lahontan declined sharply between 10,000 and 9,700 B.P., when Pyramid Lake fell below modern levels. Although, as noted above, this event seems to coincide with the retreat of juniper to higher elevations, other signals, such as the accumulation of bat guano in Leonard Rockshelter, and the pollen record from Hidden Cave, do not suggest the complete recession of lakes in the Carson Desert, although such events cannot be ruled out. The continued contribution of the Walker River through Adrian Valley may have prevented the desiccation of the Carson Desert, but we also note that Mono Lake was relatively high between 10,000 and 7,000 B.P. (Benson et al. 1990). This and the continued dominance of Artemisia steppe until after 6,900 B.P. suggest the continuation of relatively moist conditions.

There are no data regarding lakes in Dixie and Fairview Valleys during most of the Early Holocene, but Davis (1982:65) notes that at 6,900 B.P., Mazama ash fell into shallow lakes in Dixie Valley and in Big Smoky Valley in central Nevada. In the Carson Desert, Mazama ash fell into a lake deeper than about 1186 m (3891 ft amsl) (Morrison 1964:Figure 32; Davis 1978:87). Davis (1982:65) suggests the water stood at 1200 m (3937 ft amsl), but we suspect it stood lower than 1,198 m, perhaps at the 1193 m or 1190 m shorelines described by Morrison (1964) as the Third and Forth Fallon Lakes. The presence of a lake in the Carson Desert at this time also is indicated by marl underlying an archaeological site (26Ch1172) in Stillwater marsh dating to 6930 B.P. (Raven and Elston 1988).

Landscapes of the Pleistocene-Holocene Transition

In previous pages we have described a landscape of the PHT that was very different from the resource landscape of ethnographic Toedokado Territory (Figure 121); the greatest contrast between the two is the large scale homogeneity of the former. The PHT presented foragers with roughly similar opportunities from valley to valley: highly productive shallow lakes and marshes on the valley floors, brushy steppe from shoreline to the tops of most mountains, and juniper woodland with a brushy or herbaceous understory on ridge tops. In the Holocene, lakes and marshes are widely scattered mesic islands in a sea of much dryer (and less productive) valley floors and uplands. Thus, while water was a no less critical resource for early foragers than it was for ethnographic people (or ourselves), it was much more widely distributed. This suggests that habitats centered on springs would have had a lower value for people of the PHT than for later foragers in more xeric landscapes.

Plant communities of the PHT seem to be fewer and perhaps less patchy than those later in the Holocene, but this smoothness is likely an artifact of the coarse grain of the paleoenvironmental record based on few sites spread over a very large area. The progressive warming and desiccation during the PHT suggests a dynamic landscape in which climax was rarely approached, and this is supported by evidence of greater biodiversity and species turnover (Nowak et al. 1994a). Further study likely will reveal greater complexity, with plants and plant communities in places heretofore unsuspected (cf. Rhode 1994).

Because lakes and marshes of the PHT occupied a much larger proportion of valleys than they did later, valley margins with fans and sandy lowlands were smaller in area. Now covered by relatively unproductive sagebrush and desert scrub, this zone likely was occupied by a more diverse steppe (Nowak et al. 1994a), which, though dominated by *Artemisia*, contained other brushy species and forbs

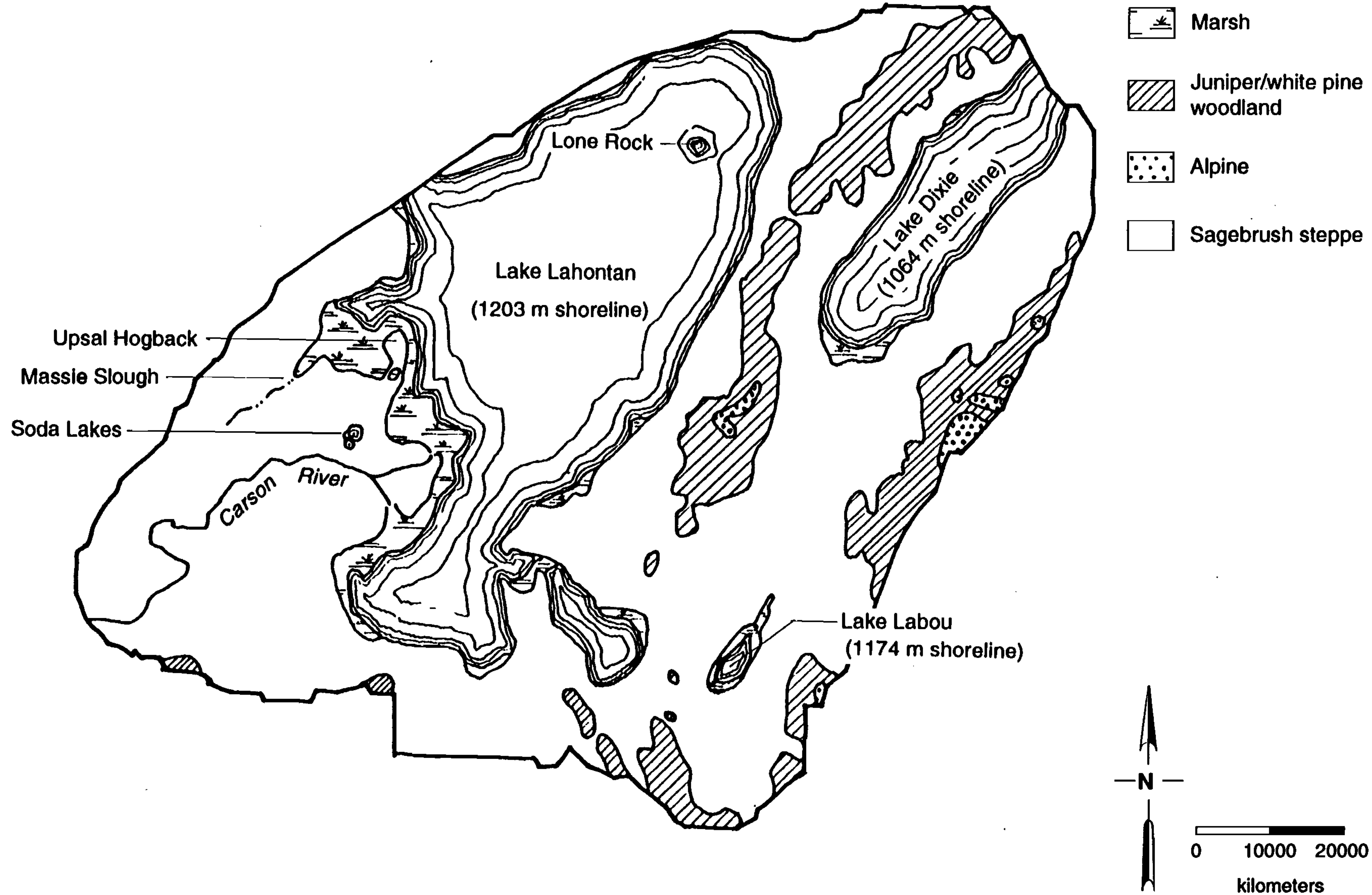


Figure 121. Interpreted Toedokado Study Area environments at the late Pleistocene/early Holocene transition.

that provided better forage for large and small herbivores than did historic sagebrush communities. If true, these lower steppe communities between the mountain slopes and lake or marsh margins would have been good places to find large mammals such as bison, elk and deer, and should be ranked among the most productive habitats.

In considering how much large game could have contributed to diets of the PHT, Simms (1987:93) stresses that animal abundance and density depends on size and quality of habitat. If large animal habitats of the PHT were large in area but low in quality, animal density would be low. On the other hand, if the quality of large animal habitats was high during the PHT, large animal density (and encounter rates) should have been high. We suspect the lower steppe zone provided a high quality habitat for herbivores and encounter rates there were high, especially if animals were concentrated in the steppe zone in winter.

The slow but continuous desiccation of valley bottoms through the PHT may have increased steppe habitat and forage for game animals, and further increased hunting opportunities before complete desiccation occurred. In contrast, the productivity of upper mountain slope and summit habitats (historically the best for hunting large game) may have been relatively low because of higher logistic costs and lower encounter rates. However, large animals such as elk, mule deer, and possibly even bison, may have been attracted to the marsh-steppe ecotone for both forage and cover. For example, at Malheur National Wildlife Refuge in eastern Oregon, we have observed mule deer foraging on marsh vegetation (in both standing water and in dry conditions), and bedding in high vegetation along marsh fringes. The lower steppe zone is convenient to both marshes and mountain slopes, and so is a good choice for bases from which to forage in other habitats as needed.

Although their true extent in the PHT is unknown, we speculate that marshes then were much more extensive than during the last half of the Holocene, and were more equably distributed across the landscape. Figure 121 approximates marshes associated with lakes Lahontan, Dixie and Labou at about 11,500 B.P. This estimate is based on water depth and wave fetch (emergent plants prefer quiet water less than one meter deep). Additional marsh is likely in places such as the poorly drained area between the Carson River and Massie Slough. We suspect that as Lake Lahontan receded from the 1203 m Russell shoreline, marshes increased apace and may have reached their maximum extent in the early Holocene.

Marshes offered the same suite of resources to foragers of the terminal Pleistocene as they did to ethnographic people: seeds, shoots, pollen, birds and bird eggs, shellfish, and small mammals. The increase in marsh area, however, may not have resulted in a corresponding increase in the abundance of these resources. If plants were not significantly in the diet of the early foragers, the value of marshes per se as patches may have been lower than they were to Archaic people, while the value of habitats in the marsh-steppe ecotone were likely as high or higher.

Great Basin Hunter-Gatherers in the Late Pleistocene-Holocene Transition

An archaeological record first becomes visible in the Great Basin between 11,500 B.P. and 10,500 B.P (Elston 1986; Grayson 1993). The earliest remains often are subsumed under the rubric "Western Pluvial Lakes Tradition" (Bedwell 1973), a widespread manifestation characterized everywhere by similar lithic assemblages and a propensity for lake margin site locations, and are believed to have been deposited during the period 11,500 and 8,000 B.P. These early lithic assemblages are marked by fluted points, by stemmed edge-ground projectile points, and by crescents (cf. Elston 1986; Basgall 1988; Fagan 1988; Willig 1988).

Clovis Foragers in the Carson Desert

Fluted Clovis projectile points were in use throughout western North America between 11,500 B.P. and 10,500 B.P. (Haynes et al. 1984), but Clovis points are rare in the Great Basin; only from the lowest levels of Danger Cave in Utah has a specimen been recovered from a stratigraphic context and dated by radiocarbon (11,452-10,270 B.P.) (Jennings 1957; Holmer 1986). The earliest cultural radiocarbon date from the western Great Basin is 11,200 B.P. from the bottom of Fishbone Cave on Winnemucca Lake (Orr 1956; 1974), but this date was not associated with diagnostic projectile points. A date of 11,199 B.P. was obtained from the bottom of a guano layer in Leonard Rockshelter (Heizer 1951; Byrne, Busby and Heizer 1979) that did contain artifacts.

Surface finds of Clovis points in the Great Basin are more frequent (cf. Davis and Shutler 1969; Tuohy 1985, 1986; Elston 1986; Willig and Aikens 1988; Schmitt and Dugas 1992;), but not common. The majority of Clovis finds are associated with lake shores (but see Schmitt and Dugas 1992). Of particular relevance here, Davis and Shutler (1969) illustrate (but do not describe) two Clovis points from a lakeside setting near Lovelock, Nevada. Anan Raymond (1990) reports the find of an obsidian Clovis point about 1.2 km south of the margin of the Labou Flat playa. The approximate elevation of the find was 1273 m (4177 ft amsl), placing it on or near the maximum elevation of pluvial Lake Labou in what now is a saltbush and greasewood community. Other flaked stone artifacts were seen in a road at this locus, but their association with the point is unknown. Of course, this find suggests the possibility that more Clovis age material lies at the original find spot and, perhaps as well, elsewhere along the 1274 m (4180 ft amsl) Labou Lake shoreline and the wash through which it spilled into Dixie Valley.

Early Holocene Foragers In the Carson Desert

Great Basin Stemmed Series (GBSS or Stemmed) points (Tuohy and Layton 1977) seem firmly dated to between 10,000 and 8,000 B.P. (Elston 1986; Grayson 1993), but may range somewhat earlier and later (Beck and Jones 1988). Compared to Clovis sites, those with Stemmed points are larger and more numerous. In the Carson Desert, several of these sites occur on ancient beaches at or just below the 1203 m (3947 ft amsl) Russell Shoreline, including the site on the ancient beach below Granite Point north of the Humboldt Sink (Heizer (1951a:94) and the Sadmat site of the western Carson Desert (cf. Hester 1973:62–68; Dansie 1981;Tuohy 1968, 1981; Warren and Ranere 1968). The Hathaway Beach site, a quarry-workshop south of Carson Lake (Grosscup 1956), is in a low pass overlooking Carson Lake.

Evidence for Human Adaptive Strategies in the Pleistocene-Holocene Transition

Assemblages of PHT sites contain bifaces, fluted and stemmed edge-ground projectile points, steep-edged end and side scrapers, bifacial chopper-like tools, fine gravers and awls, flake tools, and crescents (cf. Elston 1986; Davis and Rusco 1987; Basgall 1988; Fagan 1988; Willig 1988). Scrapers, flake tools, and point preforms often are made on blades or blade-like flakes; tools frequently are notable for their large size. Since the technology involved in the manufacture and maintenance of this tool kit is one that is expensive to master and maintain, we assume that its cost has adaptive significance. Although this tool kit is one that could be employed to capture and process a variety of resources including fish, small mammals, and plants, it seems more appropriate for use on larger prey. It also has features that minimize the risk of running out of tools and the inability to predict the encounter of sufficient toolstone sources as a consequence of high mobility (Goodyear 1986; Kelly and Todd 1988; Elston 1992).

Positioning strategies are also related to diet. People locate themselves in places most convenient to the resources they pursue. Both fluted and stemmed points frequently are associated with pluvial lake shores, river and stream terraces, or elevated places on valley margins (Basgall 1988:104; Beck and Jones 1988, 1990; Elston 1994; Kelly 1978; Rusco and Davis 1979; Willig 1988; Zancanella 1988). While these latter locations could be chosen for other reasons, they tend to provide a long line of sight which enhances ability to monitor game movement. This propensity for early foragers to select elevated site locations on old beaches, spits, and ridges suggests such geoforms as sample strata useful for increasing predictive accuracy of archaeological models.

PHT site locations often lie in what now are poor habitats where later Archaic sites are rare. Lithic scatters containing fluted points often contain Great Basin Stemmed points and crescents known to date to the Early Holocene (Elston 1986). Either later people tended to collect Clovis points, or (more likely) convenience to similar resources attracted people to the same locations through both the Late Pleistocene and Early Holocene. Although the greater abundance and size of sites with Stemmed points suggests some human population growth in the Early Holocene, along with more frequent occupation of selected sites, sites in the PHT lack evidence of intensive resource exploitation and long term residence that develops later in the Archaic.

In summary, the bulk of archaeological evidence suggests that hunter-gatherers of the PHT practiced significantly different subsistence, settlement, and mobility strategies than did subsequent Archaic and ethnographic hunter-gatherers. The locations of sites on the landscape, and the composition of artifact assemblages, suggests that this strategy emphasized the procurement of large game more than did later hunter-gatherers. This assessment accords well with our view of the environment of Toedokado territory at the time.

However, Simms recently has criticized the argument for early big game hunting specialists, reasoning that if any single trait of the normative definition can be falsified, the whole notion of significant differences between adaptations of the earliest folks and those of the Archaic must be discarded. For example, Simms (1988:43-44) suggests that the discovery of milling stones in early contexts is sufficient to demonstrate the use of plants among early foragers, hence, a "big game hunting adaptation" is falsified. This, however, is something of a straw man, since scholars have long acknowledged the presence of lower ranked resources in early diets (cf. Elston 1982:192; 1986:137). Simms argues that most of the contrasts between the archaeology of the earliest foragers and that of later times are more likely due to imperfect knowledge and understanding of the former than to substantive differences in subsistence, settlement, and technology between the two. In this regard, Simms's (1987:96-97) attempt to question the chronology of Stemmed points is not supported by the majority of radiocarbon dates (Elston 1986; Beck and Jones 1988; Grayson 1993). More importantly, the technological contrasts between the stone tools used by foragers of the PHT and later Archaic people (Elston 1986:137) are significant because they reflect differences in the economics of tool procurement, maintenance and transport.

Landscapes of the Middle Holocene

The warming trend of the Early Holocene continued beyond the fall of Mazama tephra (about 6,900 B.P.), peaking around 6,000 B.P. (cf. Figure 120; cf. Thompson et al. 1993:491). Decreased westerly flow and northward retreat of the polar jetstream continued with the final recession of continental ice and increasing global temperatures (Kutzbach et al. 1993). In the Great Basin, this seems to have reduced winter precipitation and allowed more northward penetration of the summer monsoon (Davis 1982:66). However, the monsoon could not make up for lower winter precipitation because summer rains fall during the season of maximum evaporation; consequently, lakes and marshes declined and may have disappeared altogether for long periods (Benson and Thompson 1987a:256). Packrat nest analysis (Van Devender et al. 1987:347-348) strongly suggests that mid-Holocene warming reduced winter precipitation and brought drought to the Mojave Desert and the Great Basin; at the same time, severe winter freezes due to incursions of Arctic air were much more frequent than today.

The degree of mid-Holocene aridity in the Great Basin has been a matter of dispute since Antevs (1948) proposed the Altithermal. However, radiocarbon dates from drowned trees indicate Lake Tahoe was twelve meters below its outlet at about 5,500 B.P., and did not flow down the Truckee River until about 4,250 B.P. (Davis, Elston, and Townsend 1976; Lindström 1990). Morrison (1964) estimated that about one cubic mile of sediment deflated from the Carson Sink during the mid-Holocene, which suggests that the climate was too dry to support a lake there, even with the putative contribution of the Walker River (Benson et al. 1990). This further suggests a time when marshes and lakes throughout the Lahontan Basin were greatly reduced; we might speculate the further increase of shadscale scrublands and perhaps sand-loving Indian ricegrass at this time, but presently there are no confirming data. Pinyon arrived at the vicinity of Gatecliff Shelter by about 6,600 B.P., probably impelled by warmer temperatures and increased summer precipitation (Thompson and Hattori 1983), but did not reach the Sierra Nevada or Virginia Range west of the Carson Desert before 1,200 B.P. When this valuable resource arrived in the Stillwater Range presently is unknown, but we suspect within the last two thousand years—long after the Middle Holocene.

The effect of mid-Holocene climate on human habitation and adaptive strategies in the Carson Desert has been a topic of debate for decades (cf. Elston and Raven 1991). For example, Heizer (1951), having found only scant archaeological materials referable to the period, assumed a general abandonment of the Humboldt Sink and Carson Desert. We doubt that the region ever was deserted completely, but we would expect changes in settlement and subsistence patterns. Progressive desiccation of the countryside imposed a segmentation of resources quite different from the homogeneity of the earlier regime. As surface water became more localized with the drying of the shallower basins and smaller watersheds, the abundance and distribution of animals and plants inevitably would have grown similarly focal and constrained. One would predict that, as the environment became increasingly patchy, logistically-organized subsistence strategies would appear (Binford 1980). Diet breadth should have broadened to compensate for the inevitable decline in big game, and settlement should have become increasingly tethered to the distribution of critical limiting resources such as water, as it did in the northern Great Basin (Fagan 1974).

The fact is, however, that the archaeological record between 8,000 B.P. and 5,000 B.P., is scarce throughout the western Great Basin (Elston 1986:138-141). We have suggested that this is due in part to the absence of artifact styles or technology that are diagnostic of this period, but cultural radiocarbon dates are also lacking (Elston 1986; Grayson 1993). Sites of this age may have been destroyed by deflation or buried by sand and silt dunes, but perhaps we have not searched for sites in the right places. For example, no sites associated with springs have been excavated in the Carson Desert. And consider that small marshes still would be associated with the terminus of the Carson River, but the terminus may have moved far upstream to the west during this period.

Landscapes of the Late Holocene

Grayson (1993:221) defines the Late Holocene as the period in which "the Great Basin came to look pretty much as it has looked during the last few centuries." His best guess is that essentially modern distributions of plants, animals and water were in place by 4,500 years ago, although he cautions that this varies in different parts of the Great Basin.

By 4,500 B.P. the trend to a cooler, moister climate was well underway. Lake Tahoe began to discharge down the Truckee River again at 4,200 B.P. (Lindström 1990), and Mono Lake was at a very high level at 3,700 B.P. (Stine 1990:366-367). Wigand (1990:84) suggests that by 4,000 B.P. the modern climatic pattern was established, with strengthened westerlies, a return to winter-dominated precipitation, and a resurgence of lakes and marshes on valley floors. Both Davis (1982:66-67) and Wigand (1990:84) agree that the more mesic interval lasted until 2,000 B.P.

Hunter-gatherers used Hidden Cave as a cache site twice between 3,800 B.P. and 3,600 B.P. (Thomas 1985). Hidden Cave overlooks Stillwater Slough north of the point where it drains Carson Lake. Cattail pollen is abundant in the cave deposits (which include human coprolites) and cattail stalks are present. Because high bulk, low weight plant parts such as cattail stalks have high transport costs (cf. Jones and Madsen 1989), it is unlikely that prehistoric hunter-gatherers would have transported these materials far from the locations where they harvested them. Therefore, we agree with Wigand and Mehringer (1985) that this suggests the presence of a nearby marsh, but there is no way to know whether this was Stillwater Slough or one of the "Fallon Lakes." For example, the stand at 1193 m (third Fallon Lake) would have extended Carson Lake northward past Grimes Point, and brought the lake in the Carson Sink within seven kilometers of the cave. The area along Stillwater Slough between Carson Lake and the Carson Sink lake has very little gradient and probably would have been a marsh.

Stratigraphy and radiocarbon dates (Table 72) from archaeological sites in Stillwater Marsh are the best evidence for the presence of lakes and marshes in the Carson Desert. For example, archaeological sites 26Ch1052 and 26Ch1062 occur near the center of Stillwater Marsh (Raven and Elston 1988). These sites contain no direct evidence of a high lake between 3,800 B.P. and 3,600 B.P., but water appears to have eroded the clay dune core of 26Ch1052 before 3,290 B.P., suggesting the presence of a lake at that time. Afterward, no lake seems to have encroached on Stillwater Marsh between the accumulation of marsh and cultural shell midden deposits and 2,680 B.P. (or perhaps a little later).

Table 72. Radiocarbon Dates from Stillwater Marsh, Sierra Nevada Range, and Walker Lake.

Site No.	Stillwater Marsh Date* (radiocarbon years ago)	Context	Walker River Contribution**	Dates of severe droughts*** (radiocarbon years ago)
26Ch1052	3290	cultural/marsh deposits		
26Ch1052	3190	cultural deposits		
26Ch1062	2940	marsh deposits		
26Ch1052	2690	cultural deposits		
26Ch1052	2680	cultural deposits		
			2700-2100	
26Ch1159	2265	burial		
26Ch1055	1860	cultural deposits		
26Ch1062	1390	cultural deposits		
26Ch1173	1350	cultural deposits		
26Ch1068	1320	cultural deposits		
26Ch1044	1140	burial		
26Ch1062	1100	cultural deposits		
26Ch1159	1080	burial		
26Ch1052	1040	marsh deposits	1000	980-850
26Ch1048	870	cultural deposits		
26Ch1062	830	cultural deposits		
L72	820	burial		
26Ch1048	800	cultural deposits		
26Ch1070	660	burial		690-603
				582-557
26Ch1050	290	burial		

*Raven and Elston 1988; Brooks 1991; Larson and Kelly 1995
**Benson and Thompson 1987b;
***Adam 1967; Stine 1990, 1993; Lindström 1990

Water from the Walker River may have augmented increased effective moisture in the Carson Desert between 2,800 and 2,000 B.P. (Benson and Thompson 1987b). Grayson (1993:224-245) has commented that archaeological sites in Stillwater Marsh (Table 72) lack radiocarbon dates for this interval. If the Walker River contributed enough water to create a lake in the Carson Sink, then that lake may have drowned Stillwater Marsh and prevented any human occupation until waters receded. Grayson acknowledges that, given the small number of dates (we have added a few to which he did not have access), such a chronological gap easily could be due to sampling error. But it is interesting that at 26Ch1052 a silty deposit containing small bits of shell partially overlies the last shell midden deposits (stratum 5), dated to 2,680 B.P. This material resembles stratum 1, reworked shell midden deposited during the high water of 1984-86. Stratum 4 was undated, but lies beneath marsh deposits. The upper portion of this marsh level dates to 1,042 B.P. As Grayson points out, this date is coincidental with another putative but short-lived excursion of the Walker River into the Carson River drainage about 1,000 B.P. (Benson and Thompson 1987b). Other dates from archaeological sites in Stillwater Marsh document the presence of marshes there at 1,860 B.P., between 1390 and 1320 B.P., and between 870 and 800 B.P.

Davis (1982:67) reviewed the evidence for a xeric interval between 2,000 and 600 B.P. with possible summer-dominated precipitation, but could reach no firm conclusion except that the climate was more variable than previously. Figure 120 supports this general observation. More recently, Wigand's (1990:80-82) analysis of late Holocene packrat (*Neotoma* sp.) nests in mountains west of the Carson Desert suggests an increase in temperatures and summer precipitation between 1,500 B.P. and 1,000 B.P. This allowed pinyon pine to reach its northern limits along the Truckee and Humboldt rivers, and probably the Stillwater Range as well. Wigand's (1990:80-82) packrat data also suggest harsh drought between 700 and 400 years ago, then a return to cooler, moister conditions (the Little Ice Age) generally prevailing over the last 300 years.

However, the range of radiocarbon dates (cf. Table 72) from drowned tree stumps in Mono Lake, Tenaha Lake, Independence Lake, Walker River, and Walker Lake suggests several droughts broken by short mesic intervals in the latter part of the late Holocene (Adam 1967; Stine 1990, 1993; Lindström 1990), droughts more severe and longer lived than any in recorded history. The first of these (980-850 B.P.) fits neatly between the last two marsh dates documented for Stillwater Marsh at 1,040 B.P. and 870-800 B.P. A date associated with a human burial falls within the 690-603 B.P. drought, and another comes after the last drought (Table 72; Brooks 1991), but these really inform on the presence of people in Stillwater Marsh, and say nothing about whether a marsh was present there during occupation. There are no dates from Stillwater Marsh during the return to cooler, more mesic conditions of the last three hundred years. But before we rush to speculate late prehistoric desertion of the Carson Desert, let us pause to consider that limited archaeological tests of six archaeological sites in Stillwater Marsh and a few burial dates cannot counter the strong evidence of Northern Paiute use of sites and resources offered there.

Modeling Effects of Increased and Decreased Effective Precipitation in Toedokado Territory

The paleoenvironmental record demonstrates that the basic parameters of the modern resource structure of Toedokado territory were in place by the beginning of the Late Holocene. Except for pinyon woodlands, modern plant communities were established in the region by 4500 years ago. Landforms and soils (i.e., dunes, lake terraces, sand sheets) that determine variability in the structure, content, and productivity of these communities—and therefore determine habitat types—were extant. Precipitation and temperature (although highly variable) were within the modern range and were induced by the same atmospheric conditions that determine modern climate. Consequently, the habitat model should roughly reflect the mosaic of habitat types of this time.

The Late Holocene did, however, encompass some significant environmental variation. Climate, although essentially modern compared to earlier periods, was clearly cooler and wetter than at present between 4500 and 2000 B.P., and drier and warmer between 2000 and 600 B.P. Moreover, this later period oscillated rapidly between drought and wet conditions. This variability affected hydrological regimes, probably by spawning lakes in Carson Sink in mesic intervals, and drying them up in xeric periods. Clearly, any projection of the model back into the Late Holocene must consider the probable absence of pinyon from the uplands before 2000 years ago, and must account for the fluctuation between cool-wet and warm-dry extremes. Nevertheless, since the basic structure of Toedokado territory was essentially modern, we can obtain a general idea of how Late Holocene variation in climate might effect the economic choices faced by hunters and gatherers operating in Toedokado territory by modifying the habitat model.

In the following discussion, we use the habitat model as a basis for estimating the effects of increased and decreased precipitation on the productivity of the habitat landscape of Toedokado territory; equilibrium conditions that would have been typical of prolonged warm-dry and cool-wet periods of the Late Holocene are derived from the range type data on which we have based the Toedokado model. Definitions of each range type used in the habitat model include estimates of annual productivity (in kilograms of herbage per hectare) for years of normal, above normal, and below normal precipitation. According to these data, variability in precipitation can raise or lower the biomass productivity of habitat types by an average of 45% from normal year productivity.

To consider the effects of greater and lesser effective precipitation on overall productivity of habitats in our model area, we merely use the above normal and below normal productivity values as estimates of the productivity that would have been normal during warm-dry and cool-wet intervals of the Late Holocene. We realize that raising or lowering effective precipitation over a lengthy period may expand or contract the ranges of various species (and, hence habitat types), but for simplicity, we hold the ranges of species and habitats constant in this exercise, merely altering the production values for modern habitat types.

In the one exception to this rule, we allow marshes and lake levels to expand and contract in response to wetter and drier conditions. Additionally, although severe droughts and extreme floods surely would have destroyed marshes for short periods of a few years, marshes would have reestablished quickly at new hydraulic equilibriums under conditions of prolonged drought or inundation (Elston 1990). Thus, both projections of warm-dry and cold-wet extremes assume the existence of marshes. Finally, since runoff, rather than direct precipitation, feeds marshes, we hold the biomass production of marshes (in kilograms per hectare) constant at values for normal years under present conditions, but allow them to expand or contract in spatial extent in response to wetter and drier conditions.

Late Holocene Wet Regime

Figure 122 shows the projected productivity landscape of Toedokado territory as it may have occurred during mesic intervals of the Late Holocene. Since we are modeling increased average effective precipitation over a long time, we allow shallow lakes to stand in the Carson Sink, Carson Lake, Labou Flat, and Dixie Valley. The lake in the Carson Sink stands at 1186 m (3891 ft amsl), the elevation of the fifth Fallon Lake (Morrison 1964), and about 4.5 meters above the highstand of the 1984-86 lake. A lake of this size in the Carson Sink would require an approximate 200 percent increase of the historical average inflow of the Carson and Humboldt Rivers (Elston 1989:35-40; Kerley et al. 1993:11-13). Since these rivers rise in distant mountain ranges, local precipitation in the Carson Desert does not have to increase that much. If we further assume that evapotranspiration rates are lower when the climate is wetter, less annual inflow would be required. We can also help create the Carson Sink lake by diverting the Walker River into the Carson River as proposed by Benson and Thompson (1987b).

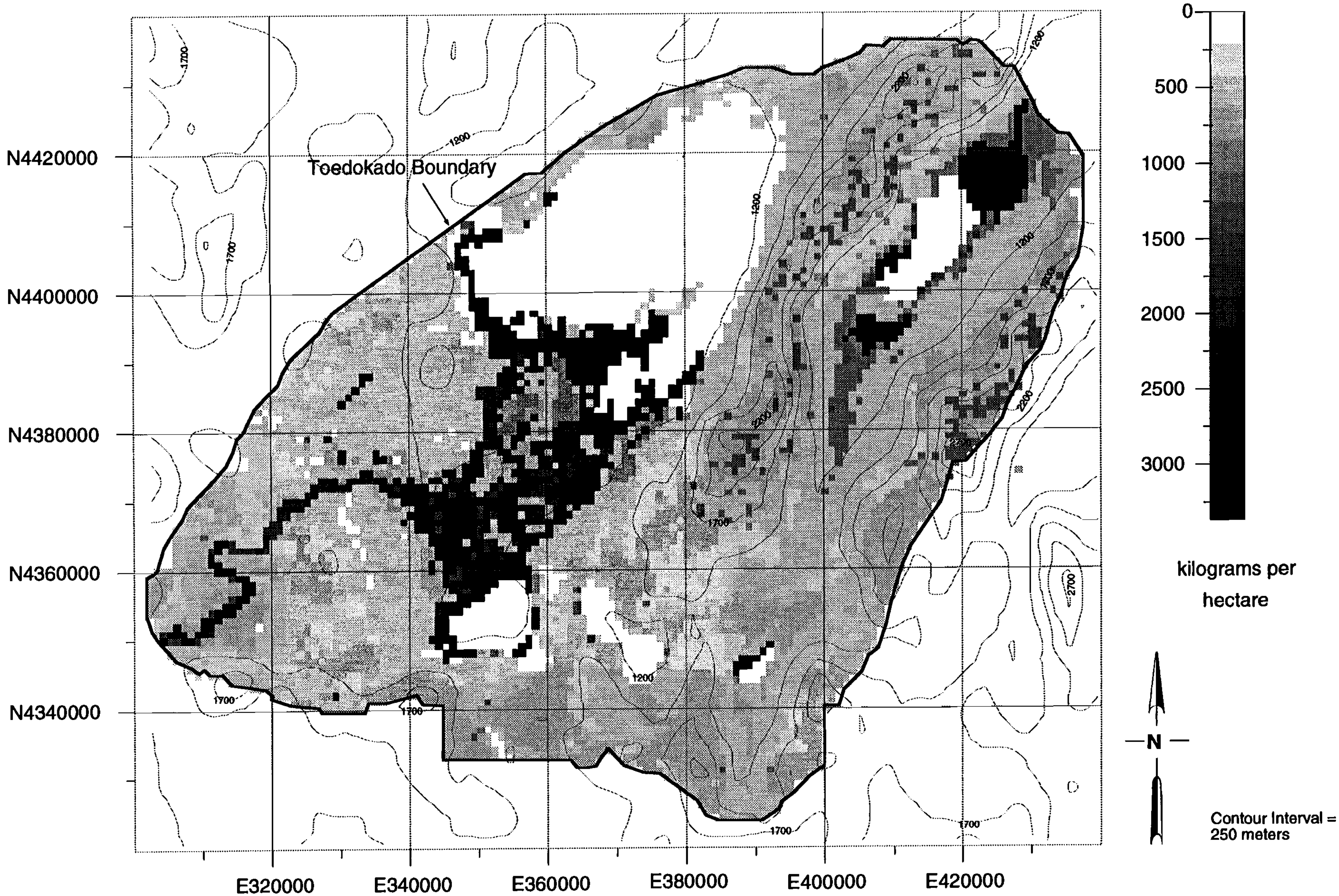


Figure 122. Wet regime habitat productivity of the late Holocene.

At 1186 m, the Carson Sink lake covers most of the present Stillwater Marsh, but now a large marsh forms along the southern and western margins of the lake where the water is less than one meter deep. Pelican Island, Battleground, and other large dunes in the dunefields extending out into the Sink from its southern margin would now be islands where foragers could base themselves. An extensive marsh also forms in Carson Lake, and small marshes fringe Lake Labou and the west shore of Lake Dixie. Most spring flow probably increases; perhaps new springs appear. In any event, finding surface water is less problematic than when drier conditions prevail.

All upland habitat annual production increases with increased precipitation, but notice in Figure 122 that no upland habitat becomes more productive (in kilograms per hectare of herbage production) than lowland marsh and riparian habitats. Of course, optimal foraging models hold that resource return rates and not overall productivity draw foragers to any particular habitat. Consequently, we must assess whether climatic conditions of Late Holocene mesic intervals would have altered the productivity of the highest ranked resources.

Certainly expanded marshes would have increased proportionally the abundance of all marsh resources, although periods of extreme flood occasionally might drown marshes for brief periods. Since mesic conditions are typical of the time before pinyon arrived in the Stillwater Range, it is unlikely that more mesic conditions would have rendered upland resources more attractive to women because higher ranked marsh plants and small mammals would have been even more abundant than at present. Cooler, moister climate might increase the production of geophytes such as bitterroot and balsamroot. Thus, we might expect more frequent springtime root-gathering trips to the mountains by women in wet times, but marshes should have been even more the focus of women's foraging activities than in the ethnographic period.

Less obvious are the potential effects of increased precipitation on large game animals in upland and desert habitats. Figures 123 and 124 graph the production of forage plants for mountain sheep and antelope in the five most productive habitats of each. The charts indicate that the production of large game forage plants increases by as much as 74% in these mountain and desert habitats. If we assume a direct relationship between the amount of forage available in a particular habitat and the carrying capacity of large game in that habitat, we must conclude that the uplands of Toedokado territory could support higher densities of large game during mesic periods of the Late Holocene than at present. Consequently, upland and desert habitat types probably were more attractive for men's hunting during mesic periods. We note, however, that mule deer, which were present in Toedokado territory at the time of ethnographic observation, probably were rare or absent in the prehistoric Late Holocene (Berger and Weyhausen 1991).

An idea of the size of early Late Holocene large game herds may be gleaned from modern wildlife management studies. Reviewing bighorn sheep habitat in the western United States, the Bureau of Land Management (1989:37) estimates that the Stillwater and Clan Alpine Ranges are currently capable of supporting 350 and 125 sheep, respectively (the mean carrying capacity of 29 Nevada mountain ranges was 360 sheep). If we assume, naively, that increasing sheep forage species by 75% (cf. Figure 123) would produce a comparable increase in sheep population, then about 600 sheep roamed the Stillwater Range, and 220 the Clan Alpine Range, in the early Late Holocene.

In summary, we expect increased abundance of all high ranked resources during mesic intervals. For men, the productivity of desert and montane habitats should have been greater than present because of higher population densities of large game in these habitats. At the same time, marshes should have tethered women's foraging to marshes, particularly absent pinyon.

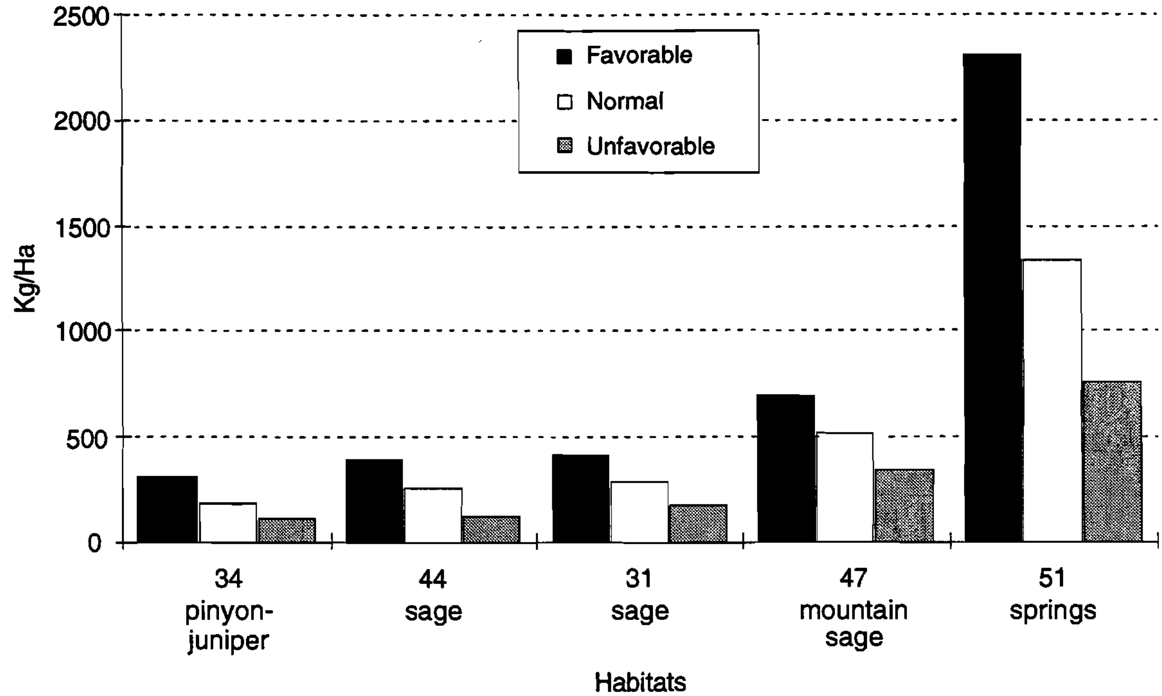


Figure 123. Forage productivity of top five bighorn sheep habitats in Toedokado territory.

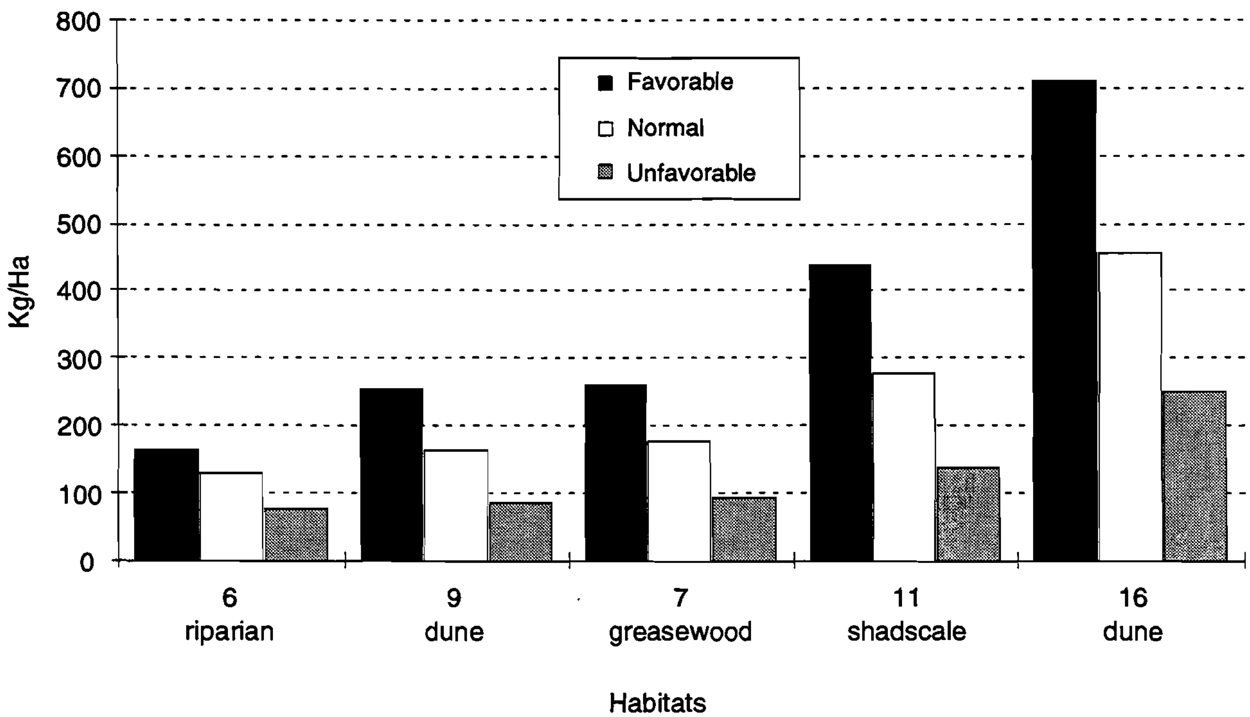


Figure 124. Forage productivity for top five antelope habitats in Toedokado territory.

Late Holocene Dry Regime

Figure 125 maps below normal habitat productivity in Toedokado territory as would have occurred during a xeric interval of the Late Holocene. Now the climate is warm and dry; there are no lakes in the Carson Desert, Fairview Valley, or Dixie Valley. Carson Lake is a saltgrass meadow; Carson Sink, Labou Flat, and Dixie Valley host playas. Stillwater Marsh has retreated southward to form a marsh about one third its normal 11,000 acres. Many springs dry up or yield reduced flow; surface water is more difficult to come by.

Returning to Figures 123 and 124, we see dramatic reductions of forage for mountain sheep, and antelope, even in the best habitats. Thus, we expect to see the populations of large game drop off and the productivity of desert and upland habitats as men's hunting patches decline. At the same time, it probably is in this xeric time that pinyon expands into the Stillwater and Clan Alpine Ranges. Whenever this occurred, the relative production for women's foraging in montane habitats should increase.

In the xeric model, habitats of highest productivity all lie in the lowlands along streams and in the small marsh remaining in Stillwater. Given the high climatic variability and frequency of droughts typical of the post 2000 B.P. period, it is likely that marshes would have disappeared for brief periods during climatic extremes. However, new marshes should quickly form in new locations suited to current hydrological situations. Even if drought was so severe that water failed to reach Stillwater at all, a new marsh would form wherever the river ended. Although they would have been vulnerable to occasional catastrophic flood and drought, marshes in typical years should have remained highly productive habitats for men's and women's foraging. Good alternatives to wetland resources are scarce. Shadscale and ricegrass habitats probably increase in area, but it is unclear if these plants also increase in density or produce more seeds. Lower plant productivity should reduce small animal abundance as well.

Modeling Hunter-Gatherer Responses to Now-Extinct Habitat Type Landscapes

Earlier we examined the paleoenvironmental record of Toedokado territory and found that the region has experienced considerable environmental variability in the past. The record for the Middle Holocene is too incomplete for us to infer reliably what the habitat landscape of that time may have been like. However, we know enough about the Late Holocene to project confidently the ethnographic model back in time and fine tune it to account for the lack of pinyon and for increased precipitation. Although our ethnographic habitat model bears little relevance to the ancient landscape of the Pleistocene-Holocene transition, we know enough about its structure to infer general resource distributions. Here, we consider whether the habitat type landscape of the Late Holocene and the Pleistocene-Holocene transition was sufficiently different to promote a hunter-gatherer adaptation different from that of the ethnographic Toedokado.

Constructing an Ethnographic Baseline

For ease of comparison we simulate the choice of ethnographic hunter-gatherers to forage within two alternative regions of the Toedokado territory model area. Figure 126 illustrates the approximate locations of two ethnographically documented base camps used by the family of Wuzzie George in the late nineteenth and early twentieth centuries (Fowler 1992:26-27, 35, 39). The George family had the option of occupying either camp in autumn contingent on the foraging activities available in any given year. Each camp served as the central place for foraging in an area that we have delineated as a 10 kilometer catchment radius. If we assume that resources occur randomly within these foraging areas, we can estimate overall foraging returns using the habitat type landscape and the diet breadth model.

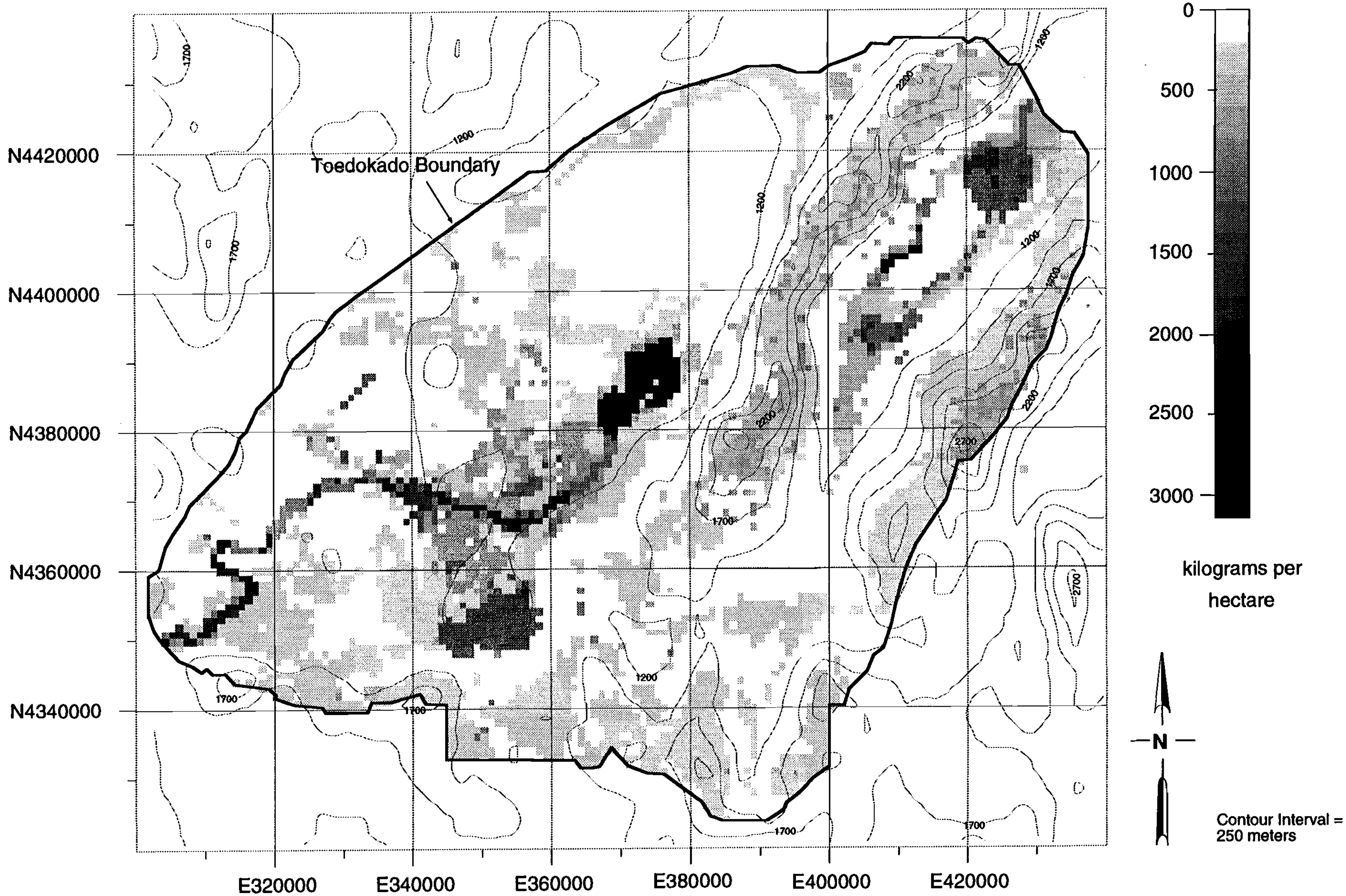


Figure 125. Dry regime habitat productivity of the late Holocene.

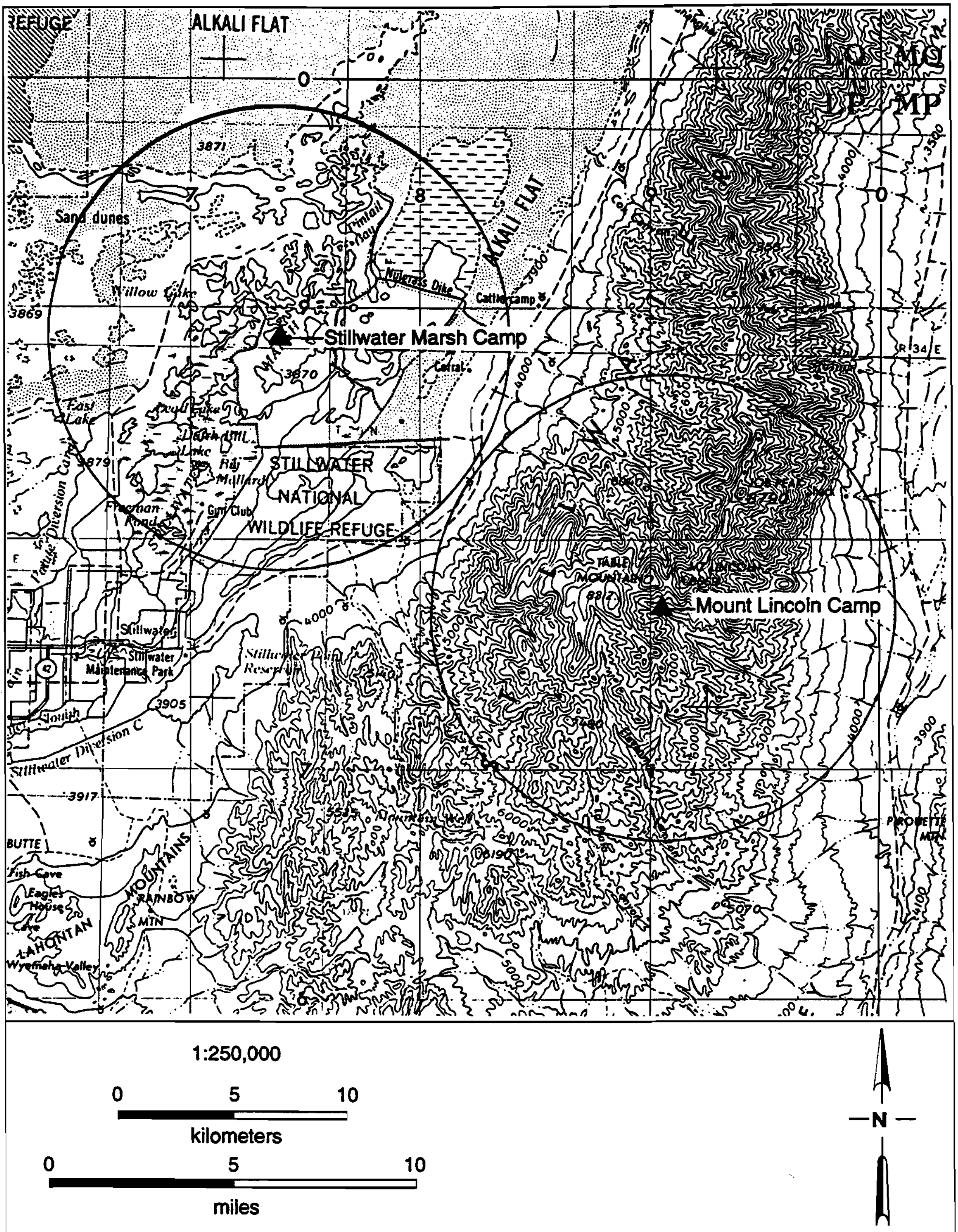


Figure 126. Ten kilometer foraging radius (after USGS Reno, Nevada; California, 1:250,000, 1957, Revised 1971).

We consider autumn foraging opportunities for purposes of this exercise because this was the time of year when ethnographic hunter-gatherers were most likely to abandon marshes for uplands (Wheat 1967:13, 29, Fowler 1989:10- see Chapter 5). Referring to the habitat type and resource descriptions of Chapters 3 and 4, we identified the set of autumn resources that would have been available within each catchment, and further divided these resources into men's and women's prey sets according to Table 29. The set of possible prey available for men within foraging radius of the Stillwater Marsh Camps includes antelope, jackrabbit, medium and small sized mammals, ducks, and fish, while women's prey includes small mammals, large bulrush seeds, shadscale seeds, small bulrush seeds, cattail roots, sedge seeds, bulrush roots, and iodine bush seeds. In the Mount Lincoln Camp, men's resources include sheep, deer, cottontail, and medium and small sized mammals, while women's resources include small mammals, pinyon nuts, wildrye seeds, and needlegrass seeds. Using the best and worst encounter rates reported by Simms (1987:74-75) and Raymond and Sobel (1990:13) as estimates of hunter-gatherers encounter rates, we can calculate an optimal diet breadth and overall foraging return rate for each foraging catchment.

Figure 127 graphically represents best and worst foraging returns for men and women at Stillwater Marsh Camp. The line beginning in the upper left corner of the chart and descending steadily to the lower right merely connects the return rate (without search time) for each resource, arrayed in rank order, on the horizontal axis. The four dome-shaped lines indicate the best and worst overall return rates (including search time) for men and women. Items on the resource return rate line that lie above and left of the overall return rate lines are in the diet while those right and lower than the overall return rate lines fall out of the diet. Intercepts of the resource return rate line with overall return rate lines estimate the overall return rate obtainable within the foraging area.

Under best encounter rates, ducks (2285 Cals/hr) are in men's optimal diet but fish (1750 Cals/hr) fall out, but under lower encounter rates, men's diet breadth broadens to include fish. Small mammals and large bulrush seeds comprise the optimal diet set of women under best and worst conditions. Note that the simulation suggests that overall foraging returns for men and women are comparable, even though men emphasize higher ranked resources. Had we considered large bulrush seeds as a men's resource, and fish and ducks as women's resource, then they would have been within the optimal diet breadth of men and women, respectively.

Figure 128 simulates optimal diet for the Mount Lincoln Camp. For men, small mammals are the lowest ranked resource in both best and worst optimal diets. Small mammals and pinyon nuts (1084 Cals/hr) comprise the optimal diet sets for women under best and worst conditions.

Observe in both charts that the simulation indicates that most of the plants known to have been taken by ethnographic Toedokado (Fowler 1990:65-75) fall out of the simulated diet. This suggests that Simms may have overestimated encounter rates of small mammals, pinyon, and large bulrush, but is consistent with his suggestion that storability rather than energetic profitability was the critical motivation for taking many of the lower ranked resources (Simms 1987:94-95). Too, the Toedokado, as we have previously noted (cf. Chapter 5), are likely to have deferred procurement of lower ranked seeds until late fall or early winter when higher ranked resources were unavailable.

Figure 129 compares best and worst overall foraging returns as estimated in the previous graphs, of both sexes at both camps. According to the simulation, foraging from the marsh camp in most situations produces higher returns for both men and women than foraging from the mountain camp. For men, this is somewhat counterintuitive because the mountain foraging area contains two resources (sheep and deer) that are higher ranked than any available in the marsh foraging area. The higher overall foraging returns of marshes are obtained because encounter rates with resources in the diet are higher in marshes than they are in mountains. By implication, both men and women should prefer to shift operations to the mountain camp only when marshes are unproductive.

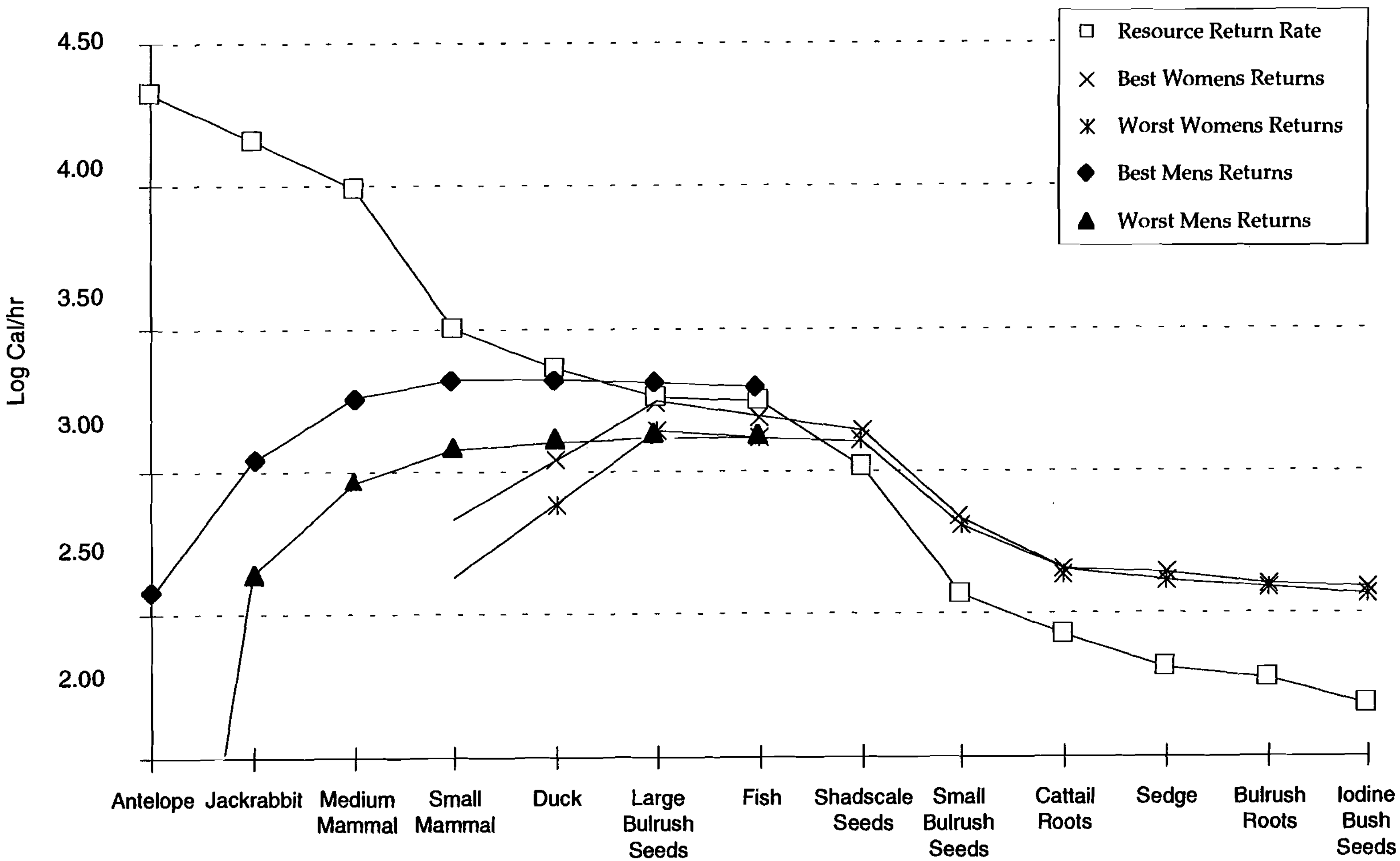


Figure 127. Autumn foraging returns for ethnographic Stillwater Marsh Camp (Habitats 1, 3, 4, 6, 7, 9, 10, 53).

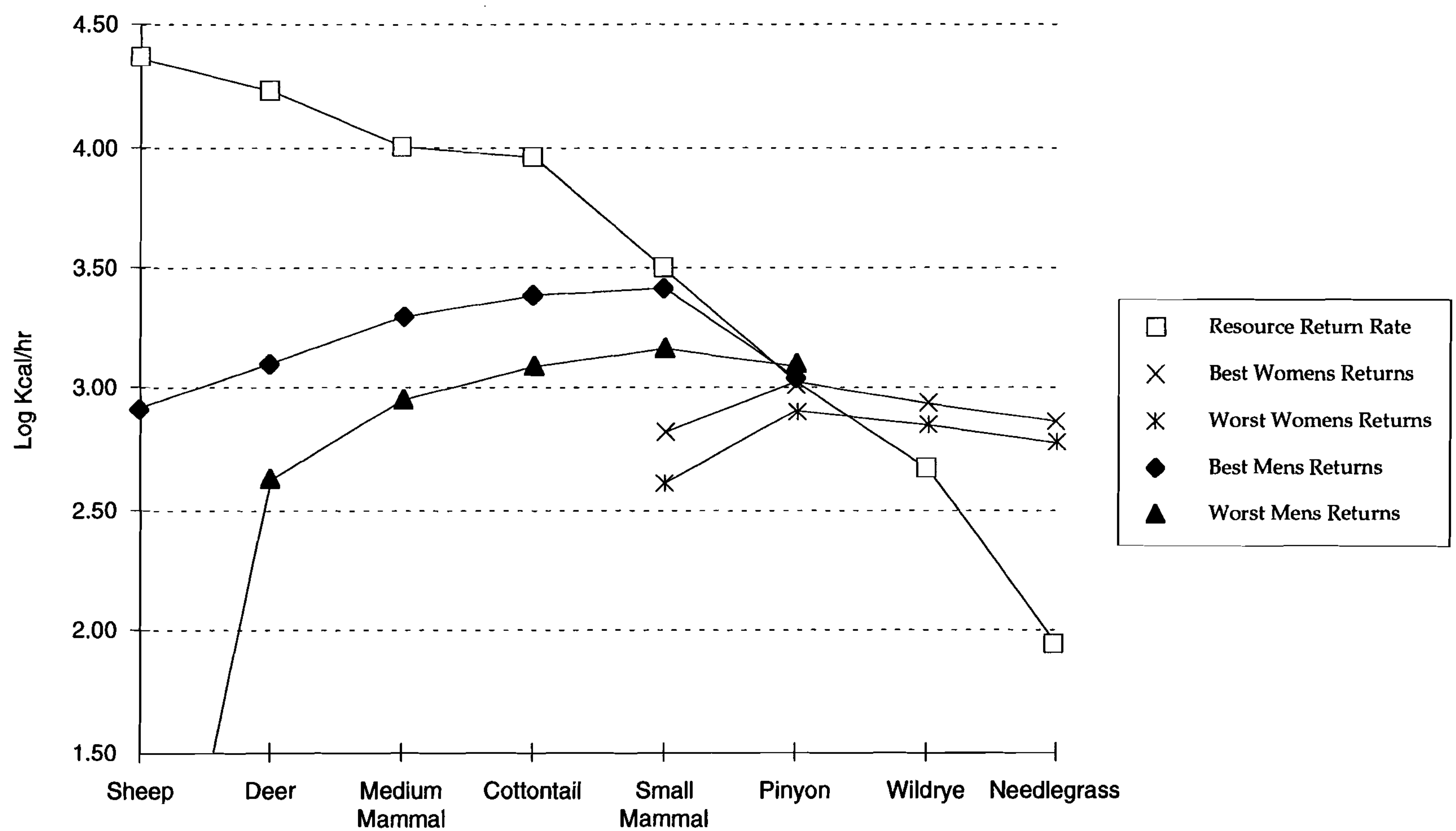


Figure 128. Autumn foraging returns for ethnographic Mount Lincoln Camp (Habitats 34, 37, 47, 51).

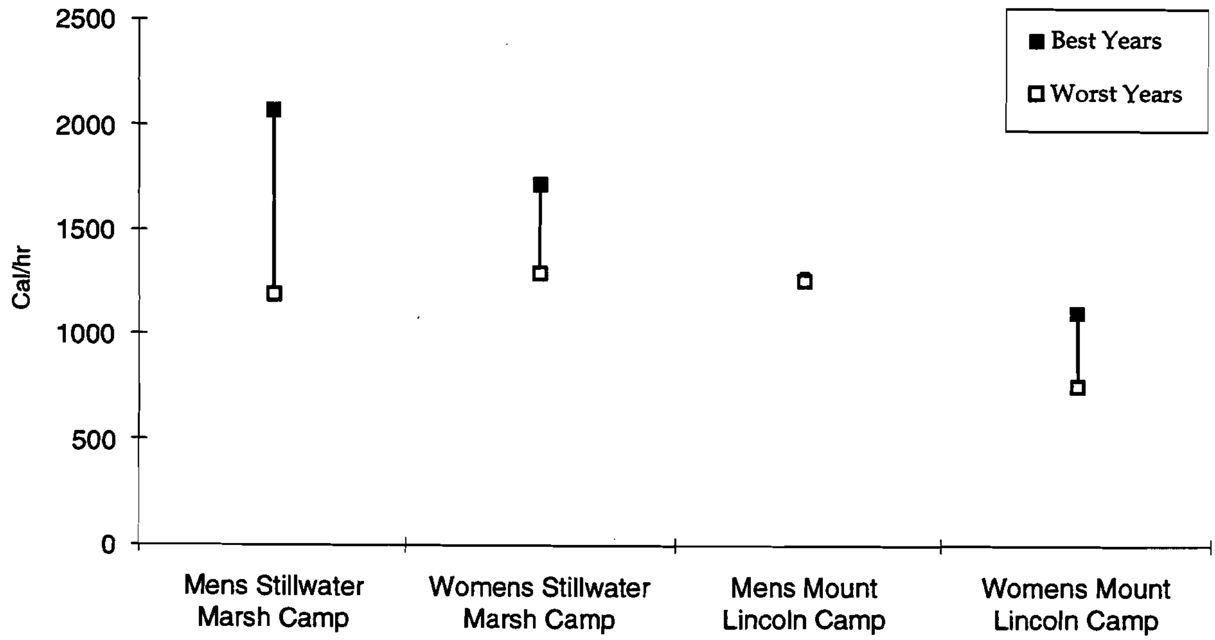


Figure 129. Estimated overall foraging returns for ethnographic Toedokado.

However, the choice of camping in Stillwater Marsh would not preclude men from logistically hunting high ranked resources on Mount Lincoln. If we assume that it took 12 hours to travel round-trip between the two camps (18 kilometers one way distance and 3 km per hour travel time) and add travel time to handling time, then a logistic hunter based at the Stillwater Marsh Camp could procure sheep from Mount Lincoln at 2900 Cal/hr. Since this is well above the best overall return rate of foraging in the marsh (2040 Cal/hr), logistically procured sheep should be in the diet of men camped at Stillwater Marsh.

Early Late Holocene Foraging Decisions

Peering back in time from the peaks of the Stillwater Range, Kelly (1985) discerned temporal change in prehistoric subsistence-settlement strategies induced by environmental variability, maintaining that mesic conditions typical of the beginning of the Late Holocene (4500 - 1450 B.P.) fostered higher densities of large game in upland habitats and that this allowed hunter-gatherers to emphasize procurement of these higher ranked resources. In contrast, severe winters, which Kelly believed typical of the last half of the Late Holocene (post 1450 B.P.), sparked catastrophic decline in large game populations. The decline of high ranked resources (and the need for storable resources during severe winters) led to an expanded diet breadth, a greater reliance on lower ranked wetland seeds, and residential occupation of the lowlands. Thus, Kelly concluded that marsh resources served to back-up preferred high ranked upland resources.

Kelly's surmise that early Late Holocene hunter-gatherers of Toedokado territory chose a residentially mobile strategy emphasizing large game at the expense of marshes requires such an abundance of large game animals that most of the relatively high ranked marsh resources procured by women fall out of the diet. In this circumstance only should women choose to leave their most productive foraging patches (when those patches were most extensive and reliable) in favor of location, accompanying hunters into the uplands. As a rule, women's foraging decisions determine residential consequences of child-rearing constraints on the mobility of women (Hurtado et al. 1985) and of the transport costs of many resources used by women (cf. Jones and Madsen 1989). Yet we have observed (cf. Chapter 5) that among ethnographic Toedokado the returns offered by hunting occasionally were high enough for women to forego their typical foraging pursuits in favor of participation in men's foraging activities: rabbit drives, antelope drives, or fish runs, for example. Greater abundance of large game might have increased the frequency of these circumstances, creating situations where men's foraging strategies influenced residential location more than did women's. Early Late Holocene hunter-gatherers surely would have emphasized male subsistence strategies if large game were sufficiently abundant.

Our interpretation of the paleoenvironment and of the resource landscape of Toedokado territory suggests that Kelly probably is correct that mountain and desert habitats were capable of supporting larger populations of large game during the early Late Holocene than later. Optimal foraging theory demands our assumption that prehistoric hunter-gatherers would have procured more large game when they were more abundant, and that declines in large game density would have resulted in expanded diet breadth. Yet our own understanding of the resource structure and paleoenvironments of Toedokado territory is better informed than was Kelly's of a decade ago (cf. Chapters 5 and 9). With no pinyon in the Clan Alpine and Stillwater Ranges before 2000 years ago, there would have been little upland competition for women's foraging attention, and marshes would have been at their most extensive in the mesic conditions of the early Late Holocene; women's foraging should have been even more highly focused on marshes in this period than at ethnographic observation. However, the arrival of pinyon in the latter Late Holocene would have rendered mountain woodlands more competitive patches for women's gathering.

To simulate foraging conditions of the early Late Holocene, we increased encounter rates with all terrestrial mammals by 75%, consistent with maximum increases of forage species under high rainfall. However, we removed mule deer from the prey set of men and pinyon nuts from the prey sets of women to accommodate paleoenvironmental data indicating the absence of these species from Toedokado territory during the early Late Holocene. Figure 130 simulates optimal diet breadth and overall foraging returns for foraging from the Stillwater Marsh Camp. Under best conditions, both ducks and fish fall out of the optimal diet of men while diet breadth broadens to include ducks under lowest encounter rate. The diet breadth of women in marshes is little different from that of ethnographic foragers; small mammals and large bulrush are in both best and worst diets. Figure 131 shows a similar analysis of foraging return rates for the Mount Lincoln Camp. Small mammals barely fall out of the best optimal diet of men but are in the worst optimal diet. Small mammals are the only upland resource that women should take in all circumstances.

Figure 132 indicates the range between the best and worst overall return rates for both sexes in both camps. Clearly the relative return rates for foraging at the two locations change dramatically under early Late Holocene conditions. Under best conditions, foraging from the Mount Lincoln Camp provides higher returns for men than foraging from the Stillwater Marsh Camp, but the foraging return rate in marshes does overlap that for the uplands. For women, the range of foraging returns is much higher from the Stillwater Marsh Camp than from the Mount Lincoln Camp. The difference between women's foraging returns in marshes and uplands is so large that we cannot expect women to forsake marshes in favor of foraging opportunities in the mountain resources as long as marshes were available.

Note that this simulation indicates that the best foraging opportunities of men conflicted spatially with those of women; if encounter rates are high, men's best foraging opportunities are in the mountains while women obtain their best returns in marshes. Since the overall return rates of men are higher than those of women, women might abandon their own foraging strategies in favor of accompanying men.

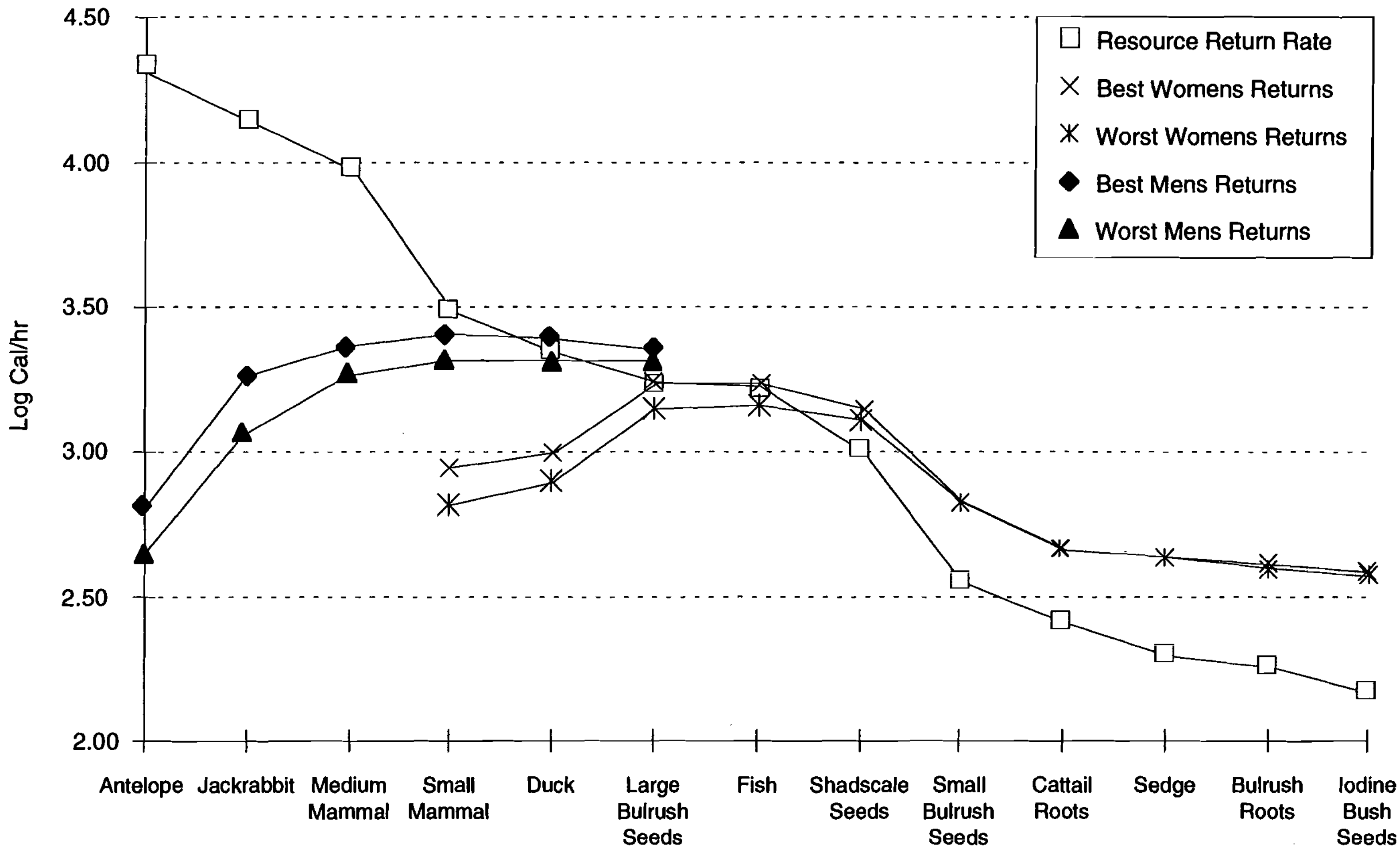


Figure 130. Autumn foraging returns for Early Late Holocene Stillwater Marsh Camp (Habitats 1, 3, 4, 6, 7, 9, 10, 53).

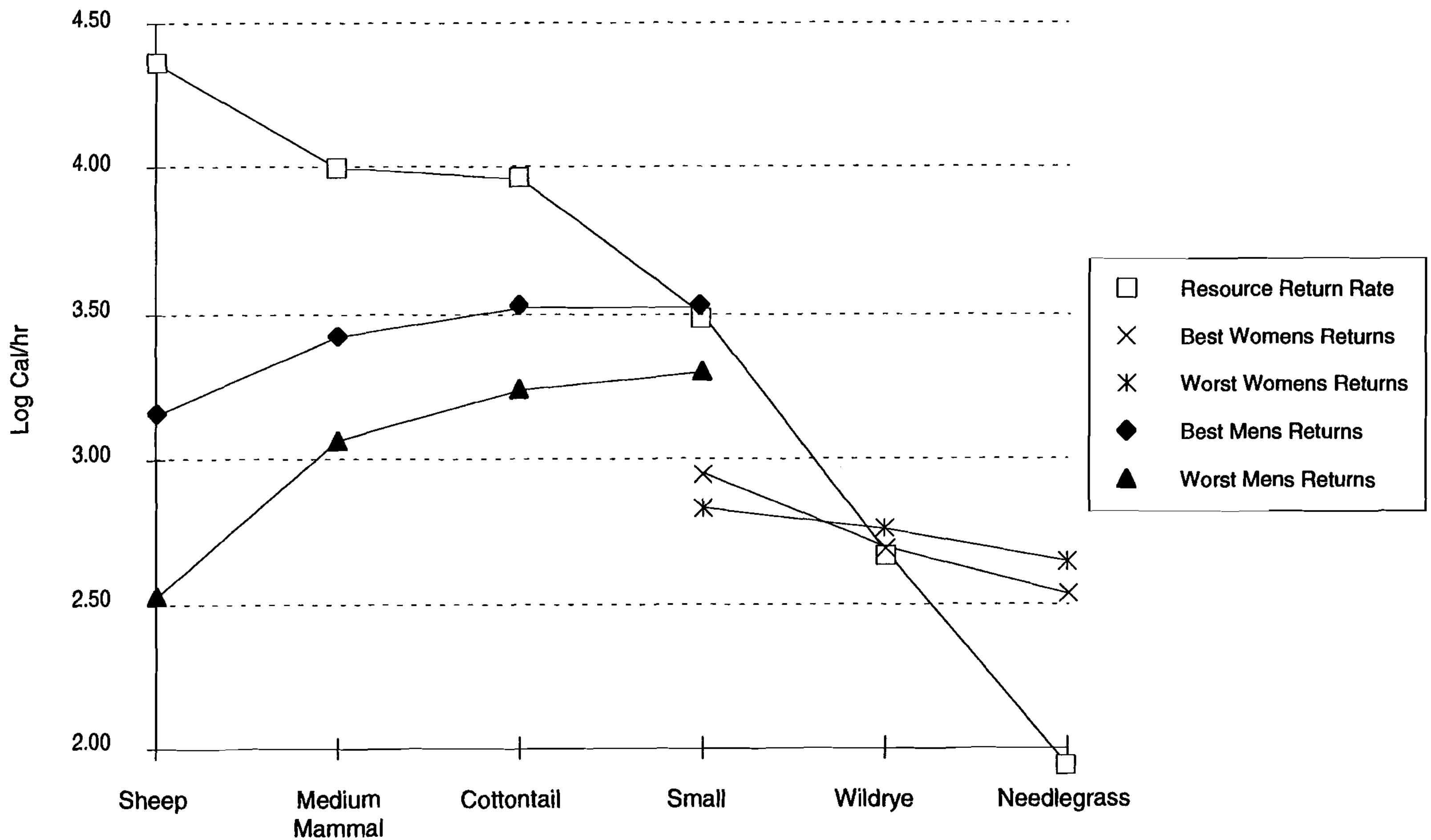


Figure 131. Autumn foraging returns for Early Late Holocene Mount Lincoln Camp (Habitats 34, 37, 44, 47, 51).

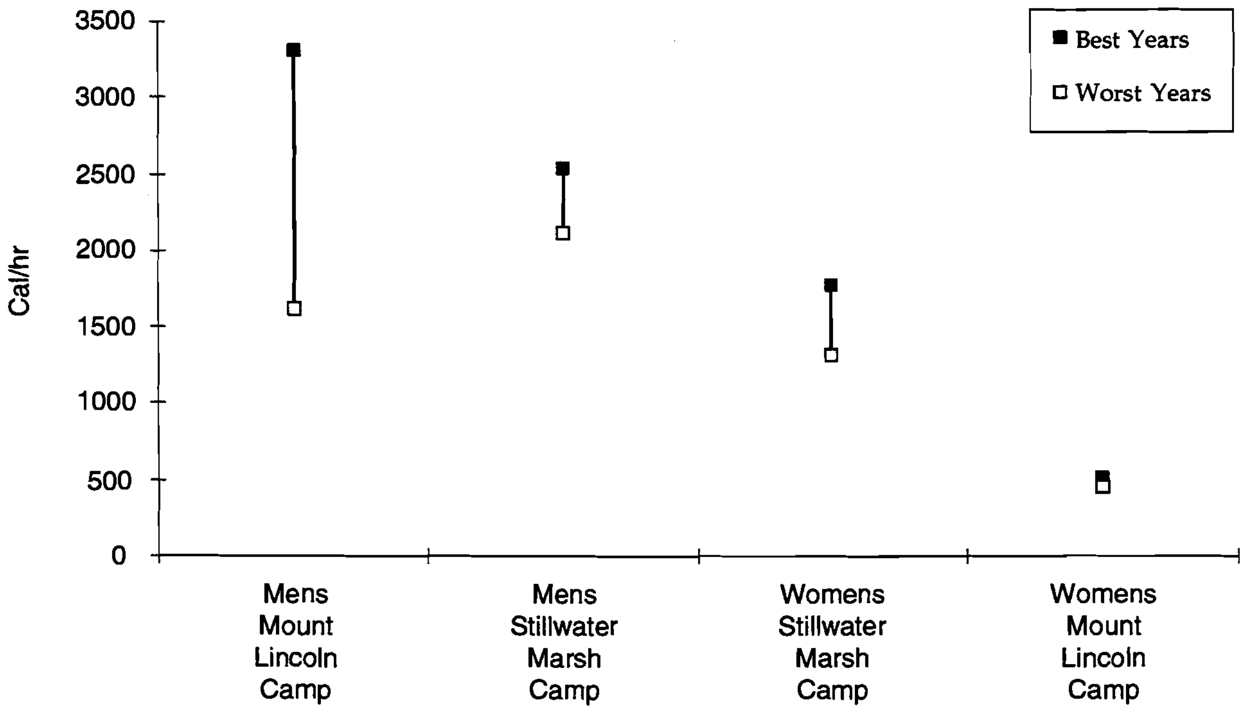


Figure 132. Estimated overall foraging returns for Early Late Holocene.

However, note that the best foraging returns for women in marshes do overlap the lower range of men's in mountains. Women could have further elevated their marsh return rates during the early Late Holocene if they incorporated high ranked marsh resources that fall out of the diet breadth of men, such as fish and ducks, into their own prey sets. Men could accommodate this decision by foraging logistically from marsh camps; a sheep procured in the Stillwater range (2900 Cal/hr) would still be in the diet breadth of hunters based in the marsh (2100-2500 Cal/hr). This strategy would allow early Late Holocene hunter-gatherers to exploit both areas simultaneously. Therefore, we suspect that the most likely response of women would be to emphasize wetland habitats even more intensively in the first part of the late Holocene than they did in the ethnographic period. Residential base camps (although not necessarily sedentary) from which men should have pursued large game logistically, should occur only in the lowlands. Exceptions to this pattern should occur when marshes crashed from catastrophic drought or flood, or possibly when encounter rates with upland game were at the higher end of their predicted range.

Pleistocene-Holocene Transition Foraging Decisions

As we have discussed, Great Basin archaeologists have long assumed that hunter-gatherers of the Pleistocene-Holocene Transition must have emphasized the procurement of large game because of the location of PHT sites and the composition of PHT assemblages. O'Connell et al. (1982:234) were among the first to approach human adaptation during the PHT from the perspective of the diet breadth model. Remarking on the common observation that milling stones are rare on Pre-Archaic sites, they suggested that human diet in the PHT may have consisted of higher return items such as large and medium mammals, roots and fish, with seeds added to the diet only as the abundance of higher ranked items declined due to climatic change.

Simms (1987, 1988) later reconsidered this issue in greater detail, taking a critical cudgel to those who would subsume the earliest subsistence strategies in the Great Basin within a normative "big game hunting adaptation," and particularly to those who argue for early large game hunting in the Great Basin because of morphological similarity between Great Basin projectile points and PaleoIndian points used elsewhere in North America. In Simms's view, these formulations deny adaptive variability among early Great Basin foragers that must have been the basis of adaptive strategies employed throughout prehistory.

Simms (1987:88) observes that in the historic Great Basin, density and abundance of highly mobile large animals varied widely, depending on animal habitat and demography, seasonal group size, and migration. Sometimes large animals were available in quantity, but often they were absent or were present in such slight density that their capture was unpredictable; moreover, the very winter conditions likely to have concentrated large animals may have hindered human access to them. Similar variability would have been characteristic of small and medium-sized animals, resulting in contingent adjustments of diet breadth at scales from a few days to a year (or more). Thus, through much of the Holocene, any "focus" on large game is likely to have been local and short term. Simms (1987:90) suggests that of all resources commonly available in the Great Basin, only fish may have been both relatively high ranked and stable over long periods. While Simms predicts that most seeds should be excluded from optimal diet breadth, seed returns are so variable that any given species may be in or out of the diet contingent on growing conditions, season, winter shortage, and so forth (Simms 1987:82).

Simms (1987:97) argues that if PHT constraints on big game hunting were similar to those of ethnographic times, then PHT diet often should have been broad enough to include small mammals and, perhaps less frequently, plants that required processing with milling stones. In fact, milling stones sometimes occur in PHT assemblages (Simms 1988; Willig 1988), but not as frequently as in Archaic assemblages (Elston 1986; Grayson 1993). Hunter-gatherers should have incorporated seeds into their diets with greater frequency as the Holocene environment became established. Simms (1987:98) concedes that while early people in the Great Basin probably did not eat enough meat to merit the appellation "big game hunters," they probably took large animals more frequently than most later Great Basin foragers. However, Simms (1987:88) estimates that encounter rates with large game would have to be 3 to 25 times greater than they were in historic times for small animals (and, by extension, the highest ranked women's marsh resources) to fall out of the PHT hunter-gatherer diet.

Although these points are well taken, the foregoing is really an argument about how the diet breadth model explains much of ethnographically observed subsistence strategies, and says little about human adaptation in the PHT. Just as we must avoid seeking, uncritically, big game hunters in the early Great Basin, we must be as cautious in projecting the present into the past. We agree that Great Basin environments always seem to have demanded the kind of broad diet and flexible foraging strategies observed ethnographically and in the prehistoric Archaic, but here we have demonstrated that the environment of the Late Pleistocene and Early Holocene was radically different from that of the Late Holocene. As we shall see, our PHT diet breadth model reflects these differences.

Following Simms's (1987) lead, we have analyzed diet by season and gender for a hypothetical marsh-side campsite similar to the ethnographic Stillwater Marsh camp used in previous simulations. However, we have altered the mix of available resources to represent the range of resources likely to have been available within the catchment of a marshside camp in this time. The prey set for men includes sheep, antelope, deer (as a proximate measure of black-tailed deer and elk), jackrabbit, medium mammal, cottontail, small mammal, duck, and fish. Women's prey set includes small mammals, large bulrush, shadscale, wildrye, small bulrush, cattail roots, sedge seeds, bulrush root, iodine bush seeds, and needlegrass seeds. In other words, we have combined many of the Holocene marsh and mountain resources to reflect the higher lake levels, more extensive marshes, and broad expanse of shrubby communities we suspect was typical of Pleistocene- Holocene transition habitats.

Figure 133 illustrates the optimal diet breadth curves for men and women with this mix of resources. The worst return rates are derived from the maximum modern return rates reported by Simms

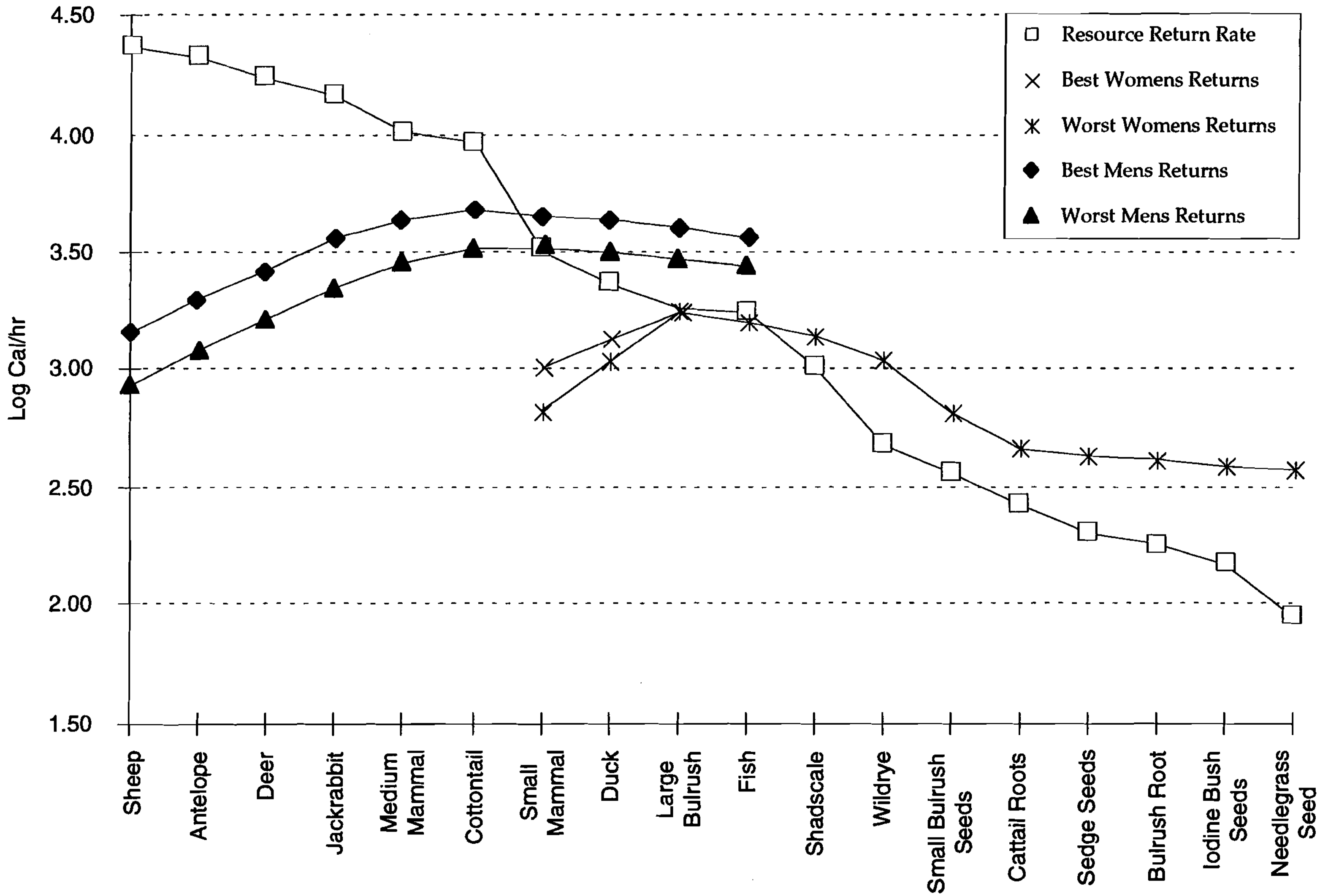


Figure 133. Autumn foraging returns for Pleistocene-Holocene Transition marsh camp.

(1987:74-75) for these resources. The best overall return rates result from increasing the encounter rates with terrestrial mammals by 75%, the same increase we postulated for the early Late Holocene. The diet breadth for women includes small mammals and large bulrush seeds under best and worst conditions. For men, fish, ducks, and small mammals fall out of both best and worst diets. Figure 134 indicates the range of overall foraging return rates calculated in the previous chart. For comparison, we have included the overall foraging return rates calculated for the early Late Holocene. Note that the range of foraging return rates for men is dramatically greater in the Pleistocene-Holocene transition than in the early Late Holocene. This difference is evident even though we increased terrestrial mammal encounter rates by the same percentage in both periods; it occurs solely because we postulate a wider diversity of game around the Pleistocene-Holocene camp.

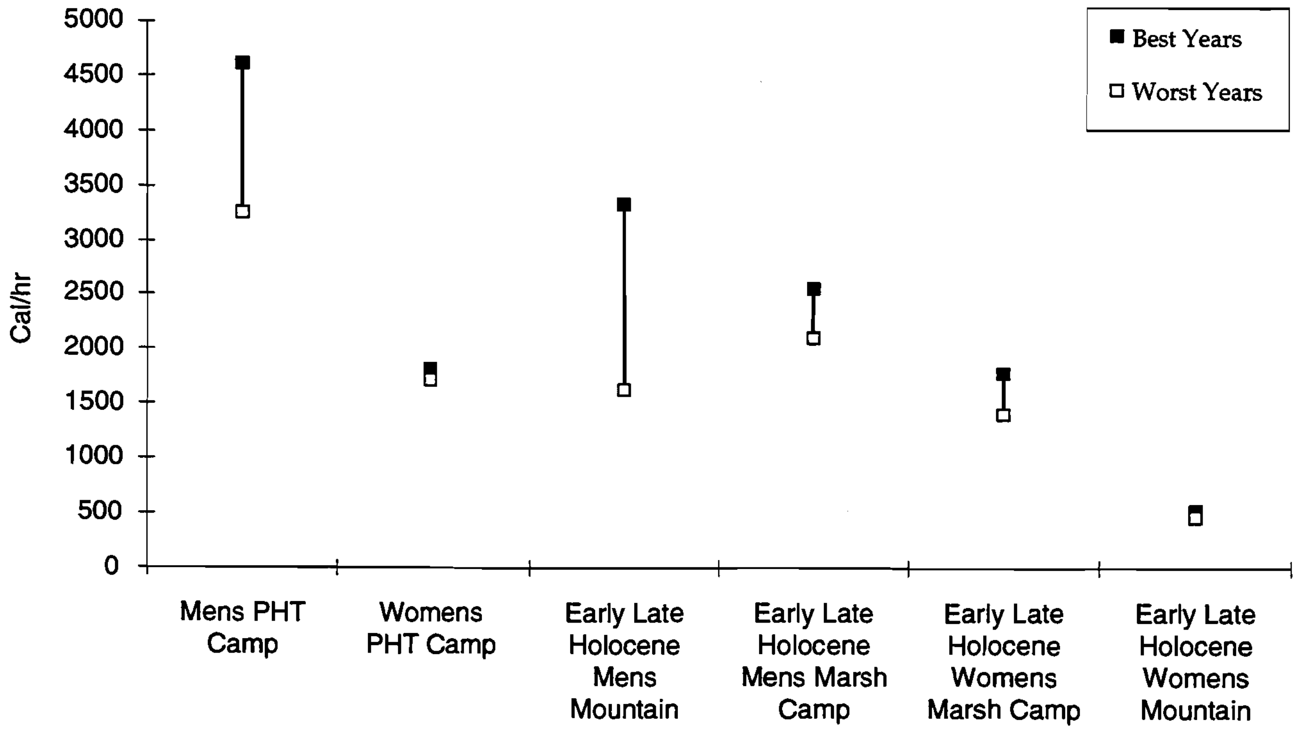


Figure 134. Estimated overall foraging returns for Pleistocene-Holocene compared to Early Late Holocene.

Unlike the early Late Holocene situation, the foraging return rates for men do not overlap with that of women, and simply incorporating ducks and fish into women's prey sets would not offset the discrepancy. Also, since both men and women could forage from the same campsite in the PHT, there is no spatial conflict between men's and women's foraging decisions as there was in the early Late Holocene. Consequently, we think it highly likely, in this case, that women would forsake their best foraging opportunities in favor of aiding men.

We suspect, moreover, that human population density in the PHT was sufficiently low that mobility was effectively unrestricted. That is, when PHT hunter-gatherers depleted the high return resources in any particular area, they were more likely to seek another patch offering similar resources than to remain and take lower ranked resources. They were even less likely to employ intensive processing and storage of low ranked resources such as seeds, because in most cases they could do better by moving on. As we have suggested, the large scale structure of the environment was such that if patches offering higher ranked resources could not be found in the same valley, they probably could be located in adjacent valleys. Thus, we do not expect the hallmarks of the Archaic (restricted mobility and intensification strategies such as seed processing and storage) to be reflected in the archaeological record of the PHT. High mobility and low population density is supported by the low abundance and scattered distribution of PHT sites compared to those of the mid-Holocene and later; short term occupation of PHT sites is indicated by lack of midden accumulation or any evidence that people constructed substantial shelter or storage facilities.

Along with Simms (1987), we also suspect that the total range of resources exploited by foragers of the PHT included most (if not all) of the resources taken by Archaic people. We are sure that early foragers knew how to capture and process virtually everything edible. We expect that foraging strategies employed by people of the PHT were flexible, and their diet expanded and contracted when required by local and regional variability in resources over the long and short term. But, as our model demonstrates, we also suspect that early foragers were much less likely to resort to lower ranked items than Archaic and Ethnographic people.

In summary, because human populations were relatively low, and high ranked resources occurred in greater abundance and diversity, we suggest that diet-breadth of Early Holocene foragers was narrow compared to later Archaic and ethnographic hunter-gatherers, focused on higher ranked food resources (chiefly game), and eschewed lower ranked resources (particularly plants requiring much processing). These folks were sufficiently mobile to shift camp whenever hunting and foraging exhausted the "cream" of resources available in the diurnal radius. They apparently did not accumulate so much food at any one time that it could not be consumed or transported; at any rate, there is no evidence for long-term storage. Elston and Raven (1991:76) suggest that

> Such a strategy could be expected to have generated a sparse, scattered archaeological record, with little functional differentiation between sites, little accumulation of residential middens (and perhaps little revisitation of sites), tool-kits dominated by hunting gear with little plant processing equipment, and the virtual absence of facilities (either labor-intensive shelters or food storage features).

And this is more or less what we observe in the archaeological record.

Chapter 10. IMPLICATIONS OF THE MODEL FROM RESEARCH AND MANAGEMENT PERSPECTIVES

David W. Zeanah

Archaeological debate over the role of wetlands and uplands in prehistoric settlement and subsistence in Toedokado territory inspired the modeling exercise and, while numerous questions await wider test for resolution, the model and the foregoing consideration of the paleoenvironmental record provide insights that are directly to relevant archaeological research and to resource management.

Research Domain

The sheer productivity of marshes in the western Great Basin convinced some scholars that hunter-gatherers must have enjoyed the luxury of a specialized marsh-edge adaptation (Heizer and Napton 1970). Kelly (1985) subsequently challenged that model by observing that large game are more energetically efficient to exploit than are most marsh resources, inferring that hunter-gatherers would forsake marsh foraging in favor of upland hunting so long as the abundance of upland game allowed. Thus, any evidence of a semisedentary, specialized palustrine adaptation in Toedokado territory must represent a subsistence intensification induced by environmental stress on higher ranked upland resources.

Reconsidering both energetic efficiency and abundance of marsh resources, Raven and Elston (1989:2) concluded that "wetlands constituted....the best foraging game in town," even though foraging opportunities in the uplands occasionally could draw hunter-gatherers out of the marshes (*ibid*:152). But since they had not modeled foraging opportunities of the uplands, the assessment of Raven and Elston lacked critical support.

The present modeling exercise relied on the same optimal foraging framework employed by Kelly (1985) and by Raven and Elston (1989) to evaluate the foraging potential of resources in Toedokado territory, and considered the entire landscape in the same detail as the much smaller area of the earlier Stillwater model. Experimental foraging returns and paleoenvironmental data heretofore unavailable were brought to bear, as was research of every human food resource of wetland, desert, and mountain for which useful estimates of distribution, abundance, and energetic return could be derived.

We conclude that, in the environment of the ethnographic period, wetlands unquestionably were the best foraging patches for women. In almost every seasonal circumstance that we can infer, wetlands offered higher ranked resources, in greater abundance, than any alternative habitat in Toedokado territory. Alternative foraging patches (of roots and pinyon nuts) might be sufficiently productive to draw women from the marshes briefly in spring and autumn. Otherwise, only when catastrophic flood or drought crippled the productivity of marshes should women have shifted their foraging activity to habitat types outside wetlands.

For men, the assessment is less clear-cut. Their highest ranked resources are large game that range outside marsh wetlands. However, under modern climatic conditions, Toedokado territory provides marginal habitat for antelope and fair habitat, at best, for sheep and deer (cf. Chapter 3). It is unlikely that men profitably could have pursued large game animals to the exclusion of small and medium sized prey, nor is there ethnographic evidence for such focused hunting strategies. No smaller and lower ranked classes of prey are available in montane or desert habitats for which similarly profitable equivalents are not available, in greater abundance, in or near marsh wetlands. Our simulation of ethnographic foraging returns demonstrates that the greater abundance of small mammals, birds, and fish in marsh wetlands provides higher overall foraging returns than do the rare but higher ranked resources of upland environments. Since males logistically could pursue large game animals from residential bases in the marshes, they rarely should have abandoned home and the more reliable and abundant, small and medium sized prey available thereto.

These observations directly apply only to the habitat mosaic of the ethnographic present. However, our extrapolations of environment into the early Late Holocene and the Pleistocene-Holocene transition suggest that marshes should have remained a central focus of hunter-gatherer subsistence-settlement strategies.

During the early Late Holocene uplands were more productive hunting territories for men because of increased game abundance but, with no pinyon in the Clan Alpine and Stillwater Ranges before 2000 years ago, there would have been little upland competition for women's foraging attention, and marshes would have been at their most extensive in the mesic conditions of the time. Even with the greater foraging return enjoyed by men in the uplands, both men's and women's foraging returns in the marsh were competitive to the extent that they overlapped the lower range of returns obtainable by upland hunting. Therefore, we suspect that women's foraging should have been even more highly focused on marshes in this period than at ethnographic observation. Since women's foraging decisions determine residential locations, consequences of child-rearing constraints on the mobility of women (Hurtado et al. 1985) and of the transport costs of many resources used by women (cf. Jones and Madsen 1989), residential base camps (although not necessarily sedentary) from which men should have pursued large game logistically should occur only in the lowlands. In this respect, our view and those of Kelly (Larsen and Kelly 1995) have grown closer over time.

Exceptions to this pattern should be when marshes crashed from catastrophic drought or flood. The vulnerability of marshes to climatic extremes should have increased during the climatic oscillations of the last part of the Late Holocene and women should have responded by broadening the breadth of their prey and foraging more frequently in less productive desert and mountain habitats. Too, the arrival of pinyon increased the attractiveness of mountains for women's foraging. Men should have continued to pursue large game, but declining game populations would have compelled them to hunt other habitats more frequently. Thus, we expect that it was during the last part of the Late Holocene, in response to deteriorating climatic conditions, that a residentially mobile strategy of exploiting a broad array of habitats developed. In short, our interpretation of the optimal responses of women to climatically induced change in the resource landscape of Toedokado territory is opposite that expressed by Kelly in 1985.

During the Pleistocene-Holocene Transition (PHT), a different resource structure existed in the Carson Desert. This extinct landscape would have provided a greater diversity of plant and animal species to be obtained on the valley floor as well as greater abundance of high ranked game animals. We have shown that merely by allowing a greater diversity of resources to be procured within a single foraging catchment, the overall foraging returns of men increase significantly over early Late Holocene levels while having little effect on the foraging returns of women.

We have observed (cf. Chapter 5) that among ethnographic Toedokado the returns offered by hunting occasionally were briefly high enough for women to forego their typical foraging pursuits in favor of participation in men's foraging strategies: rabbit drives, antelope drives, or fish runs, for example. Greater abundance of large game might have increased the frequency of these circumstances, creating situations where men's foraging strategies influenced residential location more than did those of women. In the simulated PHT environment, the overall foraging returns of women do not approach those of men and, therefore, we think it likely that women frequently abandoned their foraging strategies in favor of men's during the PHT. However, in the PHT case, men's best foraging areas would certainly have been in marshes. We also have noted that PHT return rates would have been contingent on short term circumstances that occasionally would have required PHT diet to encompass women's resources. Even so, women's best foraging interest would also have been in marshes in the PHT environment. Thus marshes would have continued to play a critical role in patterns of PHT subsistence and settlement.

The next step toward proving the model must be comprehensive sample survey of the entire Toedokado territory stratified in light of the habitat model. Data collected by survey should speak to specific hypotheses about archaeological assemblages that are designed to distinguish logistic and residential mobility in the archaeological record. Such were the goals of Kelly's 1985 survey, but absent an accounting for the effects of lithic toolstone availability on mountains and lowland assemblages (Elston 1988). Hypotheses pertinent to mobility strategy, controlling for toolstone availability, can be formulated from the habitat model and Elston's (1988) lithic toolstone procurement and utilization strategy model, using the survey data collected thus far as a pilot assemblage database.

Management Implications

A predictive model of archaeological site distribution has been expanded beyond the jurisdictional domain of the U.S. Fish and Wildlife Service to encompass interests of the Bureau of Land Management, the U.S. Navy, the Bureau of Reclamation, the State of Nevada, Churchill County, and other entities charged with management of land and resources, either as agency missions or in compliance with Federal, State, and local mandate. So far, less than 20% of the land base of the model has been sampled for purposes of testing its predictive power; a valid test of the Toedokado model against an independent sample of archaeological data remains an unfulfilled objective. Nevertheless, we have generated expectations about the distribution, abundance, and complexity of archaeological sites based on considerations of the habitat model. We have stratified administratively defined pieces of real estate within the area of the model according to the habitat model and surveyed a randomly selected 5% sample of those areas. We have used survey results to assess how well the predictions of the model correspond to the archaeological record observed in sample units. Thus, the present assessment of the model represents a *pilot study* of the predictive power of the model. Pending adequate testing and refinement of the model, its interim potential as a management tool is clear.

The model successfully predicts the archaeological complexity of 67% to 77% of sample quadrats surveyed in 1989, 1993, and 1994; most predictive errors occur in quadrats for which moderate archaeological complexity is expected. The model succeeds particularly well at predicting the absence of archaeological sites and the occurrence of sites with features. For example, 85% of quadrats lacking archaeological sites occur in habitats predicted to have few or none. Similarly, 86% of quadrats containing sites with features were assessed by the model as loci likely to contain evidence of residential occupation.

Such results suggest how the model can serve as a regional planning tool that allows land managers to estimate the complexity of the archaeological record likely to occur in any area proposed for development or to design development *around* predicted complexity. Thus, effects of development on archaeological resources can be minimized up front, thereby reducing subsequent inventory, evaluation, and mitigation costs. Without doubt, efficient allocation of time, personnel, and funds can be improved dramatically with reference to the model.

The model can serve as a standard by which managers of archaeological resources can evaluate site significance. For example, sites with features that are discovered in unexpected habitat types (i.e., predictive failures) are likely to yield significant information about the prehistory of Toedokado territory simply because such sites must reflect either paleoenvironmental conditions significantly different from those of the ethnographic present or subsistence strategies more intensive than those of the ethnographic Toedokado people. In other words, sites the model fails to predict can be highly significant in terms of their potential to yield new information about paleoenvironment and prehistoric subsistence strategies.

The President's Executive Order 11593 of 1971 directed Federal agencies to inventory and evaluate Federally-managed cultural properties. The geography of administrative jurisdictions compels the land manager to undertake this mission with an imperfect understanding of his resource base because his frame of reference is jurisdictional (administrative) rather than regional (environmental). For example, we know that Toedokado territory encompasses some two and one-half million acres of the western Great Basin and crosscuts the administrative boundaries of a score of public agencies. The Toedokado Paiute were at the top of the food chain in an ecosystem that incorporated marsh, desert, and mountain, but the modern administrative geography forces land managers to treat the environmental parts of a complex ecosystem as administrative wholes.

The Toedokado habitat model represents an evolutionary interpretation of ethnographic subsistence strategies and resource productivity that encompasses the entire range of an ethnographic hunting and gathering group. Therefore, the model can provide land managers with a more accurate understanding of archaeological site distributions everywhere in Toedokado territory and can lead the diverse administrative jurisdictions to a regional standard by which archaeological resources can be managed.

The model will achieve its full potential as a management tool upon territory-wide testing and refinement.

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Appendix A

UTM Coordinates for Boundary of Study Area

UTM mE*	UTM mN*	U.S.G.S 7.5' Quadrangle	Description
302700	4356150	Churchill Butte	
305050	4363450	Stockton Flat Well	on Hwy 50
313100	4374850	Fernley East	on road
319100	4383300	Hazen	on Hwy 50 Alt.
328600	4395800	Soda Lake NW/Eagle Rock	
340400	4404350	Parran	on road
348300	4410300	Parran	on Hwy 95
355900	4415700	Ocala	@ cave
368400	4424200	Lovelock Indian Caves	@ 1454 m peak
380000	4439250	Wildhorse Pass	
391950	4432300	Wildhorse Spring	
398800	4431900	Buena Vista Hills North	
402850	4433000	Buena Vista Hills North	on road
407800	4435450	Cornish Peak	on road
416000	4436800	Logan Peak	
425400	4433600	Fencemaker Pass	
430000	4427800	Fencemaker Pass/Boyer Ranch	
432800	4423350	Boyer Ranch	
436100	4421250	Hole in the Wall	
437950	4416250	Hole in the Wall	
435000	4402100	Bernice Canyon	head of Hoyt Canyon
431150	4393050	Byers Canyon	@ Mt. Grant
426250	4385000	Clan Alpine Ranch	
420950	4376900	Mt. Augusta	@ Mt Augusta
415850	4370000	Camp Creek Canyon	
410650	4360000	Wonder Mountain	
406750	4349400	West Gate	on Hwy 50
401000	4341800	Bell Canyon	
395750	4329400	Slate Mountain	@2177 m peak
391550	4325000	Big Kasock Mountain	
385650	4324900	Big Kasock mountain	
379200	4330000	Rawhide	
370000	4333700	Diamond Field Jack Wash	
360000	4335650	Diamond Field Jack Wash	
349750	4338700	Allen Springs	on Hwy 95
340000	4342750	Russell Spit	
330000	4340600	Wild Horse Basin	
320000	4343100	Parker Butte	
310000	4346300	Wabaska	
304100	4351600	Churchill Butte	on Hwy 28

*measured to +/- 100 meters accuracy

Appendix B

Concordance of BLM Vegetation Type Survey Range Types and Equivalent Habitats

Primary Range Site Nv-27XY-	Secondary Range Site Nv-27XY-	Tertiary Range Site Nv-27XY-	Quaternary Range Site Nv-27XY-	Habitat
1	5	41		01
5	6			28
5	9	18		04
5	11			52
6	41	5		28
7	8	999		37
7	8			37
7	11	19	999	52
7	11	20		52
7	11	27	999	52
7	11	999		52
7	15	999		37
7	17	8		39
7	17	40		37
7	17	999		39
7	17			39
7	19			37
7	27	19	999	56
7	27	999		56
7	28	11		37
7	47			48
7	51	999		37
7	54	11	999	37
7	54	11		37
7	54			37
7	999			37
7				37
8	7	17		39
8	9	23		20
8	14			27
8	14	18		31
8	17	999		31
8	18			31
8	26	18		31
8	28			31
8				31
9	14			16
9	15			16
9	18	14		11
9	18	25		11
9	18	999		11
9	18			11
9	19	15		16
9	19	23		16
9	19	25		16
9	22	34		16
9	22			16
9	23	18	999	20

Primary Range Site Nv-27XY-	Secondary Range Site Nv-27XY-	Tertiary Range Site Nv-27XY-	Quaternary Range Site Nv-27XY-	Habitat
9	23			20
9	24			16
9	27			16
9	996			16
9	997			16
9				16
11	7	20		37
11	7	50	999	52
11	7	999		52
11	7			52
11	15	17	19	52
11	15	17	19	52
11	17	7	999	52
11	17	27	999	52
11	18	7	999	52
11	18			52
11	19	999		52
11	19			52
11	29			52
11	999			52
13	9	999		36
13	27	996		36
13				36
14	20			27
14	24			27
14	29			27
14				27
15	7	999		37
15	9	18		42
15	9	19		42
15	9			16
15	11	999		42
15	17	11	9	41
15	17	11	999	41
15	17	999		41
15	17			42
15	18	999		42
15	18			42
15	20	999		42
15				42
16	25			38
16				38
17	15	9		39
17	15	999		41
17	19	18	999	25
17	19			25
17	26			39
17	27	32		39

Primary Range Site Nv-27XY-	Secondary Range Site Nv-27XY-	Tertiary Range Site Nv-27XY-	Quaternary Range Site Nv-27XY-	Habitat
17	27	999		39
17				39
18	8			31
18	9	15		11
18	9	15		11
18	9	22		11
18	9	23		20
18	9	997		11
18	9	999		11
18	9			11
18	11	15		10
18	11			10
18	14			10
18	15			10
18	15	23		20
18	17	9		11
18	17	19	11	25
18	17	19	999	25
18	17	22		21
18	17			10
18	19	15	9	49
18	19	22		49
18	19	26		49
18	19	30		49
18	19	999		49
18	19			49
18	22	999		21
18	22			21
18	23	9		20
18	23	26		20
18	23	999		20
18	23			20
18	25	997		10
18	25			13
18	26	19		26
18	26	996	27	26
18	26	999		26
18	26			26
18	27	22		26
18	27	26	999	26
18	27	996		26
18	27	999		26
18	27			26
18	29	30		10
18	29	32		10
18	29			10
18	29	999		10
18	31			10

Primary Range Site Nv-27XY-	Secondary Range Site Nv-27XY-	Tertiary Range Site Nv-27XY-	Quaternary Range Site Nv-27XY-	Habitat
18	32	8		10
18	32	29		10
18	32			10
18	45	26		27
18	45			27
18	53			10
18	996			10
18	997			10
18	999	26		26
18	999			10
18				10
19	7	27		56
19	7	999		40
19	9			40
19	9	18		16
19	15	9		16
19	15			56
19	17	26	999	25
19	17	27		39
19	17	999		25
19	17			25
19	18	25		40
19	18	999		40
19	18			40
19	26	18		40
19	27	7	999	56
19	27	999		56
19	27			56
19	32			56
19	999			40
19				40
20	7			44
20	11	7		44
20	11	29		44
20	11	999		44
20	15	19		44
20	15	999		44
20	15	999		44
20	18			44
20	19	30		44
20	27	18	999	44
20	994	11	27	34
20	994			34
20	999			44
20				44
21	11	7		37
21				52
22	17	999		21

Primary Range Site Nv-27XY-	Secondary Range Site Nv-27XY-	Tertiary Range Site Nv-27XY-	Quaternary Range Site Nv-27XY-	Habitat
22	20			21
22	29	18		21
22				21
23	11			20
23	995	18		20
23				20
23	999	18		20
24	25			14
24				14
25	6	997		03
25	16	997		38
25	16			38
25	18	30		13
25	18			13
25	24			14
25	26			03
25	26	9		03
25	41	997		29
25	42	997		03
25	997			03
25	997	42		03
25				03
26	9	18		26
26	18	8	999	26
26	18	9	999	26
26	18	27	996	26
26	18	45		26
26	18	999		26
26	18			26
26	19			40
27	7			18
27	11	19	999	18
27	11	999		18
27	18	996		26
27	18	999		26
27	18			26
27	19	30		56
27	19			56
27	20			18
27	22			18
27	26	999		18
27	26			18
27	30	19	8	56
27	32	8		56
27	43	999		18
27	47	999		18
27	999			18
27	999	11		18

Primary Range Site Nv-27XY-	Secondary Range Site Nv-27XY-	Tertiary Range Site Nv-27XY-	Quaternary Range Site Nv-27XY-	Habitat
27				18
28	26			46
28	30			46
28	45	14		46
29	18			10
29	19			10
29				10
30	19	27	8	56
30	25	18		13
30	27	19	999	56
32	7	27	999	35
32	7	27		35
32	7	999		35
32	7			35
32	19	7		35
32	48	18		35
32	999	19		35
32	999			35
32				35
33	18			10
37	27	999		46
37	999	17		39
39				10
41	5			29
41	18			29
41	25			29
41	42	25		29
41				29
43				19
45	11	7		27
45	14			27
45	28	14		27
46	54	50	999	47
46	54	999		47
46	54			47
47	7	999		48
47	7			48
47	998	7		48
47	999			48
47				48
50	46			19
50	52	57		19
50	52			19
50	54	999		19
50	57	999		19
50	57			19
50	994			34
53	45			27

Primary Range Site Nv-27XY-	Secondary Range Site Nv-27XY-	Tertiary Range Site Nv-27XY-	Quaternary Range Site Nv-27XY-	Habitat
54	7	32		37
54	46	50		47
54	46	999		47
54	46			47
57	50	994	999	34
57	50	999		19
57	50			19
58	50			19
994	7	999		34
994	7			34
994	11	29		52
994	12	29		34
994	17			34
994	32	999		34
994	50	11	999	34
994	50	997		34
994	50			34
994	999			34
994				34
995	23			15
996	18	25		13
997				02
999	27			18

Key:
992 - Mountain Upland
993 - River
994 - Woodland
995 - Dunes
996 - Badlands
997 - Playa
998 - Floodplains
999 - Rock Outcrops

Appendix C

Concordance of Fallon-Fernley and Churchill County Soil Survey Map Units, Range Site Equivalents, and Habitats

Soil Mapping Unit	Fallon-Fernley Mapping Symbol	Churchill County Mapping Symbol	Associated Range Types	Habitat
Appian clay substratum-Tiperary Complex	AS		24/25-9/12/41	07
Appian complex	Ap		18	10
Appian fine sandy loam	Ao		18	10
Appian loamy fine sand	Af	261	18	10
Appian sandy loam, clay substratum	An		18	10
Appian sandy loam, wet	Am		18	10
Appian-Juva-Bango Association		262	18	10
Appian-Playas association	AT	260	18	10
Appian-Tiperary Complex	AR		18/9	11
Badland	BA		996	54
Badland-Rebel-Yody Association		903	8	31
Bango association	BK	220	18/9	11
Bango loamy sand, 0-2% slopes	BdA		18	10
Bango loamy sand, 2-4% slopes	BdB		18	10
Bango sandy loam, 2-4% slopes	Beb		18	10
Bango silt loam, 0-2% slopes	BhA		18	10
Bango-Appian Association		221	18	10
Belate-Roca-Cleavage Association		840	46	47
Biddleman Association	BM	210	18	10
Biddleman very stony loamy sand, 2-4% slopes	BLB		18	10
Biddleman-Bluewing-Trocken Association		216	43/50	19
Biddleman-Isolde Association		215	18/23	20
Bluewing gravelly loamy sand 2-8% slopes	BnC	181	22	21
Bluewing Hawsley Association		186	50/9	19
Bluewing-Inmo Association		180	50/13	19
Bluewing-Pineval Association		184	22/50/8	21
Bluewing-Toulon-Rock outcrop Association		185	50/18	19
Bombadil-Old Camp Association		680	51/ 7	37
Buckaroo-Celeton-Wholan Association		158	18/ 27/ 14	26
Buckaroo-Rednick-Bluewing Association		153	18/22	21
Buckaroo-Rednick-Genegraf Association		154	18	10
Bunejug sandy loam	Bo		25	03
Bunejug sandy loam, slightly saline	Br		25	03
Bunejug sandy loam, strongly saline	Bs		25	03
Bunejug-Erber clay loams	BT		25	03
Carson clay	Cg		5 / 25	04
Carson clay loam, strongly saline	CE		5 / 25	04
Carson clay, slightly saline	Ch		25/5	04
Carson clay, strongly saline	Ck		25/5	04
Carson-Stillwater complex	CM		25	03
Celeton very cobbly sandy loam, 8-30% slopes	CNE		18/27	26
Celeton-Genegraf-Bedwyr Association		670	27/18	26
Chuckles-Bango Association		401	24/18	21
Churchill-Playa Complex	CP		25	03
Dia loam	Da		2/5/25	05
Dia loam, slightly saline	Dc		2/5/25	05
Dia loam, strongly saline	Dd		2/5/25	05
Dia loam, wet	De		2/5/25	05
Dithod loam	Dh		18/ 9	11
Dithod loam, slightly saline	Dk		18/ 9	11
Dithod loam, strongly saline	Dm		18/ 9	11
Downeyville, moist Downeyville-Gabbvally Association		1013	37	46
Duco/ClanAlpine/Old Camp Association		371	81/80/7	34
Duneland-Isolde Association		901	23	15
Duneland-Playas Association	Dp		23/16	15
East Fork clay loam	Ea		5 / 2	06
East Fork clay loam, slightly saline	Ec		5 / 2	06
East Fork clay loam, strongly saline	Ed		5 / 2	06
Fallon fine sandy loam	Fa		5 / 2	06
Fallon fine sandy loam, slightly saline	Fc		5 / 2	06
Fallon fine sandy loam, strongly saline	Fd		5 / 2	06

Soil Mapping Unit	Fallon-Fernley Mapping Symbol	Churchill County Mapping Symbol	Associated Range Types	Habitat
Fallon fine sandy loam, wet	Fe		5 / 2	06
Fernley clay	Fr		5 / 2	06
Fernley loam	Fo		5 / 2	06
Fernley sand	Fn		5 / 2	06
Findout-Izod-Rock outcrop Association		621	17	39
Ganaflan-Bluewing-Trocken Association		1071	18/43/50	10
Gardella gravelly silt loam	GA		25/24	07
Genegraf-Buckaroo-Bluewing Association		1233	18/ 22	21
Genegraf-Rednik-Trocken Association		1232	18/50	10
Genegraf-Trocken-Bluewing Association		1231	18/13/22	10
Hawsley sand, 2-8% slopes		140	9	16
Hawsley-Celeton-Bluewing Association		147	9/ 27/ 50	20
Hawsley-Isolde Association		141	9/ 23	20
Hawsley-Juva Association		146	9/ 18	11
Hawsley-Theon-Pirouette Association		144	9/ 19/ 18	16
Hessing-Wholan-Dun Glen Association		470	13	36
Hooplite-Old Camp-Singatze Association		731	32/7/27	35
Hooten-Bango Association	HB	600	24/ 18	14
Huxley gravelly clay loam	HU	290	25	03
Isolde-Duneland-Piouette Association		170	23/18	15
Isolde-Parran-Appian Association		171	16/25/24	38
Isolde-Pirouette-Hawsley Association		172	23/18/9	20
Itca-Reluctan-Walti Association		381	46	47
Juva sandy loam, 0-2% slopes	JuA		18	10
Juva sandy loam, 2-4% slopes	JuB		18	10
Juva silt loam, 2-4% slopes	JvB		18	10
Juva-Desatoya-Roca Association		321	32	35
Juva-Wholan-Stumble Association		460	18/9	10
Kram/Findout/Rock outcrop Assoiciation		432	17	39
Kram/Hopeka/Rock outcrop		433	32	35
Lahontan clay, slightly saline	Ls		2 / 5	06
Lahontan clay, strongly saline	Lt		5 / 2	06
Lahou-Rock outcrop Association	LR	650	18	10
Marsh	Ma		1	01
Loomer-Duco-Association		660	9/18	
Loomer-Bombadil-Old Camp		662	79/51/7	47
Mazuma-Bango Association	MB	640	25/18	13
Mazuma-Bluewing Association		643	25/50	13
Mazuma-Toulon-Chumall Association		644	24/18	14
Old Camp-Clanalpine-Colbar Association		308	7/ 80/ 51	34
Old Camp-Colbar-Rock outcrop Association		300	7/ 51	37
Old Camp-Pickup-Loomer		309	51/79	52
Old Camp-Singatse-Rock outcrop Association		302	7/27	56
Packer/Layview/Hapgood Association		720	—	47
Parran silty clay	PA		25	03
Parran-Tipperary Complex	PC		25	03
Patna Sand	PD		9	16
Pelic clay	Pf		5	04
Pelic sand, clay substratum	Ph		5	04
Pirouette-Osobb Association	PO	202	18/27	26
Pirouette-Osobb-Celeton Association		201	18/27	26
Pirouette-Osobb-Isolde Association		204	18/27	26
Pirouette-Osobb-Old Camp Association		206	18/27/7	26
Pirouette-Osobb-Rock outcrop Association		200	18/27	26
Playas	PY	900	997	02
Ragtown clay loam, slightly saline	Rc		5 / 2	06
Ragtown clay loam, strongly saline	Rg		25/ 5	04
Ragtown sandy clay loam	Ra		5 / 2	06
Rednik-Genegraf-Barnmot Association		315	18/ 27	26
Rednik-Trocken-Bluewing Association		311	18/50	10
Ricert-Rednick-Whirlo Association		357	18	10
Roic-Singatze-Celeton Association		1144	27	18
Roic-Trocken-Celeton Association		1143	27/50	18

Soil Mapping Unit	Fallon-Fernley Mapping Symbol	Churchill County Mapping Symbol	Associated Range Types	Habitat
Sagouspe loamy sand,	Sa		2 / 5	06
Sagouspe loamy sand, saline	Sb		2 / 5	06
Settlement-Louderback-Rustigat Association		330	6/ 5	28
Singatse-Rock outcrop Association		160	27	18
Slaw-Chuckles Association		341	41/25	29
Slaw-Mazuma-Hessing Association		342	41/25/13	29
Slaw-Ragtown Association		344	41/25	29
Slaw-Trocken-Chuckles Association		343	41/25	29
Soda Lake gravelly loamy sand, 0-2% slopes	ScA		18/25	13
Soda Lake gravelly loamy sand, 2-15% slopes	Sed		18/25	13
Soda Lake gravelly loamy sand, saline, 0-2% slopes	SdA		18/25	13
Soda Lake loamy sand, 0-2% slopes	SfA		18/25	13
Soda Lake sandy loam, saline, 0-2% slopes	SgA		18/25	13
Soda Lake- Rock outcrop complex	SH		18/25	13
Swingler clay loam	St		24/25-9/12/41	07
Swingler clay loam, slightly saline	Su		24/25-9/12/41	07
Swingler clay loam, stongly saline	Sv		24/25-9/12/41	07
Swingler sand	Sr		24/25-9/12/41	07
Swingler sandy loam	Ss		24/25-9/12/41	07
Teguro-Colbar-Cleavage Association		860	82/51	34
Theo-Old Camp Association		190	19/ 7	56
Theon very gravelly loam, 8-30% slopes		192	19	40
Theon-Roic-Singatze Association		1104	19/27	56
Theon-Singatse-Rock outcrop Association		191	19/27	56
Tipperary fine sand, 0-4% slopes	TPB		25/24-9/12/41	07
Tipperary fine sand, 4-15% slopes	TPD		23/9	20
Tipperary sand, 0-2% slopes	TnA		16	38
Tipperary sand, 2-8% slopes	TnC		18/9 (16)	11
Tipperary-Appian clay substratum Complex	TS		24/25-9/12/41	07
Tipperary-Appian Complex	TR		9 / 18	11
Tipperary-Paran Complex	TV		9/12-25/36	09
Trocken very gravelly loamy sand 2-15% slopes		284	50	19
Trocken-Bluewing Association		283	50/22	19
Trocken-Bluewing Association		423	50/24	19
Trocken-Hessing-Dun Glen Association		420	13	36
Trocken-Ragtown Association		281	24/25	07
Uripnes-Budihol-Chill Association		231	17/7/8	39
Walti-Roca-Belate Association		850	46	47
Welshaupt clay loam, slightly saline	We		25/5	04
Welshaupt clay loam, strongly saline	Wh		25/ 5	04
Whirlo Complex		421	18	10
Yody-Buffaran-Pineval Association		480	8	31

Appendix D

Site Concordance List

SITE NUMBER CONCORDANCE

Site Number			
BLM (CrNV 81-)	Smithsonian	Temporary Field No.	Survey Year
3532	26Ch943	7-1	1994
4613		3-1	1994
4614		3-2	1994
4615		3-3	1994
4616		3-4	1994
4617		3-5	1994
4618		4-1	1994
4619		4-2	1994
4620		4-3	1994
4621		4-4	1994
4622		4-5	1994
4623	26Ch1787	4-6	1994
4624		5-1	1994
4625		5-1	1994
4626		5-3	1994
4627		5-4	1994
4628		5-5	1994
4629		5-6	1994
4630		43-2	1994
4631		10-1	1994
4632		11-1	1994
4633		11-2	1994
4634		11-3	1994
4635		11-4	1994
4636		11-5	1994
4637		11-6	1994
4638		11-7	1994
4639		11-8	1994
4640		19-1	1994
4641		22-1	1994
4642		23-1	1994
4643		24-1	1994
4644		24-2	1994
4645		24-3	1994
4646		24-4	1994
4647		24-5	1994
4648		24-6	1994
4649		24-7	1994
4650		24-8	1994
4651		25-1	1994
4667		30-2	1994
4668		30-3	1994
4669		30-4	1994
4670		34-1	1994
4671		39-1	1994
4672		39-2	1994
4673		41-1	1994
4674		43-1	1994
4712		1-1	1993
4713		1-2	1993
4714		1-3	1993
4715		1-4	1993
4716		1-5	1993
4717		2-1	1993
4718		2-2	1993
4719		2-3	1993
4720		3-1	1993
4721		3-2	1993
4722		3-3	1993
4723		8-1	1993
4724		8-2	1993
4725		10-1	1993
4726		11-1	1993
4727		11-2	1993
4728		11-3	1993
4729		11-4	1993
4730		11-5	1993
4731		12-1	1993
4732		23-2	1994

Site Number Concordance, continued.

Site Number			
BLM (CrNV 81-)	Smithsonian	Temporary Field No.	Survey Year
4652		25-2	1994
4653		25-3	1994
4654		25-4	1994
4655		25-5	1994
4656		25-6	1994
4657		25-7	1994
4658		25-8	1994
4659		25-9	1994
4660		25-10	1994
4661		25-11	1994
4662		25-12	1994
4663		26-1	1994
4664		28-1	1994
4665		28-2	1994
4666		30-1	1994

Site Number			
BLM (CrNV 81-)	Smithsonian	Temporary Field No.	Survey Year

Appendix E

National Register Evaluations

The primary goal of this archaeological survey was to assess the predictive ability of the Toedokado habitat model. To that end we have described and analyzed observed cultural properties of the prehistoric period as attributes of square kilometer sample units, temporarily ignoring observed properties dating to the historic era and, similarly, ignoring other administrative considerations. The following discussions take up these matters and satisfy Navy and BLM cultural resource management directives. We begin with a review of evaluation standards pertinent to the National Register of Historic Places, then move on to National Register eligibility evaluation. Discussions are segregated in terms of land management jurisdiction: Navy and Bureau of Land Management. For quick answers to preliminary questions of National Register eligibility of any particular site, the reader is referred to Tables E.1 and E.2.

Standards for Evaluation of National Register Properties

The National Register of Historic Places, maintained by the Secretary of the Interior, is the national inventory of important cultural properties. Section 106 of the National Historic Preservation Act of 1966 (as amended) asks that Federal agencies evaluate cultural properties in their jurisdictions in terms of their potential for inclusion in the National Register. Evaluation is undertaken according to guidelines published by the National Park Service, administrator of the National Register program (NPS 1991:45-50). Properties eligible for National Register consideration must meet standards of significance and integrity.

Significant sites contribute to an understanding of history or prehistory through the variety, quantity, clarity, or research potential of the information inherent in them, and must meet at least one of these four criteria (NPS 1991:21):

a. be associated with events that made a significant contribution to U.S. history; or
b. be associated with the lives of significant individuals in U.S. history; or
c. embody the distinctive characteristics of a type, period, or method of construction, or represent the works of a master, or possess high artistic values or represent a significant and distinguishable entity whose components may lack individual distinction; or
d. have yielded or be capable of yielding information important in understanding prehistory or history.

Sites of the historic period commonly achieve significance through any of these four criteria, but their evaluation generally is considered in the context of historic themes. Significant historic sites in the project area will illuminate the kinds and chronologies of activities identified in the project area as delineated in the Nevada Comprehensive Preservation Plan (White et al. 1991). All these considerations, of course, assume that the property is at least 50 years old.

Prehistoric sites of the Great Basin generally (but not always) attain significance through criterion d alone. Evaluation of prehistoric archaeological sites considers their ability to address identified research questions and (therefore) to yield information important to understanding prehistory. The information potential of sites can be evaluated with respect to identified regional and local research domains, and to gaps in the available data base (Lyneis 1982a). Pendleton et al. (1982) reviewed the status of archaeological research in the Carson Desert at the end of the 1970s, identifying two overarching domains of future research: refinement of local and regional prehistoric chronologies, and reconstruction of prehistoric lifeways. More recently, Elston, Raven, and Baldrica (1992) have proposed an additional area of investigation relevant to the study area—human adaptive response to changing hydrological and biotic circumstances.

Site Number BLM CrNV 81-	Site Number Smith-sonian	Temp. Field No.	Survey Year	Site Class	UTM Location** Easting	UTM Location** Northing	Cadastral Location Town./Range	Cadastral Location 1/4 1/4 1/4 Section	Site Description	National Register Status	USGS Map Reference (1:24000)
4712		1-1	1993	Prehistoric	390010	4342450	T16N/R33E	NW NW NW Sec. 27	Lithic Scatter	Not Eligible	Chukar Canyon (1980)
4713		1-2	1993	Prehistoric	390030	4342640	T16N/R33E	SW of SW of SW of 22	Isolate	Not Eligible	Sheckler Reservoir (1985)
4714		1-3	1993	Prehistoric	390020	4342680	T16N/R33E	SW of SW of SW of 22	Isolate	Not Eligible	Sheckler Reservoir (1985)
4715		1-4	1993	Prehistoric	390200	4342750	T16N/R33E	SW of SW of SW of 22	Isolate	Not Eligible	Sheckler Reservoir (1985)
4716		1-5	1993	Prehistoric	390020	4342950	T16N/R33E	NW SW SW Sec. 22	Lithic Scatter	Not Eligible	Chukar Canyon (1980)
4717		2-1	1993	Prehistoric	389655	4341265	T16N/R33E	NW SE SE Sec. 28	Lithic Scatter	Not Eligible	Chukar Canyon (1980)
4718		2-2	1993	Prehistoric	389440	4341750	T16N/R33E	NE SW NE Sec. 28	Lithic Scatter	Not Eligible	Chukar Canyon (1980)
4719		2-3	1993	Prehistoric	389195	4341210	T16N/R33E	NW SW SE Sec. 28	Lithic Scatter	Not Eligible	Chukar Canyon (1980)
4720		3-1	1993	Prehistoric	388770	4346150	T16N/R33E	S 1/2 SW·Sec. 9	Lithic/Groundst. Scatter w/features	Eligible	Frenchman (1980)
4721		3-2	1993	Prehistoric	388440	4346620	T16N/R33E	W 1/2 Sec. 9	Lithic/Groundst. Scatter w/features	Eligible	Frenchman (1980)
4722		3-3	1993	Prehistoric	388270	4346760	T16N/R33E	E 1/2 SE NE Sec. 8	Lithic/Groundstone Scatter	Eligible	Frenchman (1980)
4723		8-1	1993	Prehistoric	356370	4334950	T15N/R30E	SE NE NE Sec. 19	Lithic/Groundstone Scatter	Not Eligible	Allen Springs (1987)
4724		8-2	1993	Prehistoric	356450	4334950	T15N/R30E	SW of NW of NW of 20	Isolate	Not Eligible	Allen Springs (1987)
4725		10-1	1993	Prehistoric	336150	4353750	T17N/R27E	SW of NW of SE of 24	Isolate	Not Eligible	Salt Cave (1985)
4726		11-1	1993	Prehistoric	335200	4356880	T17N/R27E	SE NE SE Sec. 11	Lithic Scatter	Not Eligible	Salt Cave (1985)
4727		11-2	1993	Prehistoric	335600	4356720	T17N/R27E	NE of SW of SW of 12	Isolate	Not Eligible	Salt Cave (1985)
4728		11-3	1993	Prehistoric	335480	4356540	T17N/R27E	SE SW SW Sec. 12	Lithic Scatter	Not Eligible	Salt Cave (1985)
4729		11-4	1993	Prehistoric	335260	4356460	T17N/R27E	SW SW SW Sec. 12	Lithic Scatter	Not Eligible	Salt Cave (1985)
4730		11-5	1993	Prehistoric	335500	4356380	T17N/R27E	E 1/2 NW NW Sec. 13	Lithic Scatter	Not Eligible	Salt Cave (1985)
4731		12-1	1993	Prehistoric	338980	4352650	T17N/R28E	NE SW NW Sec. 29	Lithic Scatter	Not Eligible	South of Fallon (1985)
		1-IF1	1993	Historic	390110	4342460	T16NR33E	NW of NW of NW of 27	Isolate	Not Eligible	Sheckler Reservoir (1985)
		1-IF2	1993	Prehistoric	390850	4342750	T16N/R33E	NW of SW of SE of 22	Isolate	Not Eligible	Sheckler Reservoir (1985)
		2-IF1	1993	Prehistoric	389780	4341350	T16N/R33E	NW of SE of SE of 28	Isolate	Not Eligible	Chukar Canyon (1980)
		2-IF2	1993	Prehistoric	389750	4341330	T16N/R33E	SE of NE of SE of 28	Isolate	Not Eligible	Chukar Canyon (1980)
		2-IF3	1993	Prehistoric	389750	4341630	T16N/R33E	NW of NE of SE of 28	Isolate	Not Eligible	Chukar Canyon (1980)
		2-IF4	1993	Prehistoric	389440	4341180	T16N/R33E	NE of SW of SE of 28	Isolate	Not Eligible	Chukar Canyon (1980)
		2-IF5	1993	Prehistoric	389100	4341900	T16N/R33E	SE of SE of NW of 28	Isolate	Not Eligible	Chukar Canyon (1980)
		3-IF1	1993	Prehistoric	388980	4346020	T16N/R33E	NW of SE of SW of 9	Isolate	Not Eligible	Frenchman (1980)
		3-IF2	1993	Prehistoric	388970	4346050	T16N/R33E	SW of SE of SW of 9	Isolate	Not Eligible	Frenchman (1980)
		3-IF4	1993	Prehistoric	388570	4346220	T16N/R33E	NW of SW of SW of 9	Isolate	Not Eligible	Frenchman (1980)
		3-IF5	1993	Prehistoric	388310	4346010	T16N/R33E	NE of SE of SE of 8	Isolate	Not Eligible	Frenchman (1980)
		3-IF6	1993	Prehistoric	388070	4346440	T16N/R33E	NW of NE of SE of 8	Isolate	Not Eligible	Frenchman (1980)
		3-IF7	1993	Prehistoric	388030	4346710	T16N/R33E	SW of SE of NE of 8	Isolate	Not Eligible	Frenchman (1980)
		4-IF7	1993	Prehistoric	394640	4346950	T16N/R33E	SW of NE of NE of 12	Isolate	Not Eligible	Drumm Summit (1972)
		6-IF1	1993	Prehistoric	352170	4338600	T16N/R33E	SE of SE of SE of 2	Isolate	Not Eligible	Allen Springs (1987)
		7-IF1	1993	Prehistoric	350070	4334780	T15N/R29E	NW of SW of NW of 22	Isolate	Not Eligible	Allen Springs (1987)
		7-IF2	1993	Prehistoric	350370	4334870	T15N/R29E	NE of SW of NW of 22	Isolate	Not Eligible	Allen Springs (1987)
		7-IF3	1993	Prehistoric	350390	4334670	T15N/R29E	SE of SW of NW of 22	Isolate	Not Eligible	Allen Springs (1987)
		7-IF4	1993	Prehistoric	350740	4334320	T15N/R29E	NE of NE of SW of 22	Isolate	Not Eligible	Allen Springs (1987)
		8-IF1	1993	Prehistoric	356900	4334710	T15N/R30E	NW of SE of NW of 20	Isolate	Not Eligible	Allen Springs (1987)
		8-IF2	1993	Prehistoric	356790	4334120	T15N/R30E	SE of NW of SW of 20	Isolate	Not Eligible	Allen Springs (1987)
		8-IF3	1993	Prehistoric	356700	4334560	T15N/R30E	SE of SW of NW of 20	Isolate	Not Eligible	Allen Springs (1987)
		10-IF1	1993	Prehistoric	336030	4353675	T17N/R27E	NW of NE of SE of 24	Isolate	Not Eligible	Salt Cave (1985)

Table E.1, continued.

Site Number BLM CrNV 81-	Site Number Smithsonian	Temp. Field No.	Survey Year	Site Class	UTM Location** Easting	UTM Location** Northing	Cadastral Location Town./Range	Cadastral Location 1/4 1/4 1/4 Section	Site Description	National Register Status	USGS Map Reference (1:24000)
		10-IF2	1993	Prehistoric	336000	4353450	T17N/R27E	NW of NW of SE of 24	Isolate	Not Eligible	Salt Cave (1985)
		10-IF3	1993	Prehistoric	336000	4353380	T17N/R27E	NW of NW of NE of 25	Isolate	Not Eligible	Salt Cave (1985)
		10-IF4	1993	Prehistoric	336120	4353400	T17N/R27E	NW of SW of SE of 24	Isolate	Not Eligible	Salt Cave (1985)
		10-IF5	1993	Prehistoric	336410	4353390	T17N/R27E	SW of SW of SE of 24	Isolate	Not Eligible	Salt Cave (1985)
		10-IF6	1993	Prehistoric	336510	4353900	T17N/R27E	SW of SW of SE of 24	Isolate	Not Eligible	Salt Cave (1985)
		10-IF7	1993	Prehistoric	336165	4353810	T17N/R27E	NW of SE of SE of 24	Isolate	Not Eligible	Salt Cave (1985)
		10-IF8	1993	Prehistoric	336135	4353060	T17N/R27E	NW of NW of NE of 25	Isolate	Not Eligible	Salt Cave (1985)
		10-IF9	1993	Prehistoric	336145	4353000	T17N/R27E	SW of NW of SE of 24	Isolate	Not Eligible	Salt Cave (1985)
		11-IF2	1993	Prehistoric	335480	4356610	T17N/R27E	SE of SW of SW of 12	Isolate	Not Eligible	Salt Cave (1985)
		11-IF3	1993	Prehistoric	335830	4356660	T17N/R27E	NW of SE of SW of 12	Isolate	Not Eligible	Salt Cave (1985)
		11-IF4	1993	Prehistoric	335860	4356460	T17N/R27E	SW of SE of SW of 12	Isolate	Not Eligible	Salt Cave (1985)
		11-IF5	1993	Prehistoric	335420	4356290	T17N/R27E	NW of NW of NW of 11	Isolate	Not Eligible	Salt Cave (1985)
		12-IF1	1993	Prehistoric	338020	4352940	T17N/R28E	SW of NE of NE of 30	Isolate	Not Eligible	Salt Cave (1985)
		12-IF2	1993	Prehistoric	338720	4352910	T17N/R28E	SW of NW of NW of 29	Isolate	Not Eligible	South of Fallon (Provisional,1985)
		12-IF3	1993	Prehistoric	338570	4352600	T17N/R28E	NE of SW of NW of 29	Isolate	Not Eligible	South of Fallon (Provisional,1985)
		13-IF1	1993	Prehistoric	334920	4352670	T17N/R27E	NW of SE of NE of 26	Isolate	Not Eligible	Salt Cave (1985)
		13-IF2	1993	Prehistoric	334770	4352950	T17N/R27E	SW of NE of NE of 26	Isolate	Not Eligible	Salt Cave (1985)
		16-IF1	1994	Prehistoric	385720	4412870	T23N/R32E	SW of NE of SW of 13	Isolate	Not Eligible	Lone Rock SE (1969)
		16-IF2	1994	Prehistoric	385150	4413000	T23N/R32E	NE of NE of SE of 14	Isolate	Not Eligible	Lone Rock SE (1969)
		42-IF1	1994	Prehistoric	403280	4382830	T20N/R34E	NW of NE of NW of 23	Isolate	Not Eligible	Job Peak (1982)
		42-IF2	1994	Historic	403540	4382600	T20N/R34E	SW of NW of NE of 23	Isolate	Not Eligible	Dixie Valley SE (1980)
		42-IF3	1994	Historic	403500	4382570	T20N/R34E	SE of NE of NW of 23	Isolate	Not Eligible	Dixie Valley SE (1980)
		42-IF4	1994	Historic	403640	4382450	T20N/R34E	NW of SW of NE of 23	Isolate	Not Eligible	Dixie Valley SE (1980)
		42-IF5	1994	Historic	403630	4382400	T20N/R34E	NE of SE of NW of 23	Isolate	Not Eligible	Dixie Valley SE (1980)
		42-IF6	1994	Historic	403440	4382300	T20N/R34E	SW of SE of NW of 23	Isolate	Not Eligible	Dixie Valley SE (1980)
		42-IF7	1994	Historic	403610	4382320	T20N/R34E	SE of SE of NW of 23	Isolate	Not Eligible	Dixie Valley SE (1980)
		44-IF1	1994	Prehistoric	431540	4423650	T24N/R37E	NW of NW of SE of 10	Isolate	Not Eligible	Boyer Ranch (1990)
		44-IF2	1994	Prehistoric	431810	4423980	T24N/R37E	NE of SW of NE of 10	Isolate	Not Eligible	Boyer Ranch (1990)

** UTM location of permanent datum.

Table E.2. List of Sites in Sampled Areas of Toedokado Territory (on BLM Lands)

Site Number: BLM CrNV 81-	Site Number: Smith-sonian	Temp. Field No.	Survey Year	Site Class	UTM Location**: Easting	UTM Location**: Northing	Cadastral Location: Town./Range	Cadastral Location: 1/4 1/4 1/4 Section	Site Description	National Register Status	USGS Map Reference (1:24000)
4613		3-1	1994	Prehistoric	334030	4362860	T18N/R27E	NE NW NW Sec. 26	Lithic Scatter	Not Eligible	Sheckler Reservoir (1985)
4614		3-2	1994	Prehistoric	334030	4362730	T18N/R27E	NE NW NW Sec. 26	Lithic Scatter	Not Eligible	Sheckler Reservoir (1985)
4615		3-3	1994	Prehistoric	334410	4362340	T18N/R27E	E 1/2 SE NW Sec. 26	Lithic Scatter	Not Eligible	Sheckler Reservoir (1985)
4616		3-4	1994	Prehistoric	334600	4362240	T18N/R27E	SW SW NE Sec. 26	Lithic Scatter	Not Eligible	Sheckler Reservoir (1985)
4617		3-5	1994	Prehistoric	334590	4362070	T18N/R27E	N 1/2 NW SE Sec. 26	Lithic Scatter	Not Eligible	Sheckler Reservoir (1985)
4618		4-1	1994	Prehistoric	340590	4353000	T17N/R28E	N 1/2 NE NW Sec. 28	Lithic/Groundstone Scatter	Not Eligible	South of Fallon (1985)
4619		4-2	1994	Prehistoric	340720	4353160	T17N/R28E	SE SE SW Sec. 21	Lithic/Groundst. Scatter w/features	Not Eligible	South of Fallon (1985)
4620		4-3	1994	Prehistoric	340320	4353470	T17N/R28E	NE SW SW Sec. 21	Lithic/Groundstone Scatter	Not Eligible	South of Fallon (1985)
4621		4-4	1994	Prehistoric	340200	4353740	T17N/R28E	NE NW SW Sec. 21	Groundstone Scatter	Not Eligible	South of Fallon (1985)
4622		4-5	1994	Prehistoric	340240	4353960	T17N/R28E	SE SW NW Sec. 21	Lithic/Groundstone Scatter	Not Eligible	South of Fallon (1985)
4623	26Ch1787	4-6*	1994	Prehistoric	340050	4353105	T17N/R28E	SW SW SW 21+N NW NW 28	Lithic/Groundst. Scatter w/features	Eligible	South of Fallon (1985)
4624		5-1	1994	Prehistoric	340210	4361615	T18N/R28E	SW SW NW Sec. 28	Lithic/Groundst. Scatter w/features	Not Eligible	Fallon (1985)
4625		5-1	1994	Prehistoric	340270	4361900	T18N/R28E	NW NW SW Sec. 28	Lithic Scatter	Not Eligible	Fallon (1985)
4626		5-3	1994	Prehistoric	340440	4361010	T18N/R28E	NE NW NW Sec. 33	Lithic/Groundstone Scatter	Not Eligible	Fallon (1985)
4627		5-4	1994	Prehistoric	340510	4361870	T18N/R28E	NE NW SW Sec. 28	Lithic/Groundst. Scatter w/features	Not Eligible	Fallon (1985)
4628		5-5	1994	Prehistoric	340550	4361300	T18N/R28E	NE SW SW Sec. 28	Lithic Scatter	Not Eligible	Fallon (1985)
4629		5-6	1994	Prehistoric	340710	4361310	T18N/R28E	SW SE SW Sec. 28	Lithic Scatter	Not Eligible	Fallon (1985)
3532	26Ch943	7-1*	1994	Prehistoric	349950	4336800	T15N/R29E	NE NE NE Sec. 16	Hist. Habitation and Lithic/Groundst.	Not Eligible	Allen Springs (1987)
4631		10-1	1994	Prehistoric	364020	4335470	T15N/R30E	SE NW SE Sec. 13	Lithic Scatter/Quarry	Not Eligible	Diamond Field Jack Wash (1987)
4632		11-1	1994	Prehistoric	366210	4336650	T15N/R31E	SW SW SW Sec. 8	Lithic Scatter/Quarry	Not Eligible	Diamond Field Jack Wash (1987)
4633		11-2	1994	Prehistoric	366630	4336400	T15N/R31E	SW NE NW Sec. 17	Lithic Scatter/Quarry	Not Eligible	Diamond Field Jack Wash (1987)
4634		11-3	1994	Prehistoric	367000	4336450	T15N/R31E	NW NW NE Sec. 17	Lithic Scatter	Not Eligible	Diamond Field Jack Wash (1987)
4635		11-4	1994	Prehistoric	366160	4336040	T15N/R31E	SW SW NW Sec. 17	Lithic Scatter/Quarry	Not Eligible	Diamond Field Jack Wash (1987)
4636		11-5	1994	Prehistoric	366330	4336250	T15N/R31E	S NW NW+NE SW NW Sec.17	Lithic Scatter	Eligible	Diamond Field Jack Wash (1987)
4637		11-6	1994	Prehistoric	366090	4336340	T15N/R31E	SE NE NE Sec. 18	Lithic Scatter	Not Eligible	Diamond Field Jack Wash (1987)
4638		11-7	1994	Prehistoric	366550	4336150	T15N/R31E	NW SE NW Sec. 17	Lithic Scatter	Not Eligible	Diamond Field Jack Wash (1987)
4639		11-8	1994	Prehistoric	366560	4336090	T15N/R31E	NW SE NW Sec. 17	Lithic Scatter	Not Eligible	Diamond Field Jack Wash (1987)
4640		19-1	1994	Prehistoric	388300	4335970	T15N/R33E	NW NW NW Sec. 16	Lithic Scatter	Not Eligible	Chukar Canyon (1980)
4641		22-1	1994	Prehistoric	390810	4334610	T15N/R33E	S SW SE 15+NE NW NE 22	Lithic Scatter	Not Eligible	Chukar Canyon (1980)
4642		23-1	1994	Historic	390380	4365990	T18N/R33E	NW NW SW Sec. 10	Historical Mining	Not Eligible	La Plata Canyon (1972)
4732		23-2	1994	Historic	390110	4365930	T18N/R33E	NE NE SE Sec. 9	Historical Mining	Not Eligible	La Plata Canyon (1972)
4643		24-1	1994	Historic	391360	4349940	T17N/R33E	SW SE NE Sec. 34	Historical Scatter	Not Eligible	Frenchman (1980)
4644		24-2	1994	Prehistoric	391330	4349710	T17N/R33E	NW NE SE Sec. 34	Lithic Scatter	Not Eligible	Frenchman (1980)
4645		24-3	1994	Prehistoric	391460	4349810	T17N/R33E	N1/2 NE SE Sec. 34	Lithic/Groundst. Scatter w/features	Eligible	Frenchman (1980)
4646		24-4	1994	Prehistoric	391005	4349830	T17N/R33E	NW NW SE Sec. 34	Lithic/Groundstone Scatter	Not Eligible	Frenchman (1980)
4647		24-5	1994	Prehistoric	391320	4349360	T17N/R33E	NW SE SE Sec. 34	Lithic Scatter	Not Eligible	Frenchman (1980)
4648		24-6	1994	Prehistoric	391850	4349980	T17N/R33E	SW1/4 NW Sec. 35	Lithic Scatter	Not Eligible	Frenchman (1980)
4649		24-7	1994	Prehistoric	391620	4349520	T17N/R33E	S NE SE Sec.34+W SW Sec.35	Lithic Scatter	Eligible	Frenchman (1980)
4650		24-8	1994	Prehistoric	391780	4349285	T17N/R33E	NW SW SW Sec. 35	Lithic Scatter	Not Eligible	Frenchman (1980)
4651		25-1	1994	Prehistoric	392870	4331090	T15N/R33E	SE SE NE Sec. 34	Lithic Scatter	Not Eligible	Slate Mtn. (1972)
4652		25-2	1994	Prehistoric	392480	4331450	T15N/R33E	SW NW NE Sec. 34	Lithic/Groundstone Scatter/Quarry	Not Eligible	Bell Canyon (1980)

Table E.2, continued.

Site Number BLM CrNV 81-	Smith-sonian	Temp. Field No.	Survey Year	Site Class	UTM Location** Easting	Northing	Cadastral Location Town./Range	1/4 1/4 1/4 Section	Site Description	National Register Status	USGS Map Reference (1:24000)
4653		25-3	1994	Historic	392720	4331420	T15N/R33E	SW NE NE Sec. 34	Lithic Scatter/Quarry	Not Eligible	Bell Canyon (1980)
4654		25-4	1994	Prehistoric	392350	4331520	T15N/R33E	S1/2 NW NE Sec. 34	Lithic Scatter	Not Eligible	Bell Canyon (1980)
4655		25-5	1994	Prehistoric/ Historic	392500	4331160	T15N/R33E	S 1/2 NE+E 1/2 NW +N 1/2 NE SE Sec. 34	Lithic/Groundstone Scatter and Historical Scatter	Eligible	Bell Canyon (1980) and Slate Mtn. (1972)
4656		25-6	1994	Prehistoric	392030	4331700	T15N/R33E	NE NE NW Sec. 34	Lithic Scatter	Not Eligible	Bell Canyon (1980)
4657		25-7	1994	Prehistoric	392050	4331810	T15N/R33E	SE SE SW Sec. 27	Lithic Scatter	Not Eligible	Bell Canyon (1980)
4658		25-8	1994	Prehistoric	392135	4331910	T15N/R33E	E1/2 SE SW Sec 27	Lithic Scatter	Not Eligible	Bell Canyon (1980)
4659		25-9	1994	Prehistoric	392480	4331570	T15N/R33E	NE NW NE Sec. 34	Lithic Scatter	Not Eligible	Bell Canyon (1980)
4660		25-10	1994	Prehistoric	392700	4331540	T15N/R33E	E NW NE+W NE NE Sec. 34	Lithic Scatter/Quarry	Not Eligible	Bell Canyon (1980)
4661		25-11	1994	Prehistoric	392840	4331860	T15N/R33E	SE1/4 SE Sec. 27	Lithic Scatter/Quarry	Not Eligible	Bell Canyon (1980)
4662		25-12	1994	Prehistoric	392710	4331730	T15N/R33E	S SE SE 27+N NE NE 34	Lithic Scatter/Quarry	Not Eligible	Bell Canyon (1980)
4663		26-1	1994	Prehistoric	392490	4355005	T17N/R33E	NW SW NE Sec. 14	Lithic Scatter	Not Eligible	Drumm Summit (1972)
4664		28-1	1994	Prehistoric	393700	4355980	T17N/R33E	SE NW SW Sec. 12	Lithic Scatter	Not Eligible	Drumm Summit (1972)
4665		28-2	1994	Prehistoric	393370	4355560	T17N/R33E	NE SE NE Sec. 11	Lithic Scatter	Eligible	Drumm Summit (1972)
4666		30-1	1994	Prehistoric	395610	4350520	T17N/R33.5E	SW NW NE Sec. 36	Lithic Scatter	Not Eligible	Drumm Summit (1972)
4667		30-2	1994	Prehistoric	395620	4350340	T17N/R33.5E	NE SW NE Sec. 36	Lithic Scatter	Not Eligible	Drumm Summit (1972)
4668		30-3	1994	Prehistoric	395990	4350210	T17N/R33.5E	NW SE NE Sec. 36	Lithic Scatter	Not Eligible	Drumm Summit (1972)
4669		30-4	1994	Prehistoric	395990	4350050	T17N/R33.5E	SW SE NE Sec. 36	Lithic Scatter	Not Eligible	Drumm Summit (1972)
4670		34-1	1994	Historic	398740	4333980	T15N/R34E	SW NW SE Sec. 20	Historical Habitation Site	Not Eligible	Bell Canyon (1980)
4671		39-1	1994	Historic	400940	4369070	T19N/R34E	NE1/4 SE Sec. 33	Historical Scatter	Not Eligible	Pirouette Mtn. (1972)
4672		39-2	1994	Prehistoric	400670	4369925	T19N/R34E	NE NW NE Sec. 33	Lithic Scatter	Not Eligible	Pirouette Mtn. (1972)
4673		41-1	1994	Historic	403710	4367280	T18N/R34E	SW NW SE Sec. 2	Historical Mining	Not Eligible	Wonder Mtn. (1980)
4674		43-1	1994	Historic	403390	4369610	T19N/R34E	E1/4 NW Sec. 35	Historical Mining	Not Eligible	Wonder Mtn. (1980)
4630		43-2	1994	Historic	403120	4369890	T19N/R34E	NE NW NW+NW NE NW Sec.35	Historical Mining	Not Eligible	Pirouette Mtn. (1972)
		1-IF1		Prehistoric	331790	4362900	T18N/R27E	NW of NE of NE of 28	Isolate	Not Eligible	Sheckler Reservoir (1985)
		1-IF2		Prehistoric	331110	4362630	T18N/R27E	SW of NE of NW of 28	Isolate	Not Eligible	Sheckler Reservoir (1985)
		2-IF1		Prehistoric	333000	4369270	T18N/R27E	NE of NE of NW of 3	Isolate	Not Eligible	Sheckler Reservoir (1985)
		2-IF2		Prehistoric	333090	4370000	T18N/R27E	SE of NE of SW of 34	Isolate	Not Eligible	Sheckler Reservoir (1985)
		2-IF3		Prehistoric	333270	4369210	T18N/R27E	SW of NW of NE of 3	Isolate	Not Eligible	Sheckler Reservoir (1985)
		2-IF4		Prehistoric	333870	4369320	T18N/R27E	NE of NE of NE of 3	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF1		Prehistoric	334000	4362870	T18N/R27E	NE of NW of NW of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF2		Prehistoric	334030	4362880	T18N/R27E	NE of NW of NW of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF3		Prehistoric	334060	4362750	T18N/R27E	NE of NW of NW of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF4		Historic	334060	4362580	T18N/R27E	SE of NW of NW of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF5		Prehistoric	334210	4362920	T18N/R27E	SW of SE of SW of 23	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF6		Prehistoric	334240	4362810	T18N/R27E	NW of NE of NW of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF7		Prehistoric	334160	4362260	T18N/R27E	SW of SE of NW of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF8		Prehistoric	334300	4362920	T18N/R27E	SW of SE of SW of 23	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF9		Prehistoric	334390	4362410	T18N/R27E	NE of SE of NW of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF10		Prehistoric	334390	4362170	T18N/R27E	SE of SE of NW of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF11		Prehistoric	334360	4362080	T18N/R27E	NE of NE of SW of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF12		Prehistoric	334570	4362020	T18N/R27E	NW of NW of SE of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)

Table E.2, continued.

Site Number BLM CrNV 81-	Smith-sonian	Temp. Field No.	Survey Year	Site Class	UTM Location** Easting	Northing	Cadastral Location Town./Range	1/4 1/4 1/4 Section	Site Description	National Register Status	USGS Map Reference (1:24000)
		3-IF13		Prehistoric	334600	4362010	T18N/R27E	NW of NW of SE of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)
		3-IF14		Prehistoric	334680	4362000	T18N/R27E	NW of NW of SE of 26	Isolate	Not Eligible	Sheckler Reservoir (1985)
		4-IF1		Prehistoric	340510	4353230	T17N/R28E	SW of SE of SW of 21	Isolate	Not Eligible	South of Fallon (1985)
		4-IF2		Prehistoric	340570	4353200	T17N/R28E	SE of SE of SW of 21	Isolate	Not Eligible	South of Fallon (1985)
		4-IF3		Prehistoric	340480	4353160	T17N/R28E	SW of SE of SW of 21	Isolate	Not Eligible	South of Fallon (1985)
		4-IF4		Prehistoric	340430	4353120	T17N/R28E	SW of SE of SW of 21	Isolate	Not Eligible	South of Fallon (1985)
		4-IF5		Prehistoric	340470	4353100	T17N/R28E	NW of NE of NW of 28	Isolate	Not Eligible	South of Fallon (1985)
		4-IF6		Prehistoric	340030	4353470	T17N/R28E	NW of SW of SW of 21	Isolate	Not Eligible	South of Fallon (1985)
		4-IF7		Prehistoric	340250	4353670	T17N/R28E	SE of NW of SW of 21	Isolate	Not Eligible	South of Fallon (1985)
		4-IF8		Prehistoric	340340	4353710	T17N/R28E	SE of NW of SW of 21	Isolate	Not Eligible	South of Fallon (1985)
		4-IF9		Prehistoric	340480	4353620	T17N/R28E	SW of NE of SW of 21	Isolate	Not Eligible	South of Fallon (1985)
		4-IF10		Prehistoric	340510	4353680	T17N/R28E	SW of NE of SW of 21	Isolate	Not Eligible	South of Fallon (1985)
		5-IF1		Prehistoric	340300	4362000	T18N/R29E	NW of NW of SW of 28	Isolate	Not Eligible	Fallon (1985)
		5-IF2		Prehistoric	340280	4361850	T18N/R29E	NW of NW of SW of 28	Isolate	Not Eligible	Fallon (1985)
		5-IF3		Prehistoric	340530	4361440	T18N/R29E	NE of SW of SW of 28	Isolate	Not Eligible	Fallon (1985)
		5-IF4		Prehistoric	340630	4361480	T18N/R29E	NW of SE of SW of 28	Isolate	Not Eligible	Fallon (1985)
		5-IF5		Prehistoric	340610	4361820	T18N/R29E	NW of NE of SW of 28	Isolate	Not Eligible	Fallon (1985)
		5-IF6		Prehistoric	340720	4361450	T18N/R29E	NW of SE of SW of 28	Isolate	Not Eligible	Fallon (1985)
		10-IF1		Prehistoric	364470	4335860	T15N/R31E	NW of NW of SW of 18	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		10-IF2		Historic	364820	4335450	T15N/R31E	NE of SW of SW of 18	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		10-IF3		Prehistoric	364230	4335130	T15N/R30E	SE of SE of SE of 13	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		10-IF4		Historic	364030	4335460	T15NR30E	NE of SW of SE of 13	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		10-IF5		Prehistoric	364030	4335500	T15N/R30E	SE of NW of SE of 13	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		11-IF1		Prehistoric	366730	4336380	T15N/R31E	SE of NE of NW of 17	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		11-IF2		Prehistoric	366530	4336280	T15N/R31E	SW of NE of NW of 17	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		11-IF3		Prehistoric	366650	4336250	T15N/R31E	SW of NE of NW of 17	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		11-IF4		Prehistoric	366780	4336170	T15N/R31E	NE of SE of NW of 17	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		11-IF5		Prehistoric	366640	4336150	T15N/R31E	NW of SE of NW of 17	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		11-IF6		Prehistoric	366140	4336090	T15N/R31E	NW of SW of NW of 17	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		11-IF7		Prehistoric	366160	4336110	T15N/R31E	NW of SW of NW of 17	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		11-IF8		Prehistoric	366580	4336090	T15N/R31E	NE of SE of NW of 17	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		11-IF9		Prehistoric	366390	4336035	T15N/R31E	NE of SW of NW of 17	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		11-IF10		Prehistoric	366740	4336030	T15N/R31E	NE of SE of NW of 17	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		11-IF11		Historic	366590	4336080	T15N/R31E	NE of SE of NW of 17	Isolate	Not Eligible	Diamond Field Jack Wash (1987)
		19-IF1		Prehistoric	388930	4335840	T15N/R33E	SE of NE of NW of 16	Isolate	Not Eligible	Chukar Canyon (1980)
		22-IF1		Historic	390120	4334760	T15N/R33E	NE of SW of SW of 15	Isolate	Not Eligible	Chukar Canyon (1980)
		22-IF2		Prehistoric	390630	4334970	T15N/R33E	SE of NE of SW of 15	Isolate	Not Eligible	Chukar Canyon (1980)
		22-IF3		Prehistoric	390650	4334670	T15N/R33E	NE of SE of SW of 15	Isolate	Not Eligible	Chukar Canyon (1980)
		23-IF1		Prehistoric	390260	4365300	T18N/R33E	SE of SE of SE of 9	Isolate	Not Eligible	La Plata Canyon (1972)
		23-IF2		Historic	390810	4365120	T18N/R33E	NW of NE of NW of 15	Isolate	Not Eligible	La Plata Canyon (1972)
		24-IF1		Prehistoric	391000	4349950	T16N/R33E	SW of SW of NE of 34	Isolate	Not Eligible	Frenchman (1980)
		24-IF2		Prehistoric	391060	4349630	T16N/R33E	SW of NW of SE of 34	Isolate	Not Eligible	Frenchman (1980)

Table E.2, continued.

Site Number BLM CrNV 81-	Smith-sonian	Temp. Field No.	Survey Year	Site Class	UTM Location** Easting	Northing	Cadastral Location Town./Range	1/4 1/4 1/4 Section	Site Description	National Register Status	USGS Map Reference (1:24000)
		24-IF3		Prehistoric	391120	4349540	T16N/R33E	SE of NW of SE of 34	Isolate	Not Eligible	Frenchman (1980)
		24-IF4		Prehistoric	391210	4349010	T17N/R33E	NE of NW of NE of 2	Isolate	Not Eligible	Frenchman (1980)
		24-IF5		Prehistoric	391350	4349000	T17N/R33E	NW of NE of NE of 2	Isolate	Not Eligible	Frenchman (1980)
		24-IF6		Prehistoric	391270	4349600	T16N/R33E	SE of NW of SE of 34	Isolate	Not Eligible	Frenchman (1980)
		24-IF7		Historic	391310	4349680	T16N/R33E	NE of NW of SE of 34	Isolate	Not Eligible	Frenchman (1980)
		24-IF8		Prehistoric	391320	4349830	T16N/R33E	SW of SE of NE of 34	Isolate	Not Eligible	Frenchman (1980)
		24-IF9		Prehistoric	391480	4349690	T16N/R33E	NW of NE of SE of 34	Isolate	Not Eligible	Frenchman (1980)
		24-IF10		Prehistoric	391900	4349350	T16N/R33E	NE of SW of SW of 35	Isolate	Not Eligible	Frenchman (1980)
		24-IF11		Prehistoric	391930	4349530	T16N/R33E	NE of NW of SW of 35	Isolate	Not Eligible	Frenchman (1980)
		24-IF12		Prehistoric	391700	4349830	T16N/R33E	NW of NW of SW of 35	Isolate	Not Eligible	Frenchman (1980)
		25-IF1		Historic	392890	4331020	T15N/R33E	SE of SE of NE of 34	Isolate	Not Eligible	Bell Canyon (1980)
		25-IF2		Historic	392880	4331160	T15N/R33E	SE of SE of NE of 34	Isolate	Not Eligible	Bell Canyon (1980)
		27-IF1		Prehistoric	392870	4360480	T18N/R33E	SE of SW of SE of 27	Isolate	Not Eligible	Piroutte Mtn. (1972)
		28-IF1		Prehistoric	393630	4356930	T17N/R33E	NE of NW of NW of 12	Isolate	Not Eligible	Drumm Summit (1972)
		29-IF1		Prehistoric	394570	4333680	T15N/R33E	NE of SE of SE of 23	Isolate	Not Eligible	Bell Canyon (1980)
		29-IF2		Historic	394900	4333310	T15N/R33E	NE of NW of NW of 25	Isolate	Not Eligible	Bell Canyon (1980)
		30-IF1		Prehistoric	395030	4350450	T17N/R33.5E	SW of NE of NW of 36	Isolate	Not Eligible	Drumm Summit (1972)
		30-IF2		Prehistoric	395620	4350010	T17N/R33.5E	SW of SW of NE of 36	Isolate	Not Eligible	Drumm Summit (1972)
		30-IF3		Prehistoric	395820	4350090	T17N/R33.5E	SW of SE of NE of 36	Isolate	Not Eligible	Drumm Summit (1972)
		30-IF4		Prehistoric	395900	4350000	T17N/R33.5E	SW of SE of NE of 36	Isolate	Not Eligible	Drumm Summit (1972)
		30-IF5		Prehistoric	395960	4350390	T17N/R33.5E	SW of NE of NE of 36	Isolate	Not Eligible	Drumm Summit (1972)
		31-IF1		Prehistoric	396540	4353470	T17N/R34E	NW of SW of NW of 19	Isolate	Not Eligible	Drumm Summit (1972)
		31-IF2		Historic	396820	4353040	T17N/R34E	NE of NE of SW of 19	Isolate	Not Eligible	Drumm Summit (1972)
		34-IF1		Prehistoric	398000	4333520	T15N/R34E	SW of SW of SW of 20	Isolate	Not Eligible	Bell Canyon (1980)
		34-IF2		Historic	398150	4333890	T15N/R34E	SE of NW of SW of 20	Isolate	Not Eligible	Bell Canyon (1980)
		34-IF3		Prehistoric	398570	4333990	T15N/R34E	SE of NE of SW of 20	Isolate	Not Eligible	Bell Canyon (1980)
		34-IF4		Historic	398940	4333520	T15N/R34E	SE of SW of SE of 20	Isolate	Not Eligible	Bell Canyon (1980)
		37-IF1		Prehistoric	399250	4370320	T19N/R34E	NW of SW of SE of 29	Isolate	Not Eligible	Piroutte Mtn. (1972)
		37-IF2		Historic	399460	4370680	T19N/R34E	NE of NE of SE of 29	Isolate	Not Eligible	Piroutte Mtn. (1972)
		38-IF1		Historic	400030	4360060	T18N/R34E	SW of NE of NW of 33	Isolate	Not Eligible	Piroutte Mtn. (1972)
		38-IF2		Historic	400210	4360780	T18N/R34E	SE of NE of SW of 28	Isolate	Not Eligible	Piroutte Mtn. (1972)
		39-IF1		Historic	400990	4369510	T19N/R34E	NE of SE of NE of 33	Isolate	Not Eligible	Piroutte Mtn. (1972)
		39-IF2		Historic	400990	4369690	T19N/R34E	SE of NE of NE of 33	Isolate	Not Eligible	Piroutte Mtn. (1972)
		39-IF3		Historic	400600	4369800	T19N/R34E	SW of NW of NE of 33	Isolate	Not Eligible	Piroutte Mtn. (1972)
		39-IF4		Historic	400630	4369640	T19N/R34E	NE of SW of NE of 33	Isolate	Not Eligible	Piroutte Mtn. (1972)
		41-IF1		Historic	403760	4367460	T18N/R34E	NW of NW of SE of 2	Isolate	Not Eligible	Wonder Mtn. (1980)
		43-IF1		Prehistoric	403370	4369860	T19N/R34E	NE of NE of NW of 35	Isolate	Not Eligible	Piroutte Mtn. (1972)
		43-IF2		Prehistoric	403190	4369990	T19N/R34E	NW of NE of NW of 35	Isolate	Not Eligible	Piroutte Mtn. (1972)

* site previously recorded

** UTM location of permanent datum

Questions particularly relevant to the present investigation are these:

a) How are prehistoric activities distributed with regard to features in the landscape and potential resource areas?

b) What is the range of variability in the distribution and content of archaeological sites observed in Toedokado territory?

c) Is there temporal variation in spatial patterns?

In this context, significance of prehistoric sites in the study area often turns on how the study of particular cultural remains can contribute to an understanding of human behavior, focusing on interrelated subsistence and settlement adaptations to changing environments as inferred from spatial and temporal distribution of cultural remains.

At the same time that an eligible property must meet standards of significance, it must possess integrity sufficient to convey association with past patterns, persons, designs, technology, or events. Archaeologists and historians observe six elements in their assessment of integrity: location, setting, design, material, workmanship, and feeling; Zeier (1984:46) suggests asking these questions of archaeological sites:

Location: Is the site physically in its original location or has it been moved or relocated (i.e. by stream action or human agency)?

Setting: Is the relationship between the site and its physical surroundings the same as when the site was occupied? Have subsequent events altered the surroundings to reduce integrity of setting?

Design: Is there a pattern inherent in the site that reflects "organization of space, proportion, scale, technology, and ornament," or have human or natural processes altered designs that once may have been present?

Material: Is the material at the site the same as that present when the site was occupied, or have intrusive materials been introduced that serve to reduce integrity of material?

Workmanship: Are the levels of skill and technology employed at the site during its occupation readily observable, or have human and natural actions altered the material present so as to decrease our ability to perceive workmanship?

Feeling: Do the site and its surroundings convey a sense of time and place appropriate to the period of occupancy?

Association: Does the site enjoy a strong link with the people, events, or time it represents?

Results of Site Evaluation

The sample survey conducted in 1993-94 occurred on lands administered by Naval Air Station Fallon (NAS) and by the Bureau of Land Management Carson City District (BLM). The two agencies imposed slightly different site classification and site recordation requirements. Consequently, we organized the following evaluation according to administrative jurisdiction. BLM site numbers are used everywhere, regardless of jurisdiction. In the present application, NAS Fallon defines "site" as a property containing more than 20 artifacts, and "isolate" as a property containing 20 or fewer artifacts, parameters that differ from those prescribed by the Bureau of Land Management. To avoid confusion herein, we refer to cultural properties on Navy lands that contain more than 20 artifacts as "Large Sites" and to properties on Navy lands with 20 or fewer artifacts as "Small Sites." Consistent with current Bureau of Land Management standards, we recorded all sites containing more than one artifact on Intermountain Antiquities Computer System (IMACS) "long" forms. In contrast, by direction of NAS Fallon, we recorded "small sites" on IMACS "short" forms as presented in the *Nevada BLM Cultural Resource Inventory Guidelines* (1989).

Sites in Navy Jurisdiction

We identified 71 cultural properties on lands administered by NAS Fallon; 64 are prehistoric and seven are historic.

Small Prehistoric Sites Ineligible for National Register Consideration (Navy)

Table E.3 summarizes attributes of 50 prehistoric small sites on Navy lands. Forty-one of these properties are isolated artifacts: 21 are flakes, of which two area obsidian; eight are bifaces and biface fragments; three are flake tools; one is a Desert Side-notched projectile point (cf. Chapter 7:Figure 113n); one is an Elko Corner-notched projectile point (cf. Chapter 7:Figure 113m); three represent ground stone tools; one is a hammerstone; one is an assayed cobble; and one is a core.

The remaining nine small sites contain between two and 20 artifacts apiece. Six of the small sites consist of debitage alone (sites CrNV-4714, -4715, -4724, 10-IF6, 11-IF5, 13-IF1). Besides debitage, CrNV-4713 contains three biface fragments, CrNV-4725 contains a core and two utilized flakes, and site CrNV-4727 contains a biface.

None of these is eligible for inclusion in the National Register of Historic Places. All fail to meet standards of significance because data quantity, variety, and clarity are insufficient to further inform an understanding of prehistory.

Small Historic Sites Ineligible for National Register Consideration (Navy)

Table E.4 summarizes the seven small sites belonging to the historic era found on Navy lands. These include three hole-in-cap cans, two evaporated milk cans, one sanitary can, and five shards of an aqua glass bottle. Failing to meet any standard of significance, none is eligible for National Register consideration.

Large Prehistoric Sites Ineligible for National Register Consideration (Navy)

Eleven prehistoric properties on Navy lands that are ineligible for inclusion in the National Register of Historic Places are summarized in Table E.5. All are scatters of 15 to 200 flakes; two (CrNV-4731 and CrNV-4730) contain small proportions of obsidian flakes. One site (CrNV-4717) consists of debitage alone, while ten include between one and ten other chipped stone artifacts. These include an Elko projectile point (at CrNV-4712) (cf. Chapter 7:Figure 112i), 16 bifaces, 16 flake tools and utilized flakes, 14 cores, a scraper, and a hammerstone. Only one site (CrNV-4723) contains a ground stone tool.

Table E.3. Small Prehistoric Sites Ineligible for National Register Consideration (Navy).

Site Number BLM (CrNV 81-)	Temp. Field No.	Project Element	Description
	1-IF2	B-17	One percussion flake, black obsidian
	1-IF3	B-17	One bifacial thinning flake, chert
	1-IF4	B-17	Four bifacial thinning flakes, yellow chert
4713	93-1-2	B-17	Two flakes, 3 biface frags. of local chert
4714	93-1-3	B-17	Six local chert core reduction flakes
4715	93-1-4	B-17	Nine local chert flakes, most core reduction
	2-IF1	B-17	One bifacial thinning flake, brown chert, 10 mm long
	2-IF2	B-17	One percussion flake, white chert, 25 mm long
	2-IF3	B-17	One biface fragment, brown chert (sketch)
	2-IF4	B-17	One Stage 2 biface, red chert
	2-IF5	B-17	One core reduction flake, brown chert
	3-IF1	B-17	One biface fragment, yellow/red chert (sketch)
	3-IF2	B-17	One hammerstone, basalt, 6x5x4 cm size
	3-IF4	B-17	One biface fragment, white chert (sketch)
	3-IF5	B-17	One Stage 2 biface fragment, chert
	3-IF6	B-17	One mano fragment (bifacial), gray ves. basalt (sketch)
	3-IF7	B-17	One Stage 2 biface fragment, chert
	4-IF7	B-17	One percussion flake, red chert, 140x15 mm
	6-IF1	B-19	One metate fragment, black basalt, 27x27x7 cm in size
	7-IF1	B-19	One percussion flake, brown chert, 15 mm long
	7-IF2	B-19	One percussion flake, chert w/dorsal cortex, 20 mm long
	7-IF3	B-19	One tested cobble, chert, 50x20x8 mm
	7-IF4	B-19	One angular debris flake, yellow/brown chart, 15 mm long
	8-IF1	B-19	One biface fragment, yellow chert (sketch)
	8-IF2	B-19	One flake tool, brown chert, 9 mm thick (sketch)
	8-IF3	B-19	One percussion flake, yellow/rust chert, 30x20x5 mm
4724	93-8-2	B-19	10-20 core reduction flakes of brown chert
	10-IF1	B-16	One flake tool, red/white chert (sketch)
	10-IF2	B-16	One percussion flake, chert
	10-IF3	B-16	One cobble core, chert
	10-IF4	B-16	One bifacial thinning flake, gray obsidian, 44x32x3 mm
	10-IF5	B-16	One core reduction flake, buff chert, 20x15x5 mm
	10-IF6	B-16	Two core reduction flakes, buff/red chert
	10-IF7	B-16	One core reduction flake, orange chert, 40x35x7 mm
	10-IF8	B-16	One core reduction flake, chert
	10-IF9	B-16	One flake tool, yellow chert (sketch)
4725		B-16	One core and 15 flakes (2 utilized) of local chert
	11-IF2	B-16	One bifacial thinning flake, local chert, 60 mm long
	11-IF3	B-16	One core reduction flake, gray chert, 150 mm long
	11-IF4	B-16	One weathered Stage 3 biface fragment, obsidian (sketch)
	11-IF5	B-16	Two core reduction flakes, local chert
4727	93-11-2	B-16	One biface and 10-15 core reduction flakes (all local chert)

Table E.3, continued.

Site Number BLM (CrNV 81-)	Temp. Field No.	Project Element	Description
	12-IF1	B-16	One mano, red scoria (photo: JB3,20) and flake, red chert
	12-IF2	B-16	One biface fragment, beige/pink chert (sketch)
	12-IF3	B-16	One bifacial thinning flake, beige/pink chert
	13-IF1	B-16	Two percussion flakes, chert
	13-IF2	B-16	One percussion flake, chert
	16-IF1	B-20	One white chert DSN point (illust.)
	16-IF2	B-20	One red/white chert Elko point fragment (illust.)
	42-IF1	Dixie V.	One cream colored chalcedony BIF thinning flake
	44-IF1	Dixie V.	One brown chert primary decortification flake
	44-IF2	Dixie V.	One white chert secondary reduction flake

Table E.4. Small Historical Sites Ineligible for National Register Consideration (Navy).

Site Number Temp. Field No.	Project Element	Description
1-IF1	B-17	Five pieces of aqua bottle glass (no base/embossing)
42-IF2	Dixie V.	One hole-in-cap food can 4" x 3" x 3/4" cap
42-IF3	Dixie V.	One sanitary can 4 3/4" x 3 1/2" /knife cut in "X" style
42-IF4	Dixie V.	One hole-in-cap can 4 1/4" x 2 15/16" x 1" cap /knife punch (2 holes)
42-IF5	Dixie V.	One matchstick evaporated milk can 3 7/8" x 3" /icepick (2 holes)
42-IF6	Dixie V.	One hole-in-cap food can 4 1/2" x 3 1/2" x 2" cap
42-IF7	Dixie V.	One matchstick evaporated milk can 3 3/4" x 2 3/4"

Integrity at all eleven sites has deteriorated significantly. Nine sites have suffered from erosion (CrNV-4712, -4716, -4718, -4723, -4726, -4728, -4729, -4730, -4731), while naval ordnance has disturbed four (CrNV-4717, -4718, -4723, -4731). The small undifferentiated assemblages of these sites provide insufficient data to further inform identified questions of regional prehistory. Consequently, none is eligible for National Register consideration.

Table E.5. Prehistoric Sites Considered Ineligible for Inclusion in the National Register (Navy).

Site Number BLM (CrNV 81-)	Site Number Temp. Field No.	Project Element	Site Type	Description	Integrity Deficiency	Significance Deficiency
4712	93-1-1	B-17	Lithic Scatter	One Elko point, 2 lithic tools and 25 thinning flakes all of local chert.	Erosion, ablation	Insufficient data content, site disturbance
4716	93-1-5	B-17	Lithic Scatter	One biface, one flake tool and 25-100 flakes of chalcedony and local chert.	Ablation, aeolian shifting	Insufficient data content, site disturbance
4717	93-2-1	B-17	Lithic Scatter	About 50 flakes of local chert, most are early biface thinning flakes.	Naval ordnance	Insufficient data content, site disturbance
4718	93-2-2	B-17	Lithic Scatter	Seven bifaces (three Stage 5) and over 100 chert biface thinning flakes in two discrete concentrations.	Navel ordnance, sheet erosion	Insufficient data content, site disturbance
4719	93-2-3	B-17	Lithic Scatter	One biface midsection and 25-100 flakes of local chert.	Erosion, naval ordnance	Insufficient data content, site disturbance
4723	93-8-1	B-19	Lithic/Groundstone Scatter	At least 15 flakes and five lithic tools of chert, obsidian, and basalt, 1 basalt metate and 1 quartzite hammerstone.	Naval ordnance, sheet erosion	Massive site disturbance
4726	93-11-1	B-16	Lithic Scatter	Chert cobble testing locality with very sparse scatter of about 20 flakes and one irregular core.	Sheet erosion	Insufficient data content, no evidence of depth
4728	93-11-3	B-16	Lithic Scatter	Chert cobble testing locality with 3 cores and approx. 100 core reduction flakes.	Sheet and wind erosion	Insufficient data content, no evidence of depth
4729	93-11-4	B-16	Lithic Scatter	Small scatter of 2 cores, 2 biface fragments and about 25 local chert core reduction flakes.	Sheet and wind erosion	Insufficient data content, no evidence of depth
4730	93-11-5	B-16	Lithic Scatter	Five cores, 3 bifaces, 1 scraper, 1 flake tool, and about 200 core reduction flakes imbedded in desert pavement surface. Material mostly local chert; scraper and 5% of flakes are of exotic chert or obsidian.	Sheet and rill erosion	Very diffuse, appearently unifunctional assemblage, no evidence of depth
4731	93-12-1	B-16	Lithic Scatter	Diffuse scatter of 3 cores and 37 core reduction flakes (7 utilized) of local cherts, 1 nodule and 1 thinning flake of obsidian, and 2 bifaces and 1 flake of basalt. Obsidian and basalt materials are highly weathered.	Erosion, ablation, naval ordnance	Insufficient data content, no evidence of depth

Large Sites Eligible for National Register Consideration (Navy)

Three large prehistoric sites on Navy lands are eligible for inclusion in the National Register of Historic Places under criterion d. Table E.6 summarizes their characteristics. All three sites are proximate one another and exhibit similar potential to yield significant information about prehistory.

Site CrNV-4720 is a large (52,500 m^2) lithic scatter with ground stone, distributed along a low meandering silt dune and adjacent playa on the western edge of Labou Flat (Figure E.1). The low coppice dune apparently represents an old shoreline of a shallow playa lake, as it is one of several concentric dunes paralleling the current playa edge (cf. Chapter 7:Figure 86). Greasewood, saltbush, seepweed, and Russian thistle currently vegetate the dunes.

The surface assemblage includes 29 ground stone tools (16 milling stones, one mano, one pestle, and ten grinding stone fragments), 12 utilized flakes, three bifaces, one hammerstone and one tule knife. Two Elko Corner-notched projectile points (cf. Chapter 7:Figure 112d, e) and one Rosegate point (cf. Chapter 7:Figure 113g) constitute the temporally diagnostic artifacts observed. The assemblage includes more than 500 flakes representing all stages of reduction. Multicolored cherts dominate the debitage, but a small percentage of basalt is present.

Numerous concentrations of fire-cracked rock appear on deflated dune surfaces across the site. They generally ranged from one to five meters in diameter and included as many as 40 pieces of fire-cracked rock. These disarticulated hearths closely correspond to other artifact clusters.

Wind and water erosion have deflated much of the site, and a graded roadbed traverses it. These factors have affected site integrity, but not to the point of complete degradation; potential for shallow, but intact, subsurface cultural deposits within the dune is strong. Such deposits may contain faunal and floral remains as well as datable charcoal. Surface remains are spatially patterned, suggesting little horizontal movement of cultural materials. Thus, the site retains sufficient integrity of location and design.

The site setting suggests that the site reflects exploitation of palustrine environments. Temporally diagnostic projectile points indicate association with the Middle and Late Archaic. A large, diverse assemblage of functionally and temporally diagnostic artifacts, and the potential for horizontally and vertically intact cultural deposits, indicate that further investigation of the site will yield significant information about prehistoric exploitation of palustrine environments.

Site CrNV-4721 is also on a low (10-20 cm) linear silt dune adjacent playa flats on the northwest margins of Labou Flat. The dune occurs immediately west of the dune occupied by CrNV-4720, and exhibits a parallel northeast-southwest orientation (cf. Chapter 7:Figure 86). The dune merges into gravelly alluvial fan sediments along the northern margin of the site. The concentric orientation of dunes along the margin of a playa flat suggests that the dunes represent recessional shorelines associated with periodic ponding on Labou Flat. Shadscale, saltbushes, greasewood, seepweed, and Russian thistle currently vegetate the site area, but playas undoubtedly would support a marsh under prolonged inundation.

The site is a large (750,000 m^2) lithic scatter with ground stone. Observed chipped stone tools include 28 flake tools, 45 bifaces, seven hammerstones, two scrapers, two unifaces, two tule knives, one drill, and one core. Projectile points include one Rosegate Series (cf. Chapter 7:Figure 113h), two Elko Series (cf. Chapter 7:Figure 112c, l), and one Humboldt Series (cf. Chapter 7:Figure 111f); six more projectile points are untypable fragments. Forty-three ground stone artifacts are present, including one

Table E.6. Prehistoric Sites Eligible for National Register Consideration (Navy).

Site Number						
BLM (CrNV 81-)	Temp. Field No.	Project Element	Site Type	Description	Integrity	Significance
4720	93-3-1	B-17	Lithic/Groundstone Scatter w/features	Several disaggregated hearths (FCR concentrations), at least 28 ground stone tools, 9 utilized flakes, 3 bifaces, 1 tule knife, 2 Elko and 1 Rosegate points, and 500+ flakes.	erosion, ablation, vehicle traffic, siltation	high density of artifacts in multifunctional assemblage with palustrine orientation
4721	93-3-2	B-17	Lithic/Groundstone Scatter w/features	An incomplete list of site attributes includes: 2 distinct hearths and dozens of FCR concentrations, 1 Rosegate, 2 Elko, 1 Humboldt and 6 point fragments, 43 ground stone tools, 33 flake tools, 45 bifaces, 7 hammerstones, 2 tule knives, 1 modified shell item, two quartz crystals, and 1000+ flakes (90% local chert, 10% basalt).	erosion, ablation, vehicle traffic, siltation	extremely dense and structurally complex scatter reflecting major palustrine orientation
4722	93-3-3	B-17	Lithic/Groundstone Scatter	Lithic scatter of up to 500 flakes (mostly chert), 3 bifaces and at least 9 milling stones.	Erosion, ablation, siltation	Palustrine oriented site at highest hydrologic elevation. Important to understanding of resource orientation and hydrologic chronology

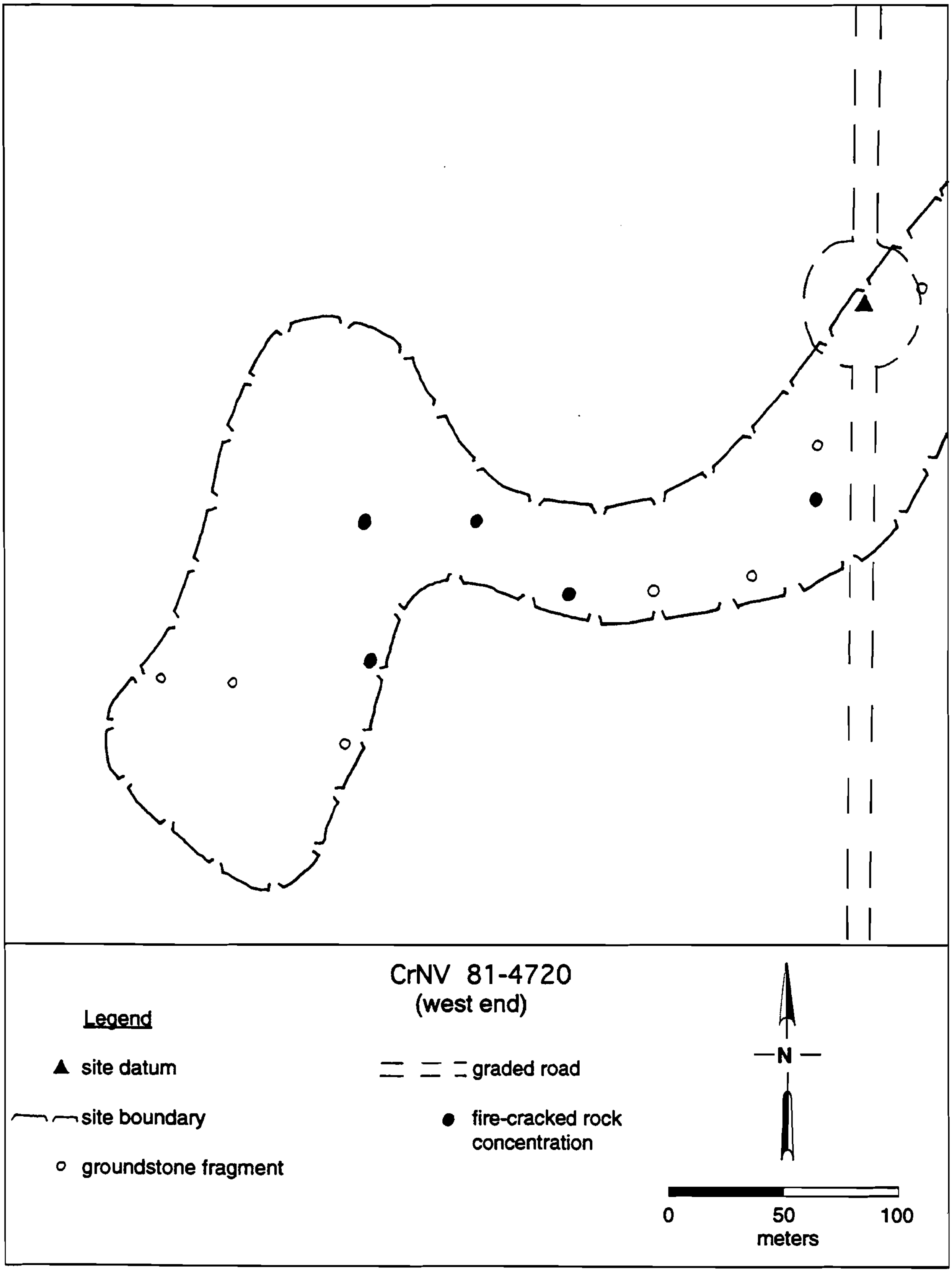


Figure E.1. Site map of CrNV81-4720.

mortar, one pestle, two manos, 30 metate fragments, and nine other ground stone fragments. Several quartz crystals and a fragment of worked mussel shell were noted. More than 500 flakes represent all stages of lithic reduction. Multicolored cherts are the most common toolstone material types, but basalt is also present.

Dozens of fire-cracked rock concentrations ranging from one to fifteen meters in diameter occur along the dune, on adjacent playa surfaces, and on gravelly fan sediments. These appear to be disarticulated hearths, some completely deflated and resting on the playa surface. Many more probably remain intact within the dune; indeed two rock concentrations in the northern part of the site are associated with charcoal-stained sediments. The hearths often cluster and generally are associated with dense artifact scatters (cf. Chapter 7:Figure 108)

Wind and water erosion have deflated much of the site. Nevertheless, a strong potential for shallow, intact subsurface cultural deposits within intact portions of the dune is indicated. The charcoal stains associated with two rock clusters suggest that features may contain faunal and floral remains as well as datable carbon. Spatial patterning of surface remains appears intact.

The site meets integrity and significance standards nearly identical to those for CrNV-4720, evaluated above.

Site CrNV-4722 is a moderate sized (23,500 m^2) lithic and ground stone scatter dispersed along an elevated silt dune along the western margin of Labou Flat. The dune here is peripheral to and concentrically aligned with the dunes containing sites CrNV-4720 and CrNV-4722 (cf. Chapter 7:Figure 86). Like the others, the low dune apparently represents a recessional shoreline associated with irregular flooding of Labou Flat.

The surface assemblage included nine ground stone fragments and three bifaces. Between 100 and 500 flakes were observed, most multicolored cherts and about 10% basalt. Secondary flakes dominate the debitage assemblage, but all reduction stages are represented.

Like sites CrNV-4720 and CrNV-4721, the physiographic location of site CrNV-4722 suggests that it was produced by hunter-gatherers exploiting periodically available marsh environments. The effects of wind and water erosion here are less noticeable than at CrNV-4720 and CrNV-4721. The dune of CrNV-4722 is higher in elevation than those to the east and apparently retains more intact sediments. Although no definitive evidence of subsurface cultural deposits was observed on site CrNV-4722, we infer them from such evidence in the similar, adjacent site settings. While the surface assemblage of CrNV-4722 is smaller and less diverse than at the adjacent sites, we suspect that variable arrays of temporally and functionally diagnostic artifacts remain buried beneath the surface. Thus, we find this site retaining sufficient integrity and significance to meet National Register standards as discussed for CrNV-4720.

Sites in BLM Jurisdiction

Site recordation procedures in BLM jurisdictions followed standards and guidelines established in *Nevada BLM Cultural Resource Inventory Guidelines* (1989, revised 1990), as modified by BLM Instruction Memorandum No. Nv-91-194. Accordingly, cultural properties consisting of only one artifact, feature, or object unassociated with other cultural remains were recorded as "isolates" for which no Intermountain Antiquities Computer System (IMACS) site forms were completed. Cultural properties consisting of two or more items were recorded as "sites," for which IMACS forms were completed.

We identified 162 cultural properties on BLM lands; 131 are prehistoric, 29 are historic, and two manifest components of both periods. All are described below, beginning with isolates.

Prehistoric Isolates (BLM)

Table E.7 lists the 77 prehistoric isolates observed on BLM land. Fifty-six are flakes, of which six are obsidian. Isolated chipped stone tools include eight bifaces and biface fragments, one flake tool, one core, two Elko Corner-notched projectile points (cf. Chapter 7:Figure 112j, k), one projectile point fragment, and one Great Basin Stemmed point (cf. Figure 111a). Three manos and four milling stone fragments represent isolated ground stone tools.

None of these isolated artifacts is eligible for inclusion in the National Register of Historic Places inasmuch as each lacks sufficient data variety, quantity, clarity, or research potential. None of the isolates demonstrates potential to yield additional information about local or regional prehistory.

Historic Isolates (BLM)

Table E.8 lists the 21 isolated historic artifacts found on BLM lands. These include six hole-in-cap cans, four tobacco tins (two integral to mining claim cairns), two evaporated milk cans, two soldered seam can fragments, one baking powder can, one sardine can, one paint can, one five-gallon metal can, one fence post, one piece of stove pipe, and one camera lens.

As above, each of these properties fails to meet significance standards; all, therefore, are not eligible for National Register consideration.

Prehistoric Sites Ineligible for National Register consideration (BLM)

We consider fifty prehistoric sites on BLM lands ineligible for inclusion on the National Register of Historic Places. Table E.9 summarizes pertinent data of each.

Ten sites (CrNV-4613, -4629, -4634, -4637, -4638, -4639, -4640, -4657, -4667, -4672) are small debitage scatters of 4 to 30 flakes that lack tools or features. Seven additional sites are small scatters of fewer than 25 flakes and associated chipped stone tools, but lacking temporally diagnostic artifacts or features. These sites (CrNV-4614, -4618, -4620, -4622, -4625, -4653, and -4659) contain 1 to 22 flakes associated with one to six tools apiece; one site (CrNV-4621) is comprised of three ground stone tools and nothing more.

Eighteen sites manifest debitage assemblages of 50 to 1000 flakes, but lack any temporally diagnostic artifacts or features. Three are comprised solely of debitage (CrNV-4633, -4651, -4656); between 1 and 18 formed artifacts appear on twelve sites (CrNV-4615, -4616, -4617, -4628, -4631, -4632, -4646, -4652, -4654, -4666, -4668, and –4669). In total, these formed artifacts include 21 bifaces, 25 cores, two assayed cobbles, two manos, one flake tool, and one scraper. The three remaining sites (CrNV-4660, -4661, and -4662) are large quarries with numerous cores (but no other diagnostics) and thousands of flakes of a yellow-red chert.

All 36 aforementioned sites fail to meet any standard of significance, lacking temporally diagnostic artifacts, subsurface deposits, or spatial patterning. The integrity of each has been affected to one degree or another by erosion. Consequently, they do not qualify for National Register consideration.

Table E.7. Prehistoric Isolated Finds on BLM Lands.

Field No.	Project Element	Description	Township/Range		Section
1-IF1	B-16 ext.	One white/brown chert biface reduction flake	T18N	R27E	NW of NE of NE of 28
1-IF2	B-16 ext.	One gray/purple chert biface reduction flake	T18N	R27E	SW of NE of NW of 28
2-IF1	B-16 ext.	One brown biface reduction flake	T18N	R27E	NE of NE of NW of 3
2-IF2	B-16 ext.	One black obsidian biface reduction flake	T19N	R27E	SE of NE of SW of 34
2-IF3	B-16 ext.	One light brown/red chert biface reduction flake	T18N	R27E	SW of NW of NE of 3
2-IF4	B-16 ext.	One red chert biface reduction flake	T18N	R27E	NE of NE of NE of 3
3-IF1	B-16 ext.	One light tan chert biface reduction flake	T18N	R27E	NE of NW of NW of 26
3-IF2	B-16 ext.	One tan/brown core reduction flake	T18N	R27E	NE of NW of NW of 26
3-IF3	B-16 ext.	One red chert core reduction flake	T18N	R27E	NE of NW of NW of 26
3-IF5	B-16 ext.	One white chert core reduction flake	T18N	R27E	SW of SE of SW of 23
3-IF6	B-16 ext.	One white chert core reduction flake	T18N	R27E	NW of NE of NW of 26
3-IF7	B-16 ext.	One white chert core reduction flake	T18N	R27E	SW of SE of NW of 26
3-IF8	B-16 ext.	One pink chert core reduction flake	T18N	R27E	SW of SE of SW of 23
3-IF9	B-16 ext.	One gray chert decortification flake	T18N	R27E	NE of SE of NW of 26
3-IF10	B-16 ext.	One white chert core reduction flake	T18N	R27E	SE of SE of NW of 26
3-IF11	B-16 ext.	Two light tan biface reduction flakes	T18N	R27E	NE of NE of SW of 26
3-IF12	B-16 ext.	Two gray chert core reduction flake	T18N	R27E	NW of NW of SE of 26
3-IF13	B-16 ext.	One brown chert core reduction flake	T18N	R27E	NW of NW of SE of 26
3-IF14	B-16 ext.	One brown/tan chert biface	T18N	R27E	NW of NW of SE of 26
4-IF1	B-16 ext.	One bifacial basalt mano (120 x 100 x 70mm)	T17N	R28E	SW of SE of SW of 21
4-IF2	B-16 ext.	One basalt core	T17N	R28E	SE of SE of SW of 21
4-IF3	B-16 ext.	One basalt milling stone fragment	T17N	R28E	SW of SE of SW of 21
4-IF4	B-16 ext.	One vesicular basalt metate (415 x 300 x 140mm)	T17N	R28E	SW of SE of SW of 21
4-IF5	B-16 ext.	One unifacial basalt mano (100 x 95 x 40mm)	T17N	R28E	NW of NE of NW of 28
4-IF6	B-16 ext.	One white chert biface	T17N	R28E	NW of SW of SW of 21
4-IF7	B-16 ext.	One gray basalt mano (150 x 110 x 30mm)	T17N	R28E	SE of NW of SW of 21
4-IF8	B-16 ext.	One tan chert biface thinning flake (retouched)	T17N	R28E	SE of NW of SW of 21
4-IF9	B-16 ext.	One brown chert biface	T17N	R28E	SW of NE of SW of 21
4-IF10	B-16 ext.	One vesicular basalt concave metate fragment (150 x 80 x 40mm)	T17N	R28E	SW of NE of SW of 21
5-IF1	B-16 ext.	One black obsidian biface thinning flake	T18N	R29E	NW of NW of SW of 28
5-IF2	B-16 ext.	One gray chert decortification flake	T18N	R29E	NW of NW of SW of 28
5-IF3	B-16 ext.	One purple chert Stage 2 biface fragment	T18N	R29E	NE of SW of SW of 28
5-IF4	B-16 ext.	One pink chert decortification flake	T18N	R29E	NW of SE of SW of 28
5-IF5	B-16 ext.	One tuff sloped milling stone fragment (190 x 80 x 35mm)	T18N	R29E	NW of NE of SW of 28
5-IF6	B-16 ext.	One black obsidian biface thinning flake	T18N	R29E	NW of SE of SW of 28
10-IF1	B-19 ext.	One yellow chert core reduction flake	T15N	R31E	NW of NW of SW of 18
10-IF3	B-19 ext.	Two brown/yellow core reduction flake	T15N	R30E	SE of SE of SE of 13
10-IF5	B-19 ext.	One black opaque obsidian Great Basin Stemmed point	T15N	R30E	SE of NW of SE of 13
11-IF1	B-19 ext.	Two yellow chert core reduction flakes	T15N	R31E	SE of NE of NW of 17
11-IF2	B-19 ext.	One translucent chalcedony biface reduction flake	T15N	R31E	SW of NE of NW of 17
11-IF3	B-19 ext.	One yellow chert core reduction flake	T15N	R31E	SW of NE of NW of 17
11-IF4	B-19 ext.	One yellow chert core reduction flake	T15N	R31E	NE of SE of NW of 17
11-IF5	B-19 ext.	One yellow chert decortication flake	T15N	R31E	NW of SE of NW of 17
11-IF6	B-19 ext.	One red chert core reduction flake	T15N	R31E	NW of SW of NW of 17
11-IF7	B-19 ext.	Two yellow chert core reduction flakes	T15N	R31E	NW of SW of NW of 17
11-IF8	B-19 ext.	One brown chert biface reduction flake	T15N	R31E	NE of SE of NW of 17
11-IF9	B-19 ext.	One brown chert biface reduction flake	T15N	R31E	NE of SW of NW of 17
11-IF10	B-19 ext.	Two yellow chert biface reduction flakes	T15N	R31E	NE of SE of NW of 17
19-IF1	B-17 S. ext.	One yellow chert biface reduction flake	T15N	R33E	SE of NE of NW of 16
22-IF2	B-17 S. ext.	One yellow chert biface reduction flake	T15N	R33E	SE of NE of SW of 15
22-IF3	B-17 S. ext.	One yellow chert biface reduction flake	T15N	R33E	NE of SE of SW of 15
23-IF1	B-17 N. ext.	One black obsidian biface thinning flake	T18N	R33E	SE of SE of SE of 9
24-IF1	B-17 N. ext.	One basalt biface reduction flake (w/ edge damage)	T16N	R33E	SW of SW of NE of 34
24-IF2	B-17 N. ext.	One gray chert biface reduction flake	T16N	R33E	SW of NW of SE of 34
24-IF3	B-17 N. ext.	One brown chert biface reduction flake	T16N	R33E	SE of NW of SE of 34

Table E.7, continued.

Field No.	Project Element	Description	Township	Range	Section
24-IF4	B-17 N. ext.	One red Stage 2 biface (50 x 40 x 15mm)	T17N	R33E	NE of NW of NE of 2
24-IF5	B-17 N. ext.	One yellow chert biface reduction flake	T17N	R33E	NW of NE of NE of 2
24-IF6	B-17 N. ext.	One brown/ black biface reduction flake	T16N	R33E	SE of NW of SE of 34
24-IF8	B-17 N. ext.	One black obsidian biface reduction flake	T16N	R33E	SW of SE of NE of 34
24-IF9	B-17 N. ext.	One tan chert biface reduction flake	T16N	R33E	NW of NE of SE of 34
24-IF10	B-17 N. ext.	One red chert biface reduction flake	T16N	R33E	NE of SW of SW of 35
24-IF11	B-17 N. ext.	One purple chert biface reduction flake	T16N	R33E	NE of NW of SW of 35
24-IF12	B-17 N. ext.	One brown chert biface reduction flake	T16N	R33E	NW of NW of SW of 35
27-IF1	B-17 N. ext.	One white/red core reduction flake	T18N	R33E	SE of SW of SE of 27
28-IF1	B-17 N. ext.	One brown chert projectile point midsection	T17N	R33E	NE of NW of NW of 12
29-IF1	B-17 S. ext.	One white chert biface fragment	T15N	R33E	NE of SE of SE of 23
30-IF1	B-17 N. ext.	One white chert biface fragment	T17N	R33.5E	SW of NE of NW of 36
30-IF2	B-17 N. ext.	One white chert biface thinning flake	T17N	R33.5E	SW of SW of NE of 36
30-IF3	B-17 N. ext.	One dark brown chert biface reduction flake	T17N	R33.5E	SW of SE of NE of 36
30-IF4	B-17 N. ext.	One brown chert biface thinning flake	T17N	R33.5E	SW of SE of NE of 36
30-IF5	B-17 N. ext.	One cream-colored chert biface thinning flake	T17N	R33.5E	SW of NE of NE of 36
31-IF1	B-17 N. ext.	One yellow chert biface thinning flake	T17N	R34E	NW of SW of NW of 19
34-IF1	B-17 S. ext.	One black obsidian biface thinning flake	T15N	R34E	SW of SW of SW of 20
34-IF3	B-17 S. ext.	One yellow chert biface fragment	T15N	R34E	SE of NE of SW of 20
37-IF1	B-17 N. ext.	One orange chert biface reduction flake (w/edge damage)	T19N	R34E	NW of SW of SE of 29
43-IF1	B-17 N. ext.	One white chalcedony Elko point base	T19N	R34E	NE of NE of NW of 35
43-IF2	B-17 N. ext.	One translucent black obsidian Elko point base	T19N	R34E	NW of NE of NW of 35

Table E.8. Historic Isolated Finds on BLM Lands.

Field No.	Project Element	Description	Township/	Range	Section
3-IF4	B-16 ext.	Five-gallon metal can, battered	T18N	R27E	SE of NW of NW of 26
10-IF2	B-19 ext.	One 6" piece of stove pipe	T15N	R31E	NE of SW of SW of 18
10-IF4	B-19 ext.	Claim cairn w/ tobacco tin, claim date "June 27, 1939"	T15N	R30E	NE of SW of SE of 13
11-IF11	B-19 ext.	One baking powder can w/ friction lid 7 3/8" x 4 1/8" with label "GOLDEN GATE SOLD ON MERIT 2 1/2 LBS NET" embossed on lid	T15N	R31E	NE of SE of NW of 17
22-IF1	B-17 S. ext.	Two fence post stubs (ca. 12" dia., 8" high) and 1 piece of bailing wire	T15N	R33E	NE of SW of SW of 15
23-IF2	B-17 N. ext.	One 4" x 4" post/rock cairn, with tobacco tin embossed "grimp out"	T18N	R33E	NW of NE of NW of 15
24-IF7	B-17 N. ext.	One camera lens "SCHODER KREAZNACH CINEBOW 1-1. 8/10"	T16N	R33E	NE of NW of SE of 34
25-IF1	B-17 S. ext.	One evaporated milk can 3" x 3 7/8" / two hole knife punch	T15N	R33E	SE of SE of NE of 34
25-IF2	B-17 S. ext.	One evaporated milk can 3 3/8" x 4 1/2" / two hole knife punch	T15N	R33E	SE of SE of NE of 34
29-IF2	B-17 S. ext.	One sardine can (4 3/8" X 3 1/8" X 7/8") / key pull ball opener	T15N	R33E	NE of NW of NW of 25
31-IF2	B-17 N. ext.	One paint pail (ca. 1 gallon)	T17N	R34E	NE of NE of SW of 19
34-IF2	B-17 S. ext.	One hole-in-cap food can (4 1/2" x 3 5/16" x 1 3/8" cap)	T15N	R34E	SE of NW of SW of 20
34-IF4	B-17 S. ext.	One tobacco tin	T15N	R34E	SE of SW of SE of 20
37-IF2	B-17 N. ext.	One tapered rectangular hole-in-cap meat can (3 11/16" x 3 1/4")	T19N	R34E	NE of NE of SE of 29
38-IF1	B-17 N. ext.	One soldered seam food can (eroded ends)	T18N	R34E	SW of NE of NW of 33
38-IF2	B-17 N. ext.	One soldered seam food can (eroded ends)	T18N	R34E	SE of NE of SW of 28
39-IF1	B-17 N. ext.	One hole-in-cap can (4 5/16" x 3" x 1" cap)	T19N	R34E	NE of SE of NE of 33
39-IF2	B-17 N. ext.	One hole-in-cap food can (4 3/4" x 4 x 2 1/4" cap)	T19N	R34E	SE of NE of NE of 33
39-IF3	B-17 N. ext.	One tobacco tin	T19N	R34E	SW of NW of NE of 33
39-IF4	B-17 N. ext.	One hole-in-cap food can (4 3/4" x 4 x 2 1/2" cap)	T19N	R34E	NE of SW of NE of 33
41-IF1	B-17 N. ext.	One hole-in-cap can (4" x 2 5/8" x 1 1/2" cap)	T18N	R34E	NW of NW of SE of 2

Table E.9. Prehistoric Sites Considered Ineligible for Inclusion in the National Register (BLM).

Site Number BLM (CrNV 81-)	Site Number Temp. Field No.	Project Element	Site Type	Description	Integrity Deficiencies	Significance Deficiencies
3532	94-7-1	B-19 ext.	Lithic/Groundstone Scatter w/ features and historical component	Three ground stone tools and 7 flakes of basalt, local chert and obsidian. Two areas of FCR may represent cultural features.	hist. disturbance, grazing, spring improvements	insufficient data content, integrity compromised
4613	94-3-1	B-16 ext.	Lithic Scatter	About 15 core reduction flakes of local chert.	erosion, deflation, grazing	insufficient data content, no evidence of depth
4614	94-3-2	B-16 ext.	Lithic Scatter	One core, 1 biface, and 18 core reduction flakes of local chert.	erosion, deflation, grazing	insufficient data content, no evidence of depth
4615	94-3-3	B-16 ext.	Lithic Scatter	Two bifaces and over 100 flakes, most being of core reduction stage.	erosion, deflation, grazing	insufficient data content, no evidence of depth
4616	94-3-4	B-16 ext.	Lithic Scatter	Three cores and about 150 flakes, most representing core reduction of local chert cobbles.	rill/sheet erosion deflation, grazing	insufficient data content, no evidence of depth
4617	94-3-5	B-16 ext.	Lithic Scatter	Large area scatter containing 3 bifaces, 4 cores, and 250-300 flakes, most representing core reduction of local cobbles.	erosion, deflation, grazing	diffuse, unifunctional assemblage, no evidence of depth
4618	94-4-1	B-16 ext.	Lithic/Groundstone Scatter	Three bifaces, a core, 3 ground stone tools, and 8 flakes of local chert.	erosion, deflation	integrity compromised, no evidence of depth
4619	94-4-2	B-16 ext.	Lithic/Groundstone Scatter w/features	Large diffuse scatter of 1 Gatecliff point, 11 ground stone tools, 1 biface, and core reduction flakes of local chert. Five areas of scattered FCR and tools may represent cultural features.	erosion, deflation	integrity compromised, no evidence of depth
4620	94-4-3	B-16 ext.	Lithic/Groundstone Scatter	Small scatter of 2 ground stone tools, 1 core fragment, and 7 flakes of local cherts.	erosion, deflation	integrity compromised, no evidence of depth
4621	94-4-4	B-16 ext.	Groundstone Scatter	Three ground stone tools.	erosion	insufficient data content, no evidence of depth
4622	94-4-5	B-16 ext.	Lithic/Groundstone Scatter	Two ground stone tools and one core reduction chert flake.	erosion	insufficient data content, no evidence of depth
4624	94-5-1	B-16 ext.	Lithic/Groundstone Scatter w/features	One Rosegate point, 4 ground stone tools, and 8 core reduction/biface thinning flakes of local chert and obsidian.	erosion, grazing	insufficient data content, no evidence of depth
4625	94-5-2	B-16 ext.	Lithic Scatter	Two bifaces and 7 flakes (1 retouched) of local chert.	erosion, grazing	insufficient data content, no evidence of depth
4626	94-5-3	B-16 ext.	Lithic/Groundstone Scatter	One Rosegate point, 1 uniface, 1 ground stone tool, and about 13 flakes of local chert and obsidian.	erosion, grazing, vehicular traffic	integrity compromised, no evidence of depth
4627	94-5-4	B-16 ext.	Lithic/Groundstone Scatter w/features	Three ground stone fragments and about 50 flakes of local chert. Vesicular basalt conc. (containing ground stone) may represent a cultural feature.	erosion, deflation	integrity compromised, no evidence of depth
4628	94-5-5	B-16 ext.	Lithic Scatter	One flake tool and a few hundred multi-stage flakes of local chert, with about 30% heat affected.	grazing	insufficient data content, no evidence of depth

Table E.9, continued.

Site Number BLM (CrNV 81-)	Site Number Temp. Field No.	Project Element	Site Type	Description	Integrity Deficiencies	Significance Deficiencies
4629	94-5-6	B-16 ext.	Lithic Scatter	Scatter of 4 local chert flakes.	erosion, grazing	insufficient data content, no evidence of depth
4631	94-10-1	B-19 ext.	Lithic Scatter/Quarry	Two cores and about 60 flakes representing core reduction of local orange chert material.	erosion, deflation	insufficient data content, no evidence of depth
4632	94-11-1	B-19 ext.	Lithic Scatter/Quarry	Three cores and about 50 flakes representing core reduction of local brown chert material.	erosion, deflation	insufficient data content, no evidence of depth
4633	94-11-2	B-19 ext.	Lithic Scatter/Quarry	About 75 flakes likely representing core reduction of local yellow chert material.	erosion, deflation	insufficient data content, no evidence of depth
4634	94-11-3	B-19 ext.	Lithic Scatter	About 16 core reduction flakes of local yellow chert.	sheet/rill erosion, deflation	insufficient data content, no evidence of depth
4635	94-11-4	B-19 ext.	Lithic Scatter/Quarry	Three bifaces and over 100 core reduction flakes of local chert. One obsidian flake noted.	erosion, deflation	insufficient data content, no evidence of depth
4637	94-11-6	B-19 ext.	Lithic Scatter	Five local chert flakes.	erosion, deflation	insufficient data content, no evidence of depth
4638	94-11-7	B-19 ext.	Lithic Scatter	One cobble core and 15 flakes representing core reduction of local chert material.	erosion, deflation	insufficient data content, no evidence of depth
4639	94-11-8	B-19 ext.	Lithic Scatter	Five local chert flakes.	erosion, deflation	insufficient data content, no evidence of depth
4640	94-19-1	B-17 S. ext.	Lithic Scatter	About 20 biface thinning flakes of yellow/red local chert.	erosion, grazing	insufficient data content, no evidence of depth
4641	94-22-1	B-17 S. ext.	Lithic Scatter	One Elko point, 1 biface fragment and 20 core reduction flakes, all of yellow local chert.	erosion	integrity compromised, no evidence of depth
4644	94-24-2	B-17 N. ext.	Lithic Scatter	One Rosegate point and three flakes of local chert.	erosion	insufficient data content, no evidence of depth
4646	94-24-4	B-17 N. ext.	Lithic/Groundstone Scatter	Two bifaces, a basalt mano, and 39 local chert flakes, most are early biface reduction stage.	erosion, deflation, grazing	insufficient data content, intact subsurface deposits unlikely
4647	94-24-5	B-17 N. ext.	Lithic Scatter	About 30 core or biface reduction flakes of local chert. One obsidian flake noted.	erosion, deflation, grazing	insufficient data content, no evidence of depth
4648	94-24-6	B-17 N. ext.	Lithic Scatter	One drill, 3 bifaces, 1 chalcedony net weight/ornament and 300-400 flakes, most representing biface reduction of local chert. Two lithic concentrations noted.	erosion, deflation, grazing, aeolian redistribution	integrity compromized, intact subsurface deposits unlikely
4650	94-24-8	B-17 N. ext.	Lithic Scatter	One Rosegate point, 1 biface, and 8 biface reduction flakes of local chert.	erosion, deflation, grazing	insufficient data content, no evidence of depth
4651	94-25-1	B-17 S. ext.	Lithic Scatter	Small area of over 100 core reduction flakes of local chert.	erosion, grazing	insufficient data content, no evidence of depth

Table E.9, continued.

Site Number BLM (CrNV 81-)	Site Number Temp. Field No.	Project Element	Site Type	Description	Integrity Deficiencies	Significance Deficiencies
4652	94-25-2	B-17 S. ext.	Lithic/Groundstone Scatter /Quarry	One mano and over 500 core reduction flakes associated with a silicious bedrock/cobble source.	erosion, grazing, mining	integrity compromised, no evidence of depth
4653	94-25-3	B-17 S. ext.	Lithic Scatter/Quarry	Small cobble quarry area with 1 biface and about 20 pieces of shatter and core reduction chert flakes.	erosion, grazing	insufficient data content, no evidence of depth
4654	94-25-4	B-17 S. ext.	Lithic Scatter	Six bifaces, at least 12 cores, and over 1000 flakes of local chert representing a cobble reduction locality.	erosion, deflation, grazing	dense, but unifunctional assemblage, no evidence of depth
4656	94-25-6	B-17 S. ext.	Lithic Scatter	About 200 core reduction flakes of local chert.	erosion, grazing	insufficient data content, no evidence of depth
4657	94-25-7	B-17 S. ext.	Lithic Scatter	About 30 flakes of local chert.	erosion, grazing	insufficient data content, no evidence of depth
4658	94-25-8	B-17 S. ext.	Lithic Scatter	One Gatecliff point and about 1000 core reduction flakes of local chert (1 obsidian flake noted).	erosion, grazing	diffuse, unifunctional assemblage, no evidence of depth
4659	94-25-9	B-17 S. ext.	Lithic Scatter	One core, 1 biface, and 10 core reduction flakes, all of red/ yellow local chert.	erosion	insufficient data content, no evidence of depth
4660	94-25-10	B-17 S. ext.	Lithic Scatter/Quarry	Four bifaces, 1 core, 2 flaked cobbles, and over 500 core reduction flakes, likely representing cobble and bedrock quarrying of local chert.	erosion, grazing	diffuse, unifunctional assemblage, no evidence of depth
4661	94-25-11	B-17 S. ext.	Lithic Scatter/Quarry	Extensive, dense chert scatter of numerous cores, unmodified cobbles, shatter, and several thousand core reduction flakes.	erosion, grazing	diffuse, unifunctional assemblage, no evidence of depth
4662	94-25-12	B-17 S. ext.	Lithic Scatter/Quarry	Bedrock source of cherts with numerous cores, shatter, and over 500 core reduction flakes.	erosion, grazing	diffuse, unifunctional assemblage, no evidence of depth
4663	94-26-1	B-17 N. ext.	Lithic Scatter	One Elko point, 2 bifaces, and 20 biface thinning flakes of local chert.	erosion	insufficient data content, integrity compromised
4664	94-28-1	B-17 N. ext.	Lithic Scatter	One Great Basin Stemmed point, 1 scraper, 1 core, and over 100 flakes. Lithics mostly of local chert, but with several rhyolite, basalt and obsidian flakes present.	erosion	integrity compromised, no evidence of depth
4666	94-30-1	B-17 N. ext.	Lithic Scatter	Small area scatter with 1 biface and about 400 biface reduction flakes of local chert.	erosion, grazing	insufficient data content, no evidence of depth
4667	94-30-2	B-17 N. ext.	Lithic Scatter	About 18 biface thinning flakes of local chert.	erosion, grazing	insufficient data content, no evidence of depth
4668	94-30-3	B-17 N. ext.	Lithic Scatter	One biface and less than 50 biface thinning flakes of local chert.	erosion, grazing	insufficient data content, no evidence of depth
4669	94-30-4	B-17 N. ext.	Lithic Scatter	Two bifaces, 1 scraper, and less than 50 biface thinning flakes of local chert.	erosion, grazing	insufficient data content, no evidence of depth
4672	94-39-2	B-17 N. ext.	Lithic Scatter	Small area scatter of 22 biface reduction chert flakes.	erosion, deflation	insufficient data content, no evidence of depth

The 14 remaining ineligible prehistoric sites (CrNV-3532, -4619, -4624, -4626, –4627, -4635, -4641, -4644, -4647, -4648, -4650, -4658, -4663, -4664) possess temporally diagnostic projectile points, sourceable obsidian, concentrations of fire-cracked rock, and debitage, in one combination or another. Temporally diagnostic points include a Rosegate series projectile point (cf. Chapter 7:Figure 113c, f, l, j) at each of four sites (CrNV-4624, -4626, -4644, and –4650); an Elko series projectile point (cf. Chapter 7:Figure 112n, f) at CrNV-4641 and at CrNV-4663; a Gatecliff series projectile point (cf. Chapter 7:Figure 112b, a) at CrNV-4619, and at CrNV-4658; and a Great Basin Stemmed projectile point (cf. Chapter 7:Figure 111b) at CrNV-4664. Six sites (CrNV-3532, -4626, -4635, -4647, -4658, and -4664) contain obsidian in their assemblages; four sites (CrNV-3532, -4619, -4624, and -4627) contain one to five scatters of fire-cracked rock apiece, and one site (CrNV-4648) contains two separate lithic concentrations. The debitage assemblages of all these sites range from 2 to 400+ flakes. Site CrNV-4647 contains no formed tools (but contains one flake of obsidian), while the remainder contain 1 to 15 of them. Total non-diagnostic tools observed on these sites were 20 pieces of ground stone, eleven bifaces, one uniface, one scraper, one drill, one ground chalcedony net weight or pendant, and one core.

The presence of temporally diagnostic points, potentially sourceable and datable obsidian on most of these sites, and the presence of fire-cracked rock and lithic concentrations on five sites, speaks to data variety and clarity, but in insufficient quantity to inform. However, erosion has adversely affected all 14 sites, and one (CrNV-3532) has been severely impacted by historical and modern development. Indeed, the potential for vertical and horizontal patterning at six sites (CrNV-4624, -4644, -4647, -4648, -4658, and -4626), has been severely compromised, and at eight (CrNV-3532, -4635, -4641, -4619, -4627, -4650, -4663, and –4664) has been entirely obliterated. Therefore, these 14 sites are ineligible for inclusion in the National Register of Historic Places.

Historic Sites Ineligible for National Register Consideration (BLM)

Field crews discovered ten historic sites (Table E.10) on land administered by BLM; none appears eligible for National Register consideration.

Four of the historic sites are undifferentiated debris scatters with no depth potential, which date, on the bassi of can technology, to the turn-of-the-century. Site CrNV-4643 contains two flour cans, two tobacco tins, one milk pail, one water pail, one whiskey bottle, and one baking soda tin. Site CrNV-4670 is comprised of a campfire ring and adjacent scatter of 12 cans, one horseshoe, and several wire nails. Site CrNV-4655 is associated with an improved spring, and contains several recent firepits, and a dispersed scatter of 12 cans and pieces of barbed wire. Site CrNV-4671 is a can scatter dispersed down an ephemeral drainage, representing redeposition; no original integrity of location remains.

Six sites are surface scatters with features, dating (on the basis of glass and can technology) to the early twentieth century. Of these, CrNV-3532 is a surface scatter and stone foundation associated with a spring, clearly an early twentieth century habitation site (note that the prehistoric component of CrNV-3532 is evaluated in the previous section). Surface debris includes bottle glass shards, four fragments of a porcelain plate, 20 food and milk cans, two stove parts, a bed spring, and various remains of coal, milled wood, and chicken wire. The other five sites (CrNV-4630, -4642, -4673, -4674, -4732) are mines. All five contain mining features such as adits, shafts, prospects, and cairns, as well as small scatters of milled wood, bottle glass fragments, nails, and cans. Undoubtedly, some of the mining features are modern. A wooden superstructure is built over the shaft at CrNV-4630. Debris here includes a ladder, an ore chute, four barrel hoops, a sheet of corrugated tin, and numerous wire nails and milled lumber. Site CrNV-4674 contains a tent platform and a hoist foundation as well as a debris scatter comprised of a bed spring, 33 cans, numerous lamp glass and bottle fragments, barrel hoops, stove parts, nails, and milled wood.

Table E.10. Historic Sites Considered Ineligible for Inclusion in the National Register (BLM).

Site Number BLM (CrNV 81-)	Site Number Temp. Field No.	Project Element	Site Type	Description	Integrity Deficiencies	Significance Deficiencies
3532	94-7-1	B-19 ext.	Historic Habitation (with prehistoric component)	Stone foundation, coal scatters, few fragments of bottle glass, 4 fragments of a porcelin plate, 20 food and milk cans, 2 stove parts, 1 bed spring, milled wood, and screen and chicken wire.	grazing, spring improvements	no association with significant person, event or construction, insufficient data content
4630	94-43-2	B-17 N. ext.	Historical Mining	One vertical adit with wooden superstructure, 1 horizontal adit, 1 prospect, 1 ladder, 1 ore shute, 4 barrel hoops, 1 sheet corregated tin, 2 cans, and numerous round nails and pieces of milled wood.	erosion	no association with significant person, event or construction
4642	94-23-1	B-17 N. ext.	Historical Mining	One vertical adit with frame box, few square and round nails, one fragmented wine bottle, and 1 milled wood piece.	construction of drill road, grazing	insufficient data content, no association with significant person, event or construction
4643	94-24-1	B-17 N. ext.	Historical Scatter	One milk pail, 2 flour cans, 1 water pail, 2 tobacco tins, 1 whiskey bottle, 1 baking soda tin, and a few wagon and stove parts.	erosion, grazing	insufficient data content, no evidence of depth
4655	94-25-5	B-17 S. ext.	Historical Scatter (with prehistoric component)	Scatter of 12 cans, 2 paint pails, and a few pieces of barbed wire associated with a developed spring. Modern firepits and debris also present.	erosion, grazing, recreational use	insufficient data content, depth to historical component; significant prehist. component
4670	94-34-1	B-17 S. ext.	Historical Camp Site	Scatter of 12 cans, 1 horseshoe and several round nails, cut firewood, 1 piece milled wood, and a probable campfire ring.	erosion	insufficient data content, no evidence of depth
4671	94-39-1	B-17 N. ext.	Historical Scatter	Dispursed scattered of at least 21 milk and food cans, 1 fuel can, and two wood posts.	erosion, grazing	integrity compromised, insufficient data content
4673	94-41-1	B-17 N. ext.	Historical Mining	Two horizontal adits, several milled boards, 2 spikes, 1 oil can, and few glass bottle fragments.	erosion, grazing	insufficient data content, no association with significant person, event or construction
4674	94-43-1	B-17 N. ext.	Historical Mining	Three mining adits, several prospects (many are modern), earthen tent platform, 1 cairn, 1 bed springs, and 33 cans. Numerous glass lamp and bottle fragments, metal keg bands and barrel hoops, stove parts, round nails and pieces of milled wood. Site is recorded as 4 distinct loci.	erosion, modern mining	no association with significant person, event or construction
4732	94-23-2	B-17 N. ext.	Historical Mining	One horizontal adit, 2 prospects, 5 cans, and a few pieces of milled wood.	erosion, grazing	insufficient data content, no association with significant person, event or construction

These six historic sites with features exhibit varying degrees of integrity of location, setting, design, feeling, and association. However, all have been disturbed by modern activity, all lack evidence of subsurface deposits, and all contain small artifact assemblages. Their limitations indicate that additional investigations would not further inform inquiries into early twentieth century mining and occupation of the region.

In summary, none of the ten historic sites on BLM lands meets significance standards: none is associated with the lives of significant individuals or with significant historical events; none represents distinctive characteristics of a type, period, or method of construction. All the sites lack buried cultural strata. None possesses an assemblage sufficient for informative analysis. Therefore, none appears eligible for inclusion in the National Register of Historic Places.

Prehistoric Sites Eligible for National Register Consideration (BLM)

Six prehistoric sites in BLM jurisdiction are eligible for inclusion into the National Register of Historic Places, as summarized in Table E.11.

Table E.11. Prehistoric Sites Eligible for National Register Consideration (BLM).

Site Number BLM (CrNV 81-)	Temp. Field No.	Project Element	Site Type	Description	Significance Potential
4623	94-4-6	B-16 ext.	Lithic/Groundstone Scatter w/features	Five Rosegate, 1 Elko, and 3 point fragments, 2 bifaces, 2 drills, 2 cores, and over 500 flakes (ca. 90% chert and 10% obsidian), 4 ground stone tools, 12 Olivella shell beads, and at least 5 concentrations of FCR likely representing cultural features.	large, multifunctional assemblage, heavily eroded, but intact subsurface deposits remain
4636	94-11-5	B-19 ext.	Lithic Scatter	Three cores and 13 bifaces, 2 Great Basin Stemmed, 1 Humboldt, and 2 point fragments, and over 400 core reduction flakes of local chert. Debitage is in 5 concentrated areas, with the western-most containing over 50 biface reduction obsidian flakes.	no depth, but horizontal differentialtion, Early Archaic diagnostics, and a quantity of obsidian are present
4645	94-24-3	B-17 N. ext.	Lithic/Groundstone Scatter w/features	One drill, 2 bifaces, 1 uniface, 2 ground stone tools, and one about 20 biface reduction flakes of local chert and obsidian. One dense concentration of FCR (probable hearth) present.	depth likely, high diversity of assemblage for relatively small site size
4649	94-24-7	B-17 N. ext.	Lithic Scatter	One Rosegate point (reworked into a drill), 1 other drill, 10 bifaces, and over 1000 chert flakes. All stages of biface reduction are present in at least 3 lithic concentrations.	depth possible, horizontal differentiation and lithic reduction sequences present
4655	94-25-5	B-17 S. ext.	Lithic/Groundstone Scatter(with historical component)	One non-portable milling slick, 1 Cottonwood, 1 Rosegate, 1 Elko and 3 point fragments, 2 cores, 1 drill, 45 bifaces an over 1000 flakes, most of early stage reduction of local cherts. Quartz crystal and ignimbrite also utilized as toolstone. At least 7 discreet loci of lithic concentration recorded.	significant surface , disturbance but intact subsurface elements are likely at this multi-component site
4665	94-28-2	B-17 N. ext.	Lithic Scatter	One Great Basin Stemmed point, 8 bifaces, 2 unifaces, 5 cores, and over 500 flakes (at least 1 utilized). Debitage mostly core reduction of local chert, but large quantities of basalt, obsidian, and chalcedony, and all stages of biface reduction are present.	subsurface deposits probably limited, but Early Archaic point, relatively diverse assemblage, and quantity of exotic material present

Site CrNV-4623, recorded previously, was revisited by the present survey. Located approximately 10 km west of Carson Lake, near the confluence of several intermittent channels flowing eastward from the Dead Camel and Desert Mountains, it occupies three semicircular, deflated sodic dunes and intervening playa surfaces (cf. Chapter 7:Figure 85, and Figure E.2). The playa appears to have been inundated recently, but the elevation of the site (1198 m [3930 ft amsl]) is more than three meters higher than the feasible inundation level of Carson Lake (1194.5 m [3919 ft amsl]; cf. Chapter 2).

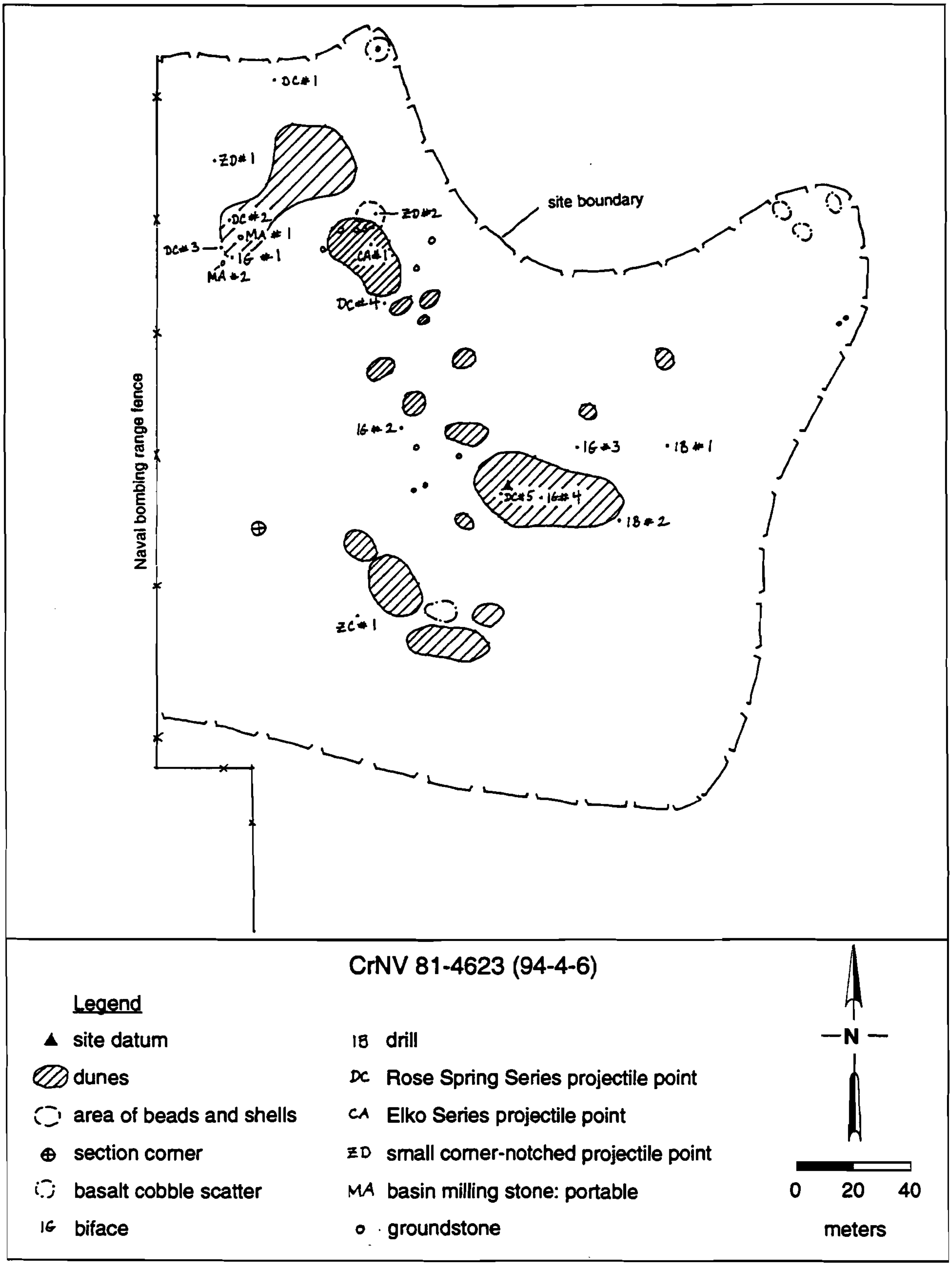


Figure E.2. Site map of CrNV81-4623.

Possibly, modern drainage and irrigation channels associated with nearby ranches have induced recent flooding artificially, or inundation occurs naturally when nearby intermittent stream channels overflow to create ponds behind the numerous dunes in the area. Greasewood, hop sage, saltbush, shadscale, and seepweed currently grow on site.

The site is a large (46,000 m^2) lithic scatter with ground stone. Numerous metate, mano, mortar, and pestle fragments dominate the surface assemblage; almost all are manufactured of vesicular basalt. Chert cores of local alluvial gravel are numerous. Chipped stone tools include four bifaces, two drills, and six projectile points: five Rosegate Series points (cf. Chapter, Figure 113a, b, d, e, k) and one Elko Corner-notched (cf. Chapter 7:Figure 112g). Twelve *Olivella* shell beads of two diagnostic types (cf. Chapter 7:Figure 114) were observed. The debitage assemblage contains more than 500 flakes, mostly of local alluvial cherts, exhibiting all stages of reduction; obsidian late stage reduction flakes comprise about 10% of the assemblage.

At least five basalt cobble concentrations were noted, ranging from one to ten meters in diameter. Fire-cracked rock, ground stone tool fragments, and lithic tools and debitage are common elements of these clusters, but unmodified basalt cobbles are their most common constituents. These concentrations appear to represent deflated cultural features.

Wind and water erosion have heavily affected the site to the extent that almost all artifacts on playa surfaces are redeposited or are remnants of deflated deposits. Evidence of this is apparent in the size sorting of playa surface artifacts, where larger, heavier items occur directly on playa surfaces but smaller items accumulate at the base of dunes (see Nials 1994). Compromised surface integrity notwithstanding, there remains good potential for intact cultural deposits within the intact dunes. For example, all 12 *Olivella* shell beads occur on one coppice mound within a 15 m diameter area. This clustered distribution indicates that they eroded recently from cultural features within the dune. Thus, sufficient integrity of location and design is retained in dune areas.

The dune-playa setting suggests that site occupants were exploiting palustrine environments, but the hydrological conditions under which the playa would have flooded and developed marsh patches are unclear. Occupation may have been entirely a consequence of exploitation of non-wetland playa margin resources such as seepweed. In either scenario, the site retains integrity of setting and that its further investigation could inform inquiries into the interplay of subsistence strategies and environmental change.

The numerous temporally diagnostic projectile points indicate a Late Archaic association. Too, the assemblage of sourceable, datable obsidian can inform questions of chronology, as can the shell beads. Finally, the site exhibits a large, diverse, multifunctional artifact assemblage that would inform about activities conducted there and from there. The nature of the assemblage and the potential for horizontally and vertically intact cultural deposits indicate that further investigation of the site would yield significant information about the exploitation of palustrine and playa margin environments in prehistory, as well as paleoenvironmental trends around Carson Lake. Therefore, the site is eligible for inclusion in the National Register of Historic Places under criterion d.

Site CrNV-4636 occurs at the head of Diamond Field Jack Wash, in the alluvium separating the Barnett Hills and Cocoon Mountains (cf. Chapter 7:Figure 88). It occupies three low knolls armored with desert pavement and intervening silty sediments. Desert thorn, saltbush, and Indian ricegrass dominate the surrounding vegetation.

The site is a large (25,500 m^2) lithic scatter of more than 500 items. All stages of lithic reduction are present and approximately 85% of the assemblage is of locally available chert, with obsidian comprising the remainder. Surprisingly, much of the obsidian assemblage—which is not available locally—is in early to middle stage reduction. Obsidian flakes are most common in one of five discrete lithic concentrations occurring along the flanks and crests of the three knolls (cf. Chapter 7:Figure 110).

Two obsidian Great Basin Stemmed points (cf. Chapter 7:Figure 111g) and one Humboldt concave base projectile point suggest that the site dates to the Pre-Archaic, an inference that can be tested through hydration of the glass assemblage. Two obsidian projectile point fragments, 17 middle stage bifaces (three of obsidian), and three cores (one an obsidian cobble) were observed. Further investigation of the assemblage would inform inquiries into lithic procurement, reduction and mobility during the Pre-Archaic.

The site's position on gravel armored knolls indicates little likelihood of subsurface deposits, but surface patterns indicate a high degree of horizontal spatial integrity. The obsidian concentration in one cluster supports this inference, and hints that each may be a discrete lithic reduction locus. The tight spatial patterning also indicates that these clusters are relatively unaffected by erosional processes. An excellent vista of Diamond Field Jack Wash to the southwest demonstrates that the site is well situated as a hunting overlook.

We believe the site eligible for inclusion in the National Register of Historic Places under criterion d.

Site CrNV-4645 is on a sand dune adjacent a small playa (cf. Chapter 7:Figure 96), approximately 1.5 km northwest of Labou Flat in Fairview Valley. Russian thistle, desert thorn, Indian ricegrass, and greasewood currently vegetate the site.

The site is a small (4000 m^2) lithic scatter containing two milling stone fragments, one drill, two bifaces, and a uniface (Figure E.3). Approximately 25 flakes were observed on the surface, most secondary flakes of locally available chert and some obsidian debitage. Approximately 10 fire-cracked vesicular basalt fragments are scattered in a 15 m diameter area at the northwest margin of the site, probably representing a now-dispersed hearth.

Wind erosion has affected the site, but integrity generally remains intact. Most artifacts and the fire-cracked rock scatter occur in a deflated portion of the dune, while other artifacts occur on playa margins immediately adjacent. This indicates a strong potential for buried cultural deposits within the dune, hearths among them. Such buried features hold potential for datable carbon and for subsistence remains. The obsidian in the assemblage offers an avenue of temporal inquiry.

The site occurs adjacent small portions of playa but is three meters higher than the area of Labou Flat believed to be inundated irregularly (1264.5 m, cf. Chapter 2). It is possible that the site was occupied during more mesic times when the vicinity was flooded and supported a marsh community. Alternatively, the site could be related directly to Indian ricegrass procurement.

Although the assemblage is small, it is diverse, multifunctional, and likely extends below the dune surface. These characteristics,together with the environmental setting, suggest that further investigations would inform inquiry into paleoenvironment and prehistoric subsistence around Labou Flat. Consequently, the site is eligible for inclusion in the National Register of Historic Places under criterion d.

Site CrNV-4649 is approximately one kilometer northwest of Labou Flat in northern Fairview Valley. It sits on a large sand dune rising 1.5 meters above small, adjacent playa flats (cf. Chapter 7:Figure 96). Greasewood, shadscale, desert thorn, halogeton, Russian thistle, Indian ricegrass, and horsebrush grow on site.

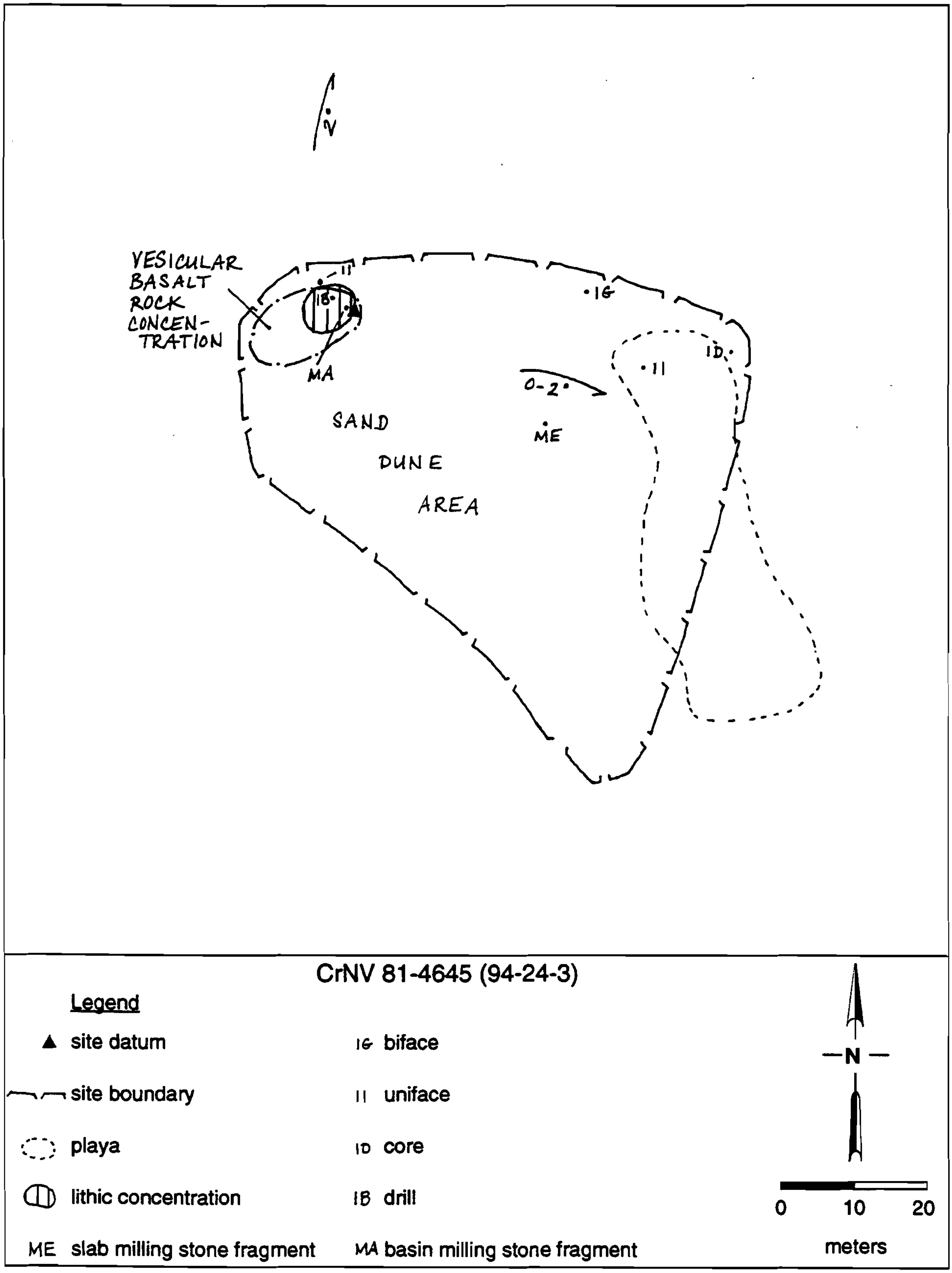


Figure E.3. Site map of CrNV81-4645.

The site is a large (102,000 m^2) lithic scatter composed of more than 500 flakes (Figure E.4). Debitage are mostly secondary reduction flakes, and a variety of local and exotic cherts is represented. Three concentrations of lithic debris were noted on small inter-dunal playas. Eleven chipped stone tools were inventoried, including ten bifaces and a Rosegate series point reworked into a drill (cf. Chapter 7:Figure 113m). The point/drill indicates a Late Archaic association.

Wind erosion has deflated the site, but it generally remains intact and there is a probability of cultural deposits buried within the dune, as evinced by the three lithic concentrations which appear to have eroded from the dune.

The site is adjacent small playa flats but is three meters higher than the area of Labou Flat which currently is inundated irregularly (1264.5 m, cf. Chapter 2). The site may have been occupied during more mesic conditions, when the vicinity was flooded and supported small patches marsh community in the inter-dunal playas around the site. Alternatively, the site may reflect Indian ricegrass procurement.

Since further site investigation would inform questions into paleoenvironment and prehistoric subsistence strategies around Labou Flat, we find the site eligible for inclusion in the National Register of Historic Places under criterion d.

Site CrNV-4655 occupies the western slopes of Slate Mountain, overlooking Fairview Valley. It is centered on an improved spring (note that the historic component of this site is described above). A steep rocky canyon is north of the site. This site occurs at the transition between upper alluvial fan sediments and lower piedmont slopes (cf. Chapter 7:Figure 90), and at the transition between greasewood-saltbush and sagebrush vegetation communities; greasewood and shadscale are common on the lower western slopes of the site, while sagebrush is common on upper rocky slopes to the east. Indian ricegrass is common throughout the site, Great Basin wildrye grows in low spots near the spring, and serviceberry appears occasionally in upper drainages.

The site is an extensive (290,000 m^2) lithic scatter with ground stone (cf. Chapter 7:Figure 109). Thousands of flakes were observed, almost all of a local yellow-red chert and a few of high quality translucent quartz, both of which outcrop in small veins on site. Larger quarries of the yellow-red toolstone occur north of CrNV-4655 (see earlier discussion of CrNV-4660, -4661, and -4662), and CrNV-4655 undoubtedly served as a processing location for toolstone extracted from those quarries. Most flakes are early to middle stage reduction. A small percentage of obsidian and exotic chert (mid-late stage reduction) is also apparent.

The observed tool assemblage included 45 bifaces, three projectile point fragments, two cores, and one drill. One Cottonwood Triangular projectile point (cf. Chapter 7:Figure 113p), one Rosegate Series projectile point (cf. Chapter 7:Figure 113i), and one Elko Series projectile point (cf. Chapter 7:Figure 112h) are the temporally diagnostic artifacts noted. A non-portable milling slick appears on site.

Densities of surface lithics are highly variable across the site, ranging from zero to 50 flakes per square meter. Because of the site's large size and the patchy surface distributions, we divided it into seven loci, each composed of at least one lithic concentration (cf. Chapter 7:Figure 109). Two loci (E and F) are small outcrops of toolstone quality material associated with lithic scatters that lack buried deposits. Three loci (C, D, and G) are comprised of lithics scattered along ephemeral drainages; most appear to be washed from surrounding rocky slopes, but buried cultural deposits in benches along the washes are suspected. Locus B is a lithic concentration (400 m^2) in a small saddle between two rocky ridges, where the sediment is 40 cm deep. There is good potential for buried cultural deposits in this area. Locus A occurs immediately around the spring. It has been heavily disturbed by modern activities: a dirt road traverses the locus, the spring has been impounded and channelized, and several modern campfire rings are present. However, the stream cut below the spring suggests the possibility that buried cultural deposits remain intact in this locus.

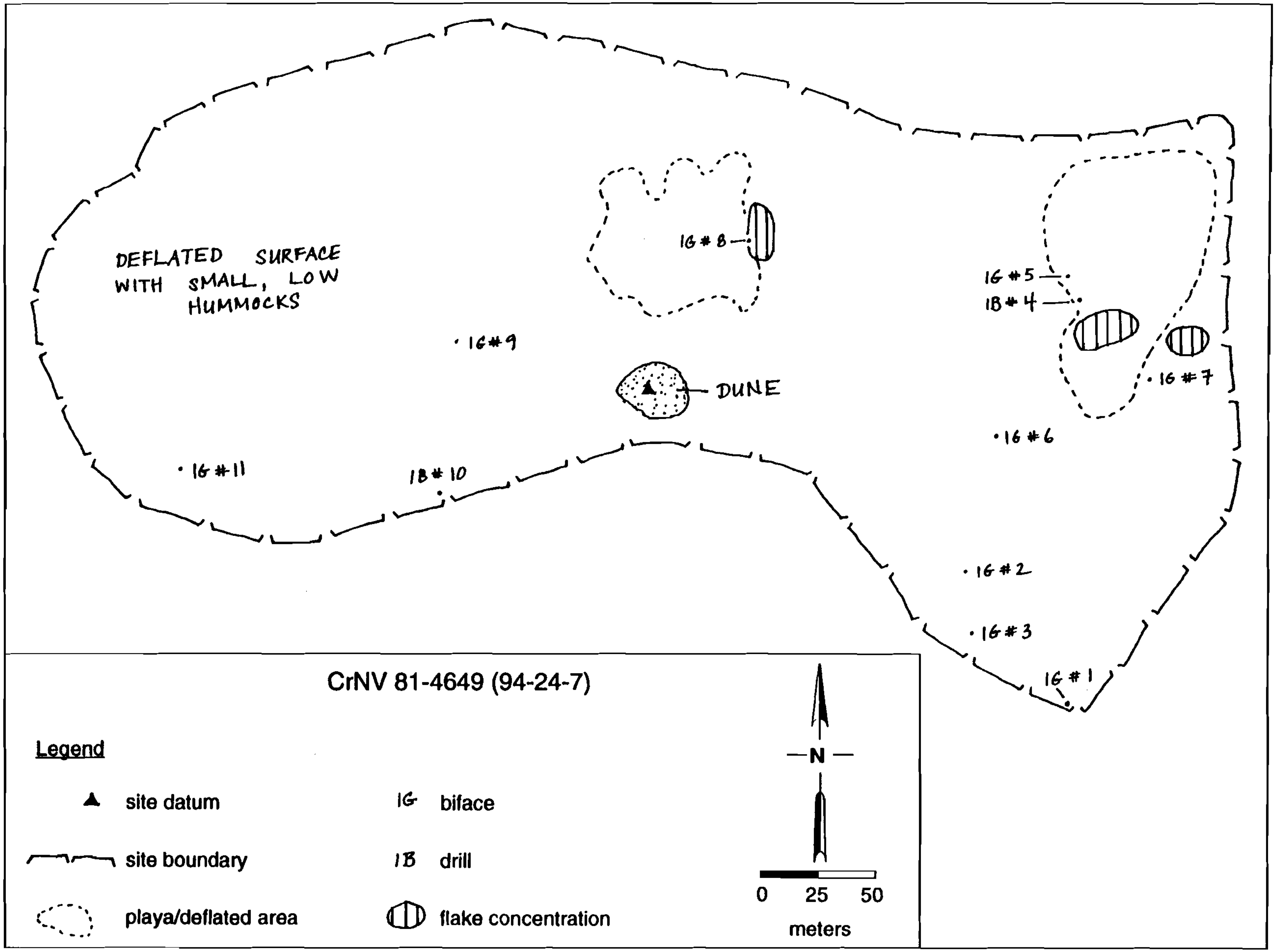


Figure E.4. Site map of CrNV81-4649.

Erosion and modern disturbance have affected the integrity of this site to varying degrees. However, horizontal patterning is retained variously and buried cultural deposits are suggested at Loci A and B. The site is positioned to access a water source, toolstone sources, and different vegetation communities. Thus, the site retains sufficient integrity of design, location, and setting.

Further investigation would inform inquiry into local toolstone procurement and processing, as well as subsistence and mobility. Thus, we consider it eligible for inclusion in the National Register of Historic Places under criterion d.

Site CrNV-4665 sits on the lower alluvial fan slopes of the southern Stillwater Mountains, approximately eight kilometers north of Labou Flat. It is adjacent (on the west) an ephemeral drainage (cf. Chapter 7:Figure 91). A north-south ridge blocks view of Dixie Valley to the east, but a good vista of Fairview Valley to the south can be had from the site. Much of the surface is desert pavement interspersed with pockets of eolian sand. Bud sagebrush, greasewood, four-wing saltbush, shadscale, and bluegrass currently vegetate the site.

The site is a moderate sized (7500 m^2) lithic scatter containing a large, diverse artifact assemblage (Figure E.5). More than 500 flakes of various multicolored cherts, basalt, and obsidian appear in the surface assemblage. Most are early and middle stage reduction flakes, but all stages are represented. Maximum density is 20 flakes per square meter. Chipped stone tools include eight bifaces, five cores, three scrapers, two unifaces, and one utilized flake. A large bifacial outrepassé flake appears in the assemblage. A fragment of a Great Basin Stemmed projectile point (cf. Chapter 7:Figure 111e) was the only temporally diagnostic item observed.

The latter evinces a Pre-Archaic association, as does nearby CrNV-4664 and its Great Basin Stemmed point. The antiquity of the site can be further investigated through sourcing and hydration of its obsidian artifacts.

The location of the site on desert pavement argues against buried cultural deposits (although some may exist in the pockets of eolian sand on the site). Inasmuch as there is no evidence of size sorting or linear alignment of artifacts along drainage channels, surface integrity appears intact.

Physiographic location and inferred antiquity suggest that occupation of the site occurred when Labou Flat contained a shallow lake, possibly extending into the large valley depression east of the site and south of Dixie Valley (cf. Chapter 9). At such times, the ridge east of the site would have offered an excellent hunting overlook into Dixie Valley while protecting the site from view. Too, water may have been available in the adjacent drainage. Such characteristics suggest that the site would have served as an excellent hunting camp.

A hunting camp function is supported by the tool assemblage, which represents toolstone reduction, hunting, and game procurement. The obsidian in the assemblage offers an opportunity for sourcing analysis that might provoke insight into Pre-Archaic mobility.

In sum, further investigation of CrNV-4665 could inform inquiries into chronology, paleoenvironment, mobility, lithic technology and subsistence strategies of the Pre-Archaic period. Therefore, we consider the site eligible for inclusion in the National Register of Historic Places under criterion d.

Summary

The present survey observed 233 cultural properties on lands administered by Naval Air Station Fallon and the Bureau of Land Management Carson District. Six prehistoric sites on BLM lands (CrNV-4623, -4636, -4645, -4649, -4655, -4665) and three prehistoric sites on Navy lands (CrNV-4720, -4721, -4722) are eligible for inclusion in the National Register of Historic Places.

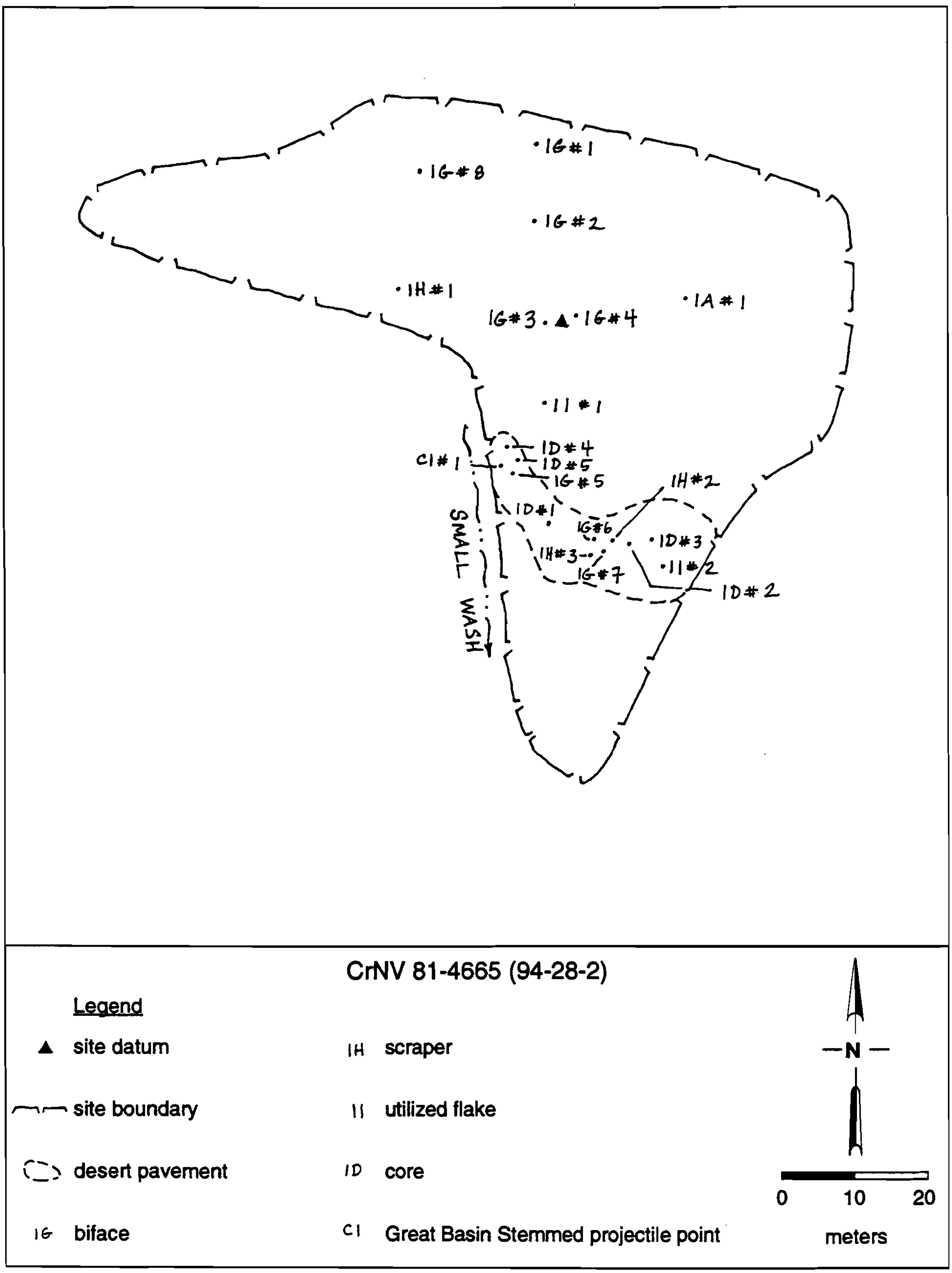


Figure E.5. Site map of CrNV81-4665.

Appendix F

IMACS Site Documentation

IMACS Site Documentation Bound Separately

Appendix G. Common/Latin Name Concordance

Plant Names

Grasses

alkali bluegrass	*Poa juncifolia*
alkali sacaton	*Sporobolus airoides*
alkaligrass	*Puccinellia sp.*
alpine timothy	*Phleum alpinum*
arrowgrass	*Triglochin sp.*
blue wildrye	*Elymus glaucus*
bluegrass	*Poa sp.*
bottlebrush squirreltail	*Sitanion hystrix*
Canada wildrye	*Elymus canadensis*
Canby bluegrass	*Poa Canbyi*
creeping (or beardless) wildrye	*Elymus triticoides*
Cusick bluegrass	*Poa Cusickii*
desert needlegrass	*Stipa speciosa*
foxtail barley	*Hordeum jubatum*
Great Basin wildrye	*Elymus cinereus*
Idaho fescue	*Festuca idahoensis*
Indian ricegrass	*Oryzopsis hymenoides*
inland saltgrass	*Distichlis stricta*
mat muhly	*Muhlenbergia richardsonis*
meadow barley	*Hordeum brachyantherum*
muttongrass	*Poa Fendleriana*
needleandthread	*Stipa comata*
needlegrass	*Stipa sp.*
Nevada bluegrass	*Poa nevadensis*
rabbitfootgrass	*Polypogon sp.*
sacaton	*Sporobolus sp.*
Salina wildrye	*Elymus salinas*
saltgrass	*Distichlis sp.*
sand dropseed	*Sporobolus cryptandrus*
Sandberg's bluegrass	*Poa secunda*
scratchgrass, dropseed	*Sporobolus asperifolius, Muhlenbergia asperifolia*
six-weeks fescue	*Festuca octoflora*
slender wheatgrass	*Agropyron trachycaulum*
squirreltail	*Sitanion sp.*
thickspike wheatgrass	*Agropyron dasystachyum*
Thurber needlegrass	*Stipa Thurberiana*
tufted hairgrass	*Deschampsia caespitosa*
Webber ricegrass	*Stipa Webberi*
western needlegrass	*Stipa occidentalis*
western wheatgrass	*Agropyron Smithii*
wheatgrass	*Agropyron sp.*
wildrye	*Elymus sp.* or *Leymus sp.*

Upland Annual and Perennial Forbs

amaranth	*Amaranth sp.*
arrowleaf balsamroot	*Balsamorhiza sagittata*
balsamroot	*Balsamorhiza spp.*
Baltic rush	*Juncus balticus*
biscuitroot	*Lomatium spp.*
bitterroot	*Lewisia rediviva*
blazing star	*Mentzelia albicaulis*
buckwheat	*Eriogonum sp.*
cinquefoil	*Potentilla sp.*
clover	*Trifolium sp.*
Cusick's sunflower	*Helianthus Cusickii*
dalea	*Dalea sp.*
desert parsley	*Lomatium ravennii*
dock	*Rumex sp.*
evening primrose	*Oenothera sp.*
bitterroot	*Lewisia rediviva*
galleta	*Hilaria jamesii*
gilia	*Gilia sp.*
globemallow	*Sphaeralcea sp.*
goosefoot	*Chenopodium sp.*
groundsel	*Senecio sp.*
hopsage	*Grayia spinosa*
horsebrush	*Tetradymia sp.*
lily	*Chlorogalum spp.*
little horsebrush	*Tetradymia glabrata*
lupine	*Lupinus sp.*
Mariposa lily	*Calochortus sp.*
meadow barley	*Hordeum brachyantherum*
milkvetch	*Astragalus sp.*
mule's ears	*Wyethia sp.*
oceanspray	*Holodiscus sp.*
onion	*Alium spp.*
penstemon	*Penstemon sp.*
phlox	*Phlox sp.*
povertyweed	*Iva axillaris*
pricklygilia	*Leptodactylon sp.*
prickly pear	*Opuntia erinacea*
sand cholla	*Opuntia pulchella*
snowberry	*Symphoricarpos*
spring beauty	*Claytonia sp.*
sunflower	*Helianthus sp.*
tansy mustard	*Descurainia pinnata*
yarrow	*Achillea sp.*

Shrubs

Anderson peachbrush	*Prunus Andersonii*
antelope bitterbrush	*Purshia tridentata*
Bailey's greasewood	*Sarcobatus vermiculatus Baileyi*
Basin big sagebrush	*Artemisia tridentata tridentata*
big/tall sagebrush	*Artemisia tridentata*
black greasewood	*Sarcobatus vermiculatus*
black sagebrush	*Artemisia arbuscula nova*
bud sagebrush	*Artemisia spinescens*
burrobrush	*Hymenoclea sp.*
choke cherry	*Prunus virginiana*
currant	*Ribes sp.*
desert blite	*Suaeda torreyana*
desertbroom	*Baccharis sarothroides*
desert peach	*Prunus Andersonii*
Douglas rabbitbrush	*Chrysothamnus vicidiflorus*
elderberry	*Sambucus sp.*
four-wing saltbush	*Atriplex canescens*
green ephedra	*Ephedra viridis*
gray molly kochia	*Kochia americana vestita*
green molly kochia	*Kochia americana*
hawksbeard	*Crepis sp.*
iodine bush	*Allenrolfea occidentalis*
kochia	*Kochia sp.*
low sagebrush	*Artemisia arbuscula*
Mormon tea	*Ephedra sp.*
mountain big sagebrush	*Artemisia vesayana*
mountain mahogany	*Cerocarpus ledifolius*
Nevada ephedra	*Ephedra nevadensis*
rabbitbrush	*Chrysothamnus sp.*
rubber rabbitbrush	*Chrysothamnus nauseosus*
Russian olive	*Elaeagnus angustifolia*
sagebrush	*Artemisia sp.*
saltbrush	*Atriplex argentea*
serviceberry	*Amelanchier sp.*
shadscale	*Atriplex confertifolia*
silver buffaloberry	*Sherpherdia argentea*
silver sagebrush	*Artemisia cana*
tamarisk	*Tamarix sp.*
tapertip hawksbeard	*Crepis acuminata*
Torrey quailbush	*Atriplex Torreyi*
Utah juniper	*Juniperus osteosperma*
wada	*Suaeda depressa*
wild rose	*Rosa sp.*
willow	*Salix sp.*
winterfat	*Eurotia lanata*
wolfberry	*Lycium sp.*
Wood's rose	*Rosa woodsii*
Wyoming big sagebrush	*Artemisia tridentata wyomingensis*

Wetland Plants

alkali bulrush	*Scirpus robustus*
arrowhead	*Sagittaria latifolia*
bulrush	*Scirpus spp.*
chufa fatsedge	*Cyperus esculentus*
common catttail	*Typha latifolia*
dock	*Rumex occidentalis*
hardstem bulrush	*Scirpus acutus*
narrowleaf cattail	*Typha angustifolia*
nutgrass	*Scirpus paludosus*
rush	*Juncus sp.*
sedge	*Carex sp.*
sego pondweed	*Potamogeton pectinatus*
southern cattail	*Typha domingensis*
spikerush	*Eleocharis palustris*
wapato	*Sagittaria latifolia*
water plantain	*Alisma geyeri*

Trees

Fremont cottonwood	*Populus Fremontii*
pinyon	*Pinus monophylla*
Utah juniper	*Juniperus osteosperma*

Animal Names

Large Animals

bighorn sheep	*ovis canadensis*
black bear	*Ursus americanus*
mule deer	*odocoileus hemionus*
pronghorn antelope	*antelocapra americana*

Small/Medium-sized Animals

badger	*Taxidae taxus*
beaver	*Castor canadensis*
Belding's groundsquirrel	*Spermophilus beldingi*
black-tailed jackrabbit	*Lepus californicus*
bobcat	*Felis rufus*
bushy-tailed woodrat	*Neotoma cinerea*
deer mouse	*Peromyscus maniculatus*
desert woodrat	*Neotoma lepida*
golden-mantled groundsquirrel	*Spermophilus lateralis*
grasshopper mouse	*Onychomys spp.*

kangaroo rat	*Dipodomys sp.*
least chipmunk	*Tamius minimus*
muskrat	*Ondatra zibethicus*
Nuttall's cottontail	*Sylvilagus nuttallii*
pinyon mouse	*Peromyscus truei*
pocket gopher	*Thomomys spp.*
porcupine	*Erethizon dorsatum*
thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*
Townsend's groundsquirrel	*Spermophilus townsendii*
vole	*Microtus sp.*
white-tailed antelope squirrel	*Ammospermophilus leucurus*
white-tailed jackrabbit	*Lepus townsendii*
yellow-bellied marmot	*Marmota flaviventris*

Waterfowl and Shorebirds

American coot	*Fulica americana*
Canada goose	*Branta canadensis*
canvasback duck	*Aythya valisineria*
mallard duck	*Anas platyrhynchos*
redhead duck	*Aythya americana*
snow goose	*Chen caerulescens*
tundra swan	*Cunus columbianus*
white-fronted goose	*Anser albifrons*

Upland Game Birds

blue grouse	*Dendragapus obscurus*
mountain quail	*Oreortyx pictus*
sage grouse	*Centrocercus urophasianus*

Fish

cui-ui	*Chasmistes cujus*
Lahontan cutthroat trout	*Salmo Clarki henshawi*
redside shiner	*Richardsonius egregius*
speckled dace	*Rinichthys osculus*
Tahoe sucker	*Catostomus tahoensis*
tui chub	*Gila bicolor obesus*

Invertebrates

bivalve mollusc	*Anadonta spp.*
brine fly larvae	*Ephydra hians*
Mormon cricket	*Anabrus simplex*
snail	*Gastropoda spp.*

Appendix H

Sample Unit Forms

ARCHAEOLOGICAL SURVEY SAMPLE UNIT RECORD

Sample Unit (SW UTM) 358/4392

Stratum 44 Map USGS Pintail Bay 7.5'

Principal Landforms * Playa margin rising gradually to rolling, moderately dissected terraces; spur of extensive dune system intrudes from N. Elevation (range) 1180-1192 m

Present Vegetation Communities * Greasewood/seepweed, Shadscale/IRG, Barren flats; greasewood stumps on flats suggest larger pre-flood community Av. % cover 20%

Trees None

Shrubs Greasewood, smokebush, shadscale, hop sage

Forbs Dock, Mentzelia, 1 unidentified (collected)

Grasses IRG, GBWR, Squirreltail

Hydrology * Major seasonal drainage empties to small sink; numerous ephemeral drainages run E→W and S→N. Playa is inundated seasonally from other sources (outside sample uni

Geomorphic Observations * Dune at N is unstabilised & may be recent. Eroded terraces & depth of channel cut suggest flow from south more substantial in past. Sink slightly diked to N.

Sites/Isolates Observed * Hab. site 3169; lithic scatter 3165. Isolates: 3166 HCB projectile point, 3167 basalt chopper/core, 3168 basalt millingstone fragment

Disturbance/Intrusions * Dirt road SW-NE; pasture fence at E. margin; abandoned clamshack at W. margin

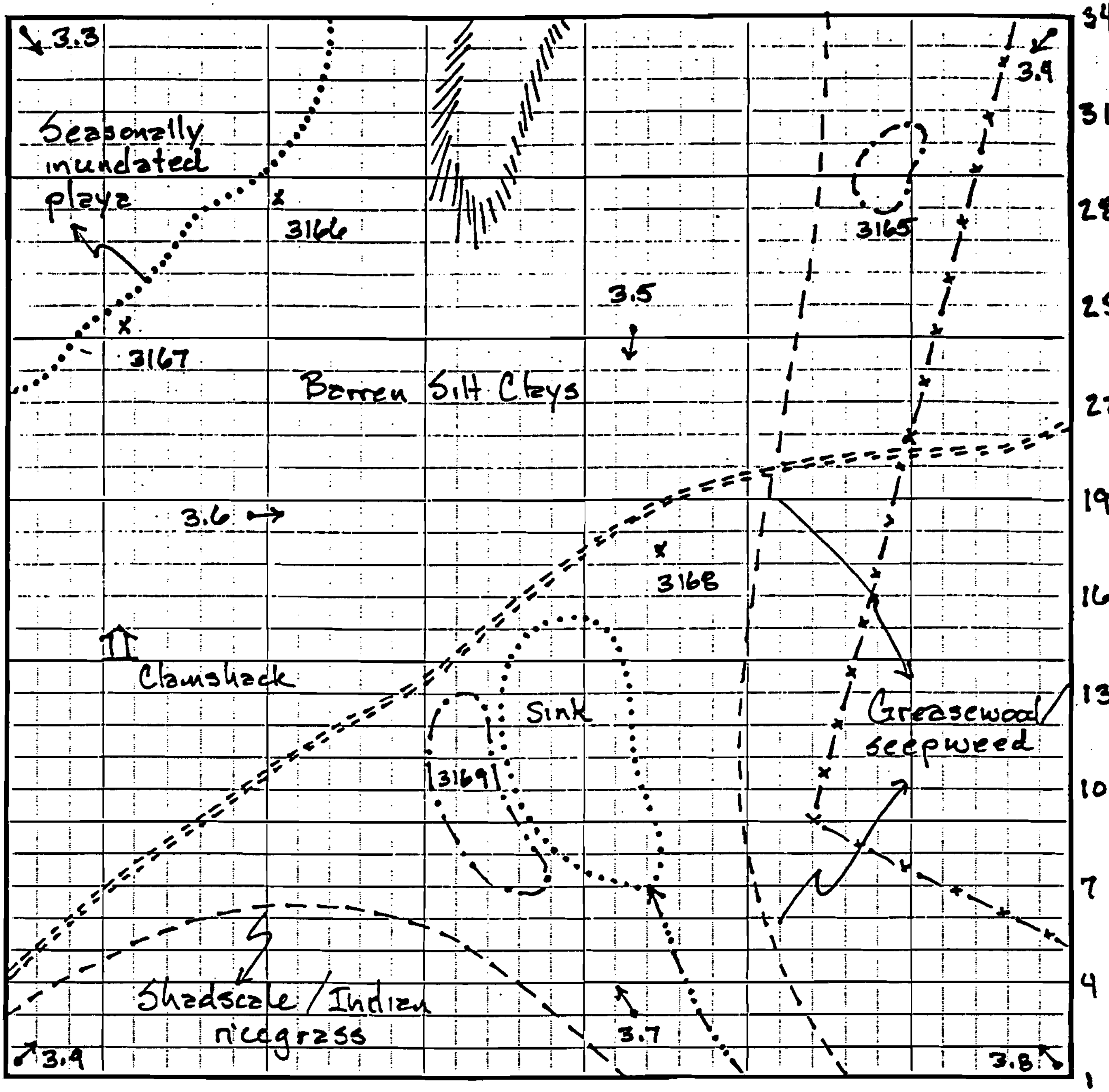
Photo Documentation * Areal views 3.3-3.9

Recorders CR, VS, PZ, NK Date 10.27.43

* All asterisked items to be clarified on map (reverse)

Sample Unit 358/4392

150 m



KEY

Symbol	Attribute	Symbol	Attribute
— — —	Veg. communities	—x—x—x	Fenceline
·····→	Water flow	======	Road
··········	Hydrologic basins	↗	Photo station
—·—·—	Arch. site boundary	x	Isolated artifact

ARCHAEOLOGICAL SURVEY SAMPLE UNIT RECORD

Sample Unit (SW UTM)______________________________________

Stratum_______________________Map___________________________

Principal Landforms * ______________________________________

____

____________________________Elevation (range)______________

Present Vegetation Communities * ___________________________

____

____________________________Av. % cover____________________

Trees____

Shrubs____

Forbs____

Grasses____

Hydrology * ____

____

____

Geomorphic Observations * __________________________________

____

____

Sites/Isolates Observed * __________________________________

____

____

Disturbance/Intrusions * ___________________________________

____

Photo Documentation * ______________________________________

Recorders________________________________Date_______________

==

* All asterisked items to be clarified on map (reverse)

Sample Unit________________________________

150 m

KEY

Symbol	Attribute	Symbol	Attribute
__________	__________________	__________	__________________
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Unscanned large fold-out map at rear of document titled Habitat Types of Toedokado Territory.