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Surprise Valley Settlement and Subsistence: A Critical Review of the Faunal Evidence

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PREHISTORIC settlement-subsistence patterns within the Great Basin have been characterized as *dispersed* and *restricted* patterns (Elston 1982: 189). The dispersed pattern is best represented by Shoshonean groups in the central Great Basin who established several base camps in the course of their seasonal round and might not return to the same winter camp each year because of unpredictable food resources, particularly pinyon nuts. This pattern has been commonly termed the Desert Culture, Desert Archaic, or Shoshonean pattern (Aikens 1970: 200-202; Bettinger 1978a; Jennings 1957, 1964; Jennings and Norbeck 1955; Steward 1938, 1955; Thomas 1971a, 1972, 1983).

In contrast, seasonal movements from base camps to winter camps were more regular in the restricted pattern due to more dependable resources. Aboriginal populations in optimum resource areas may have even resided at the same site throughout the year. The settlement-subsistence pattern identified in the western Great Basin essentially conforms to the restricted type, which has also been called the Desert Village pattern (Bettinger 1978a). One of the major examples of the restricted pattern comes from King's Dog, Menlo Baths, and Rodriquez, three excavated sites in Surprise Valley which are inferred to indicate year-round occupation (O'Connell and Hayward 1972; O'Connell 1975). The restricted pattern is also represented in the lower Humboldt Valley (Heizer and Napton 1970; Napton 1969), Owens Valley (Bettinger 1975, 1976, 1977, 1982), and Warner Valley (Weide 1968, 1974; Lyneis 1978; but see Bettinger 1978a, 1978b). A similar pattern may have existed along well-watered areas of the Wasatch Front in the eastern Great Basin (Janetski 1981: 155; Madsen 1982). In all these areas, however, year-round occupation remains to be adequately demonstrated. If the two Basin-wide patterns are considered on a continuum, the Surprise Valley prehistoric pattern appears to be at the extreme end of the spectrum with permanent habitation, whereas the seasonal round of the dispersed pattern is at the other end.

While a settlement-subsistence pattern of semi-permanent to permanent occupation is not without some precedent in the Great Basin (e.g., among the Washoe and Owens Valley Paiute), the Surprise Valley evidence is unusual for two reasons. First, this sedentary pattern appears quite early in the Great Basin archaeological record and, as such, may even be the earliest evidence of this kind in western North America. Secondly, the pattern contrasts sharply with the ethnographic record of the Surprise Valley Paiute and Western Shoshoni, as well as with the archaeological evidence from the central Great Basin.

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THE PROBLEM

From research in Surprise Valley, O'Connell (1975; O'Connell and Hayward 1972) developed a model of regional settlement and subsistence spanning the past 6000 years. The major evidence used in support of year-round occupation in Surprise Valley was the seasonality of faunal remains from the King's Dog, Menlo Baths, and Rodriquez sites.

In the initial Menlo Phase occupation (6000-4500 B.P.), the presence of diverse artifact assemblages and semi-subterranean earth lodges suggested year-round settlement at King's Dog and Menlo Baths. The faunal remains, however, represented a winter meat diet and lacked species representative of summer occupation. After examining several settlement pattern alternatives, O'Connell (1975: 39) concluded that these two sites were occupied throughout the year in the Menlo Phase and that summer faunal indicators were absent because the inhabitants lived outside the earthen structures during the summer as did the ethnographic Klamath (Spier 1930).

In the Bare Creek and later phases (4500-500 B.P.), summer faunal remains were supposedly present at King's Dog and Rodriquez, while Menlo Baths contained a higher percentage of ungulates probably killed in the winter months and a near absence of summer fauna. This evidence suggested that King's Dog and Rodriquez were inhabited year-round, but that Menlo Baths was occupied only in the winter and early spring.

As opposed to O'Connell's (1975) prehistoric evidence, the ethnographic pattern for the Surprise Valley Northern Paiute involved an annual hunting-gathering cycle with frequent moves (Kelly 1932: 76-78). A typical annual round began with the spring thaw when winter camps on the west side of the valley were abandoned, and the Paiute moved to the Hays Canyon Range across the valley to consume buried foods cached the previous year and to dig for roots. During the rest of the spring and into the summer, roots such as camas and epos were dried and cached. They returned to the valley to gather berries and seeds in the late summer. Although deer, antelope, and rabbits were hunted throughout the year, this was the primary activity in the fall and winter months. Waterfowl were also hunted at this time. Winter camps were again established on the west side of the valley with the Paiute subsisting on stored foods. When their food supply ran low, winter camps were moved to other food caches. In short, Surprise Valley Paiute occupied the valley floor sites *only* during the late fall, winter, and early spring and spent the rest of the year at other localities, particularly in the surrounding uplands.

There are, however, several problems with Kelly's ethnographic account which suggest she was describing a post-1860 pattern (Layton 1981: 130-131; Voegelin 1955, 1956:4). Whether the pattern is post-aboriginal or not is beyond the scope of this paper, although I am inclined to believe that it had been substantially disrupted by the time of Anglo-European contact. What is important is that the ethnographic pattern is distinct from the prehistoric settlement-subsistence pattern proposed for Surprise Valley. In other words, we see that at least two different settlement-subsistence patterns have apparently existed in Surprise Valley at one time or another. The basic problem to be addressed in this paper is the extent to which the faunal data can support O'Connell's settlement-subsistence model.

THE SURPRISE VALLEY SITES

Surprise Valley lies on the extreme western edge of the Great Basin in the northeastern corner of California and adjacent northwestern Nevada (Fig. 1). The valley trends north-south with parallel mountain ranges on

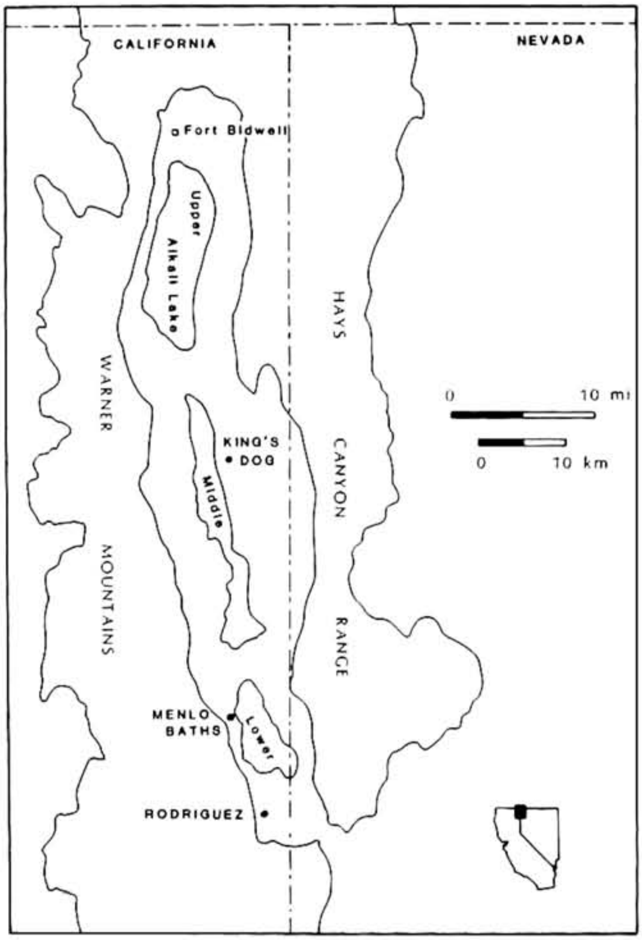

Fig. 1. Map showing location of sites in Surprise Valley (from O'Connell 1975).

either side and is a basin of internal drainage. On the west, the pine- and fir-covered Warner Mountains rise sharply to 3050 m. elevation above the valley floor, which averages about 1525 m. elevation. The barren Hays Canyon Range across the valley to the east attains a height of slightly over 1830 m. elevation and lies in the rainshadow of the Warner Mountains.

King's Dog (CA-MOD-204), Menlo Baths (CA-MOD-197), and Rodriquez (CA-LAS-194) are deep, stratified, midden sites situated on the valley floor. They were excavated by the Archaeological Research Facility, University of California, Berkeley, between 1966 and 1969 under the direction of James F. O'Connell (1971, 1975; O'Connell and Ambro 1968; O'Connell and Ericson 1974; O'Connell and Hayward 1972).

King's Dog provided the longest continuous sequence of the three sites, dating from about 6000 to 600 years B.P. (Table 1). Six components were identified, the earliest of which, KI (6000-5000 B.P.), contained at least five superimposed house floors of what are believed to be semi-subterranean earth lodges similar to those reported ethnographically from the Columbia Plateau to the northwest. During KII times and throughout the later components, house types shifted to smaller brush wickiup and windscreen structures like those built by the Northern Paiute of the area.

At Menlo Baths, three components were identified. The earliest is MI (5500-5000 B.P.), which yielded evidence of a house floor similar to the semi-subterranean structures uncovered in the earliest component at King's Dog. A gap in the sequence occurs from 5000 to 3000 B.P., between MI and MII, after which the site is occupied continuously until 600 B.P.

Four components were recognized at the Rodriquez site, dating between 4500 and 600 B.P. Approximately 31 superimposed house floors were discerned in a trench wall through the Rodriquez deposits. The only house types were domed wickiups like those in the upper levels at King's Dog.

FAUNAL SAMPLE

The three sites were excavated in arbitrary 6-in. levels, except where floor features were discernible. The deposits were passed through ¼-in. mesh screen. Only those faunal remains considered identifiable by the excavators were saved, and a grab sample of unidentifiable bone fragments in each level was collected. In several excavation units, ca. 10-15% at each site, all faunal remains were saved. Further excavation details are contained in O'Connell

Table 1

CORRELATION OF COMPONENTS AND SURPRISE VALLEY PHASES
(after O'Connell 1975: Fig. 10)

Years B.P.	Phases	King's Dog	Menlo Baths	Rodriquez
	Bidwell	NR*	NR	NR
500	Alkali	KIV	MIII	RIII
1000		KIII/IV		RII/III
1500	Emerson		MII	
2000		KIII		RII
2500				
3000	Bare Creek	KII	NR	RI
3500				
4000		KI/II		
4500	Menlo			
5000		KI	MI	
5500				
6000				
6500				

*NR: Not represented

(1971) and O'Connell and Ambro (1968: 101-102).

Faunal identifications were performed by Paul S. Hayward in the early 1970s using comparative collections at the Museum of Vertebrate Zoology, University of California, Berkeley. While the archaeofauna were summarized by O'Connell and Hayward (1972) and O'Connell (1975), these data have never been completely reported on until now.

Identified species from the three sites are listed in Tables 2-4 by minimum number of individuals per taxon (MNI) for each component and number of identified specimens per taxon (NISP). MNI for each species was calculated using left and right distinctions and age differences. A total of 1474 bone elements representing 39 mammalian and bird taxa, were identified at the genus or species level. These include 1 species in the order Talpidae, 4 Lagomorpha, 14 Rodentia, 8 Carnivora, 5 Artiodactyla, and 7 Anseriformes. The majority of the faunal remains were bighorn sheep, jackrabbits, and cottontails. Many of the other species are represented only by several identified elements.

METHODOLOGICAL CONSIDERATIONS

Several problems are now apparent in the original faunal analysis that cast some doubt on the interpretation of the settlement-subsistence patterns proposed by O'Connell (1975; O'Connell and Hayward 1972). The major problem concerns inferences drawn from the seasonality of the faunal remains. First however, problems with the recovery techniques, species identifications, natural introduction, and quantification of the faunal assemblages need to be discussed.

Recovery Techniques

Since the faunal remains were collected in

Table 2

IDENTIFIED FAUNAL REMAINS FROM THE KING'S DOG SITE

Species	MNI[1] by Component						
	KI	KI/II	KII	KIII	KIII/IV	KIV	NISP[2]
Order Lagomorpha							
Black-tailed jackrabbit, *Lepus californicus*	3	4	7	4	7	13	271
White-tailed jackrabbit, *Lepus townsendii*	4	1	4	1	1	3	75
Jackrabbits, *Lepus* spp.	2	3	1	1	1	1	50
Nuttall's cottontail, *Sylvilagus nuttallii*	2	3	5	1	2	4	75
Pygmy rabbit, *Sylvilagus idahoensis*	-	-	-	-	-	1	1
Order Rodentia							
California ground squirrel, *Spermophilus beecheyi*[3]	-	-	1	-	1	1	4
Golden-mantled squirrel, *Spermophilus lateralis*	-	-	1	1	-	1	3
Ground squirrel, *Spermophilus* sp.	-	-	-	-	-	1	1
Beaver, *Castor canadensis*	-	-	1	-	-	-	1
Muskrat, *Ondatra zibethica*	-	-	1	-	-	-	2
Order Carnivora							
Coyote, *Canis latrans*	1	1	2	1	1	1	35
Red Fox, *Vulpes fulva*	-	-	-	-	-	1	19
Black bear, *Ursus americanus*	-	-	1	-	-	-	3
Mountain lion, *Felis concolor*	-	-	2	-	-	-	2
Order Artiodactyla							
Mule deer, *Odocoileus hemionus*	-	-	-	-	1	-	1
Pronghorn, *Antilocapra americana*	1	-	-	1	-	-	2
Bison, *Bison bison*[4]	2	1	2	-	-	1	20
Bighorn sheep, *Ovis canadensis*[4]	10	4	3	1	2	2	236
Order Anseriformes							
Canada goose, *Branta canadensis*	-	-	1	-	-	-	1
Mallard, *Anas platyrhynchos*	-	-	-	1	-	-	1
Pintail, *Anas acuta*	-	-	-	-	-	1	1
Blue-winged teal, *Anas discors*	-	-	-	-	-	1	1

[1] MNI: Minimum number of individuals per taxon

[2] NISP: Number of identified specimens per taxon

[3] Introduced into the assemblage by natural processes

[4] Extirpated in the Surprise Valley region

¼-in. mesh screens, some small animal remains were undoubtedly lost (cf. Thomas 1969). Given the wide range of species identified from the sites, particularly many small rodents and birds (Tables 2-4), screen size does not appear to have significantly affected the faunal sample. Use of 1/8-in. mesh screens would have increased the number of specimens per taxon; however, the recovery of only identifiable elements overshadows the loss of faunal remains due to screen size, for this is the major source of sample bias. Field crews, untrained in faunal analysis, could not be expected to accurately distinguish between potentially identifiable and unidentifiable elements. This situation was indicated by the fact that in excavation units where all bones were recovered, a higher number of identifiable specimens were represented in comparison to those units in which only identifiable elements were collected. As a result, a small percentage of potentially identifiable faunal remains were lost, which may have increased the MNI, the number of elements identified per taxon, and perhaps even the number of species represented.

The lack of unidentifiable bone fragments affected other aspects of the faunal analysis as

Table 3

IDENTIFIED FAUNAL REMAINS FROM THE MENLO BATHS SITE

Species	MNI[1] by Component			
	MI	MII	MIII	NISP[2]
Order Talpidae				
California mole, *Scapanus latimanus*[3]	-	1	1	3
Order Lagomorpha				
Black-tailed jackrabbit, *Lepus californicus*	1	2	2	16
White-tailed jackrabbit, *Lepus townsendii*	2	4	5	50
Jackrabbits, *Lepus* spp.	-	1	-	1
Nuttall's cottontail, *Sylvilagus nuttallii*	1	1	-	11
Order Rodentia				
Yellow-bellied marmot, *Marmota flaviventris*	-	1	-	1
Golden-mantled squirrel, *Spermophilus lateralis*	1	-	-	1
Muskrat, *Ondatra zibethica*	1	-	-	1
Order Carnivora				
Coyote, *Canis latrans*	1	1	1	10
Red fox, *Vulpes fulva*	1	1	1	10
Bobcat, *Lynx rufus*	-	1	-	1
Mountain lion, *Felis concolor*	1	-	-	1
Order Artiodactyla				
Mule deer, *Odocoileus hemionus*	-	1	1	3
Whitetail deer, *Odocoileus virginianus*	1	-	-	1
Pronghorn, *Antilocapra americana*	1	1	1	14
Bighorn sheep, *Ovis canadensis*[4]	4	4	3	118
Order Anseriformes				
Teal, *Anas* cf. *cyanoptera*	-	1	-	2

[1] MNI: Minimum number of individuals per taxon

[2] NISP: Number of identified specimens per taxon

[3] Introduced into the assemblage by natural processes

[4] Extirpated in the Surprise Valley region

well. Based on the recovered bone sample, an analysis of butchering patterns for large animals was severely hampered because it was not known to what extent ribs, vertebra, and "unidentifiable" long bone elements were represented. This fact is apparent from the distribution of bighorn sheep elements shown in Table 5. For this reason, no attempt at butchering reconstruction is presented. Had unidentifiable bones been recovered, these fragments could have been separated into different animal size categories such as small, medium, large, and very large mammals to reconstruct the butchering patterns (cf. Dansie 1979a, 1979b; James, Brown, and Elston 1982; James and Pecotte 1983).

Use of size classes for unidentifiable elements has been applied in another fashion which might have produced some interesting results concerning consumption patterns and seasonality in Surprise Valley. For several western Great Basin sites, Dansie (1979a, 1979b) has determined a winter village pattern based on the presence of highly fragmented bones. This pattern appears to be the result of bone meal, grease, and marrow processing of large game and dried rabbits during the winter months when food supplies were low and all available caloric value was obtained from the bones. The discarded "unidentifiable" Surprise Valley faunal remains might have displayed a similar pattern, thus

Table 4

IDENTIFIED FAUNAL REMAINS FROM THE RODRIQUEZ SITE

	MNI[1] by Component				
Species	RI	RII	RII/III	RIII	NISP[2]
Order Lagomorpha					
Black-tailed jackrabbit, *Lepus californicus*	2	4	4	2	88
White-tailed jackrabbit, *Lepus townsendii*	1	1	2	2	21
Jackrabbits, *Lepus* spp.	1	9	3	6	147
Nuttall's cottontail, *Sylvilagus nuttallii*	1	5	4	3	66
Order Rodentia					
Yellow-bellied marmot, *Marmota flaviventris*	-	1	-	-	1
Ground squirrel, *Spermophilus* sp.[3]	-	1	-	-	2
Least chipmunk, *Eutamias minimus*[3]	-	1	-	-	1
Townsend's chipmunk, *Eutamias townsendii*[3]	-	1	-	-	4
Yellow pine chipmunk, *Eutamias amoenus*[3]	-	1	-	-	1
Pocket gopher, *Thomomys* sp.[3]	1	-	-	-	1
Ord's kangaroo rat, *Dipodomys ordii*[3]	1	-	-	-	4
Great Basin kangaroo rat, *Dipodomys microps*[3]	1	-	-	-	1
Beaver, *Castor canadensis*	-	1	-	-	1
Bushy tail woodrat, *Neotoma cinerea*	-	1	-	1	2
Desert woodrat, *Neotoma lepida*	-	-	-	1	1
Woodrat, *Neotoma* sp.	-	-	1	1	2
Longtail vole, *Microtus longicaudus*[3]	-	2	-	-	4
Vole, *Microtus* sp.[3]	-	3	-	-	4
Order Carnivora					
Coyote, *Canis latrans*	2	1	1	-	6
Coyote, *Canis* sp.	-	1	-	-	2
Grizzly bear, *Ursus horribilis*[4]	-	1	-	-	1
Badger, *Taxidea taxus*	-	-	-	1	2
Striped skunk, *Mephitis mephitis*	-	-	-	1	1
Bobcat, *Lynx rufus*	-	1	-	-	1
Order Artiodactyla					
Bighorn sheep, *Ovis canadensis*[4]	-	4	1	2	50
Order Anseriformes					
Canada goose, *Branta canadensis*	-	-	1	-	1
Ross' goose, *Chen rossi*	-	1	1	1	4
Mallard, *Anas platyrhynchos*	-	1	-	1	4
Green-winged teal, *Anas crecca*	-	-	-	1	1
Ducks, *Anas* spp.	-	1	-	1	5

[1] MNI: Minimum number of individuals per taxon

[2] NISP: Number of identified specimens per taxon

[3] Introduced into the assemblage by natural processes

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helping to establish the season of site occupation.

Identifications

Another source of bias in the collection concerns the identifications. As Grayson (1979: 203) has pointed out, identifiable specimens actually represent those elements that a particular investigator can identify. Short of re-identifying the entire faunal collection, a matter beyond the scope of the present work, it is assumed that the identifications were accurately made with the exception of certain waterfowl species and jackrabbits.

Parmalee (1980: 244, 246) has noted that

Table 5

IDENTIFIED BIGHORN SHEEP ELEMENTS

Element	King's Dog	Menlo Baths	Rodriquez
Antler	-	-	-
Skull	2	-	2
Maxilla	1	-	-
Mandible	8	8	3
Incisor	3	8	-
Premolar	13	8	-
Molar	33	25	1
Misc. teeth	-	5	-
Atlas	2	-	-
Axis	2	-	1
Vertebrae	-	-	4
Rib	2	2	-
Scapula	2	-	-
Blade	-	-	-
Glenoid	1	1	3
Pelvis	-	1	-
Prox. humerus	1	-	-
Dist. humerus	4	2	1
Prox. radius	-	-	-
Dist. radius	-	-	-
Prox. ulna	-	-	-
Dist. ulna	-	-	-
Scaphoid	2	1	-
Lunate	5	-	-
Cuneiform	3	1	-
Magnum	5	-	-
Trapezoid	-	1	-
Unciform	4	4	-
Sesamoid	2	2	-
Prox. metacarpal	4	2	-
Dist. metacarpal	2	4	-
Prox. femur	1	3	-
Dist. femur	2	1	-
Patella	2	1	-
Prox. tibia	-	2	1
Dist. tibia	6	2	6
Astragulas	28	5	5
Calcaneus	1	-	-
Naviculo-cuboid	12	4	-
Misc. pes	2	2	-
Prox. Metatarsal	3	3	-
Dist. metatarsal	-	1	-
Prox. metapodial	4	3	-
Dist. metapodial	20	13	2
Metapodial	7	1	3
Phalange	36	1	6
Long bone	11	1	12
Total	236	118	50

hybrids of the duck family (*Anatidae*) may cause identification problems, as do similarities between species such as cinnamon teal (*Anas cyanoptera*) and blue-winged teal (*A. discors*). Distinguishing correctly between these two species is important to inferences concerning seasonality of the Surprise Valley sites, as discussed later. A single proximal humerus in the collection was assigned to blue-winged teal; only one unspecified element was identified as *possibly* cinnamon teal. According to Woolfenden (1961: 13), it is even quite difficult to distinguish the genus *Anas* from several other genera of dabbling ducks on the basis of the humerus. This evidence suggests that future reanalysis of the elements assigned by Hayward to cinnamon and blue-winged teal may show the differences to be so variable that these elements could probably only be identified as *Anas* sp.

The osteological remains of black-tailed (*Lepus californicus*) and white-tailed (*L. townsendii*) jackrabbits are difficult to distinguish, even with complete skulls (Grayson 1977; Hoffmann and Pattie 1968: 18). O'Connell and Hayward (O'Connell, personal communication 1981) used femur length to distinguish between the two species. While this method is probably adequate, a more accurate criterion would have been to measure the alveolar length of the mandible, since mandibles of *L. townsendii* are larger than those of *L. californicus*, thus following Bergmann's rule (Grayson 1977; see also Grayson [1983: 106] for other measurements using bivariate analyses). A correct identification of these two species is not critical to the present analysis. If these data are used for future paleoclimatic inferences, as was done earlier by O'Connell and Hayward (1972: 37), the jackrabbit bones should be re-identified to insure a valid sample.

Natural Introduction

In any given archaeological site, some percentage of the faunal remains has probably been introduced and modified by animals. The problem is in determining what portion is the result of natural introduction and attrition by predators, scavengers, and other natural processes (e.g., Behrensmeyer and Hill

1980; Binford 1981; Binford and Bertram 1977; Bonnichsen 1973; Brain 1981; Gifford and Behrensmeyer 1977; Thomas 1971b).

Since the Surprise Valley faunal remains are from open sites, they are probably more representative of species consumed in the prehistoric diet than are faunal remains recovered from rockshelters which are subject to problems of natural introduction (McGuire 1980; cf. Gruhn and Bryan 1981). Nevertheless, several identified species from the sites were introduced by natural means (see Tables 2-4). During the excavations, voles, kangaroo rats, and chipmunks were observed at the Rodriquez site (O'Connell n.d.). These species probably died naturally and were incorporated into the cultural deposits. This is particularly the case with the kangaroo rat and pocket gopher remains that were both found in burrows just below the cultural deposits (O'Connell n.d.). Similarly, mole remains from Menlo Baths are probably from intrusive burrowing.

The presence of ground squirrels as a result of natural introduction is harder to establish. Ethnographically, they were considered a food resource by Great Basin Indians (Hall 1946; Kelly 1932; Steward 1938, 1941) and undoubtedly were used in prehistoric times. There is, however, one possible way to identify the culturally introduced ground squirrels at the sites. California ground squirrels (*Spermophilus beecheyi*) inhabit both the valley floor and lower slopes and could be present through natural introduction, a view which is taken here. Conversely, golden-mantled squirrels (*S. lateralis*) generally inhabit upland mountainous areas such as the Warner Mountains and Hays Canyon Range (cf. Hall 1946) and may have been brought to the sites by the prehistoric inhabitants.

Quantification of Faunal Remains

Grayson (1979) has elaborated on the problem of aggregation in calculating MNI estimates (see also Casteel 1977: 126; Grayson 1973, 1978). Because this problem is noticeable in the earlier analysis (O'Connell n.d., 1975), it should be discussed in order to resolve the issue.

In the initial Surprise Valley faunal analysis, the component MNI was derived by first calculating the MNI for each 6-in. level in a single component and then adding these numbers (O'Connell n.d.). These incorrect MNI figures are shown in O'Connell (1975: Tables 2-4). The component MNI for each species in the present analysis was calculated on the basis of all identified elements for that species in the component (Tables 2-4). When O'Connell's (1975: Tables 2-4) MNI figures are compared, those in the present analysis are generally lower or remain unchanged and are probably a more accurate MNI estimate of species abundance at the three sites.

SEASONALITY EVIDENCE

Inferences concerning seasonality are crucial to the argument for year-round site occupation in Surprise Valley. O'Connell (1975; O'Connell and Hayward 1972) based his conclusions on very tentative seasonality evidence. This evidence is critically reevaluated in this section along with other seasonality methods that are applied to the Surprise Valley faunal data. These methods include: (1) age determinations, (2) habits and migration patterns of species represented, and (3) regional ethnographic hunting accounts.

Age Determinations

An important aspect of seasonality involves establishing the age of the species represented. Aging techniques include analysis of tooth eruption and wear patterns, annual growth increments on teeth, epiphyseal fusion of long bones, suture closure on skulls, and horn and antler growth (Chaplin 1971: 76-90; Monks 1981; Ziegler 1973: 46-49, 1975).

The current study is limited by what can be done with age determinations to establish the season(s) of site occupation. For present purposes, only epiphyseal fusion will be discussed of all the available aging techniques since immature elements were noted in the faunal collection. As shown in Table 6, relatively few identified elements were those of young individuals, most of which were immature, unfused epiphyses. I suspect that the lack of immature elements, particularly for the ungulates, may be a function of sampling in that mature specimens with fused epiphyses were readily considered identifiable by the excavators, whereas immature unfused elements, such as shafts, were not and were discarded at the sites.

The age of an animal, and hence the season of death, can be calculated by knowing its birth season and the length of time that is required for a given epiphysis to fuse in that species. While the timing of epiphyseal closure varies for each limb bone in a particular species, the sequence of bone fusion for that species proceeds at a fairly regular rate from birth.

Epiphyseal closure for most small mammals is completed within about a year from birth. Complete epiphyseal closure among eastern cottontail (*Sylvilagus floridanus*) occurs nine months after birth (Hale 1949). In black-tailed jackrabbits, the proximal humeri begin to fuse at five months from birth and are fused completely with no visible epiphyseal line by about 15 months (Tiemeier and Plenert 1964), although Lechlietner (1959: 66) placed complete epiphyseal closure around 11 months.

Table 6

IMMATURE ELEMENTS

Species/Element	King's Dog	Menlo Baths	Rodriquez
Lepus californicus			
Pelvis	1		
Prox. humerus	2		
Prox. ulna			1
Prox. femur	1		
Shaft femur	1		
Prox. tibia	2		1
Shaft tibia	1		
Dist. tibia		1	2
Calcaneum	1		
Lepus townsendii			
Phalange			1
Lepus sp.			
Mandible			1
Prox. humerus			1
Shaft tibia			1
Dist. tibia			2
Phalange			1
Sylvilagus nuttallii			
Prox. humerus			2
Metacarpal			1
Prox. femur			1
Dist. femur			1
Prox. tibia			2
Dist. tibia			1
Sylvilagus idahoensis			
Humerus	1		
Castor canadensis			
Mandible			1
Vulpes fulva			
Various elements	19		
Felis concolor			
Canine	1	1	
Ovis canadensis			
Teeth		2	
Vertebrae			3
Shaft tibia			1
Dist. tibia	1		
Prox. metatarsal		1	
Metapodial		1	
Bison bison			
Cuboid	1		

On the other hand, fusion rates for long bones in larger mammals may span several years. For black-tailed deer (*Odocoileus hemionus*), the proximal radii and distal humeri are first to fuse at 8 to 10 months, whereas the distal femora and proximal humeri do not close until about 52 months in males (Lewall and Cowan 1963). Nutrition, and to some extent sexual dimorphism, appear to affect the rate of closure. Unfortunately, epiphyseal closure data for other ungulates are incomplete although the rates are assumed to be similar (cf. Spiess 1979: 92-93).

Due to the variability in epiphyseal closure and paucity of data on closure rates, aging large mammals by this method has to be applied with caution (see Watson [1978] for other criticisms). For these reasons, I will just focus on aging the cottontails, for they have a limited birth span between April and July (Burt and Grossenheider 1976). Age and seasonality calculations for immature jackrabbits in the Surprise Valley collection cannot be derived since they breed throughout the year, except possibly in winter (Hall 1946: 605; Orr 1940: 94).

Nearly all immature cottontail elements were recovered from the Rodriquez site (Table 6). If these cottontails were born in April at the earliest, then using an epiphyseal closure rate of nine months, fusion would have been completed by December. If, on the other hand, they were born in July, epiphyseal closure was not completed until the following March. Based on these calculations, the season of occupation at the Rodriquez site is ambiguous, for immature cottontails could conceivably have been killed at any time of the year.

Conversely, at King's Dog and Menlo Baths, it is the near absence of immature cottontail elements that is more conclusive. Given a nine-month epiphyseal closure rate and depending upon the month of birth, a December to March site occupation is suggested at the two sites since cottontail elements would have been fused by this time. In line with this evidence, Steward (1938: 39) mentions that cottontails were often hunted at this time to supplement the food supply in winter villages.

Other aging techniques might have provided more accurate seasonality inferences had the data been available. For instance, aging bighorn sheep by tooth eruption and wear patterns might have been helpful in determining the season of death (Demming 1952; for similar studies of other ungulates, see Severinghaus 1949; Robinette et al. 1957; Klein et al. 1981; Frison 1982), but such an analysis is limited by the small mandible sample from the three sites (19 total). A more rewarding effort in future work would be to age the many single *Ovis canadensis* teeth fragments by counting annual tooth cementum layers (cf. Dean 1975; Turner 1977).

Habits and Migration Patterns

Another major seasonality method involves making inferences about the habits and migratory patterns of waterfowl, ungulates, and hibernating mammals. Seasonality inferences from these animals, however, have to be treated with caution.

A basic assumption of this method is that animal migration patterns have not changed as a result of Holocene environmental changes. Aside from late Pleistocene-early Holocene megafaunal extinctions and separation of small mammals on mountain tops in the Great Basin (Brown 1971, 1978; Grayson 1982; Thompson and Mead 1982), it is not known how Holocene environmental fluctuations have influenced animal migrations. For the moment, it must be assumed that modern seasonal migration patterns were similar throughout most of the Holocene, as other researchers have done (cf. Smith 1974: 281). This assumption is critical to any argument relying upon this method of seasonal inference given the magnitude of historic animal extinctions in the Great Basin, particularly for bighorn sheep (Buechner 1960; Grayson 1982; McQuivey 1978; Pippin 1979; Schulz and Simons 1973; Thomas 1970).

Waterfowl. All identifiable bird fragments recovered from the three sites were those of waterfowl (Tables 2-4). With the exception of Ross' goose, blue-winged teal, and cinnamon teal, the waterfowl could be year-round residents in that their breeding and wintering ranges include northeastern California (Johnsgard 1975; Maillard 1927; Peterson 1961; Robbins, Bruun, and Zim 1966).

Ross' goose, on the other hand, breeds in a limited region of the Arctic and spends winters in the California Central Valley, passing by the Surprise Valley region on southward migrations in mid-October and on return flights in February or March (Johnsgard 1975: 116). Blue-winged teal breeds throughout northern North America, even as far south as central Arizona, and in the winter migrates to central California and southward to Central America (Johnsgard 1975; Peterson 1961). While the breeding range of cinnamon teal includes northeastern California, their winter range is located along coastal Mexico (Johnsgard 1975: 284).

The presence of Ross' goose in the assemblage indicates that they could only have been killed during the fall and spring migrations and perhaps in the winter if they stayed in Surprise Valley. The other migratory and resident species probably were hunted during the fall and spring migrations when waterfowl are the most concentrated. The identifications of blue-winged and cinnamon teal as noted above may be incorrect, and they might not even be represented in the faunal collection. In any event, these two migratory species would not have been available in the winter months.

Ungulates. Given the vertical relief that exists in the Great Basin, distances covered in ungulate migrations are not great. For example, the summer range of California bighorn sheep in the southern Sierra Nevada is along the Sierran crest around 3660 to 3960 m. elevation. Triggered by the first heavy snow in the fall, the sheep herd migrates to its winter range along the steep, rocky slopes adjacent to Owens Valley between 1525 and 2590 m. elevation. Distances between summer and winter ranges are only between 5 to 11 km. (McCullough and Schneegas 1966). Migration patterns of bighorn sheep that formerly occupied Surprise Valley were probably similar to the southern Sierra Nevada herds. Thus, bighorn sheep would have spent summers at upper elevations in the Warner Mountains and Hays Canyon Range and migrated to lower slopes during the winters, perhaps even onto the valley floor.

The present summer range of antelope includes most of Surprise Valley and the Hays Canyon Range. In comparison, their winter range is restricted to an area along the eastern side of Surprise Valley between Upper and Middle Alkali lakes and into the Hays Canyon Range (McLean 1944: Figs. 86-87; Springer 1950: 296). Likewise, mule deer in the Intermountain West migrate from their summer ranges in higher elevations to winter on the foothills and valley floors (Aldous 1945; Gruell and Papez 1963; Rickens 1967); however, the route of their migration may be quite extensive. Although mountain bison were exterminated in the early historic period (Bailey 1923, 1932; Christman 1971; Merriam 1922, 1926; Riddell 1952) and little is known about their prehistoric migration patterns or abundance, this species probably spent summers in the unforested upland meadows of the Warner Mountains and winters in Surprise Valley.

It becomes apparent from this evidence that ungulate herds were more concentrated during late fall and spring migrations and on their winter ranges in Surprise Valley than at other times of the year. The proximity of these large ungulate herds to the three valley-floor sites during these seasons suggests that the inhabitants could easily have hunted these animals at such times.

Hibernating Mammals. In the earlier Surprise Valley analysis, marmots, ground squirrels, and chipmunks were considered to be available only during the spring and summer. While these rodents do have a propensity to hibernate in the fall and winter months, their patterns are more variable than previously assumed by O'Connell (1975; O'Connell and Hayward 1972), for they may be present above ground at various times during winter months.

Marmots are generally active only in spring and summer and hibernate from August to late February or March (Burt and Grossenheider 1976); however, differences in latitude, elevation, and amount of summer food can affect the timing of their seasonal patterns (Hall 1946: 284). Chipmunks (*Eutamias* spp.) are dormant in the winter except in their southern Nevada range where they may be active during part of the winter (Hall 1946: 329). Some ground squirrels hibernate during the winter months, but their patterns are even more variable depending upon their summer food supply. For example, while California ground squirrels (*Spermophilus beecheyi*) usually are inactive between October or November and January, some remain above ground during this time (Burt and Grossenheider 1976). Golden-mantled squirrels (*S. lateralis*) hibernate in October and emerge in March to May; however, the species has been reported to push through the snow in winter (Burt and Grossenheider 1976). Elevation, amount of snow cover, and even age and sex also affect the springtime emergence of golden-mantled squirrels (Bronson 1980).

Although bears were not considered among the hibernating species by O'Connell, their presence might also be inferred to solely represent spring and summer site occupation. However, ethnographic accounts indicate that bears in the region were often hunted during the winter months when they were hibernating (Downs 1966: 33; Garth 1953: 133-134; Kelly 1932: 86-87).

Ethnographic Accounts

Ethnographic and ethnohistoric accounts can provide some information on the seasons that certain species were hunted. Because of problems associated with reconstructing the structure of pre-contact lifeways in the Great Basin from the ethnographic record, this data source is the least reliable of the three seasonality methods reviewed here. However, ethnographic accounts can be used to supplement and even to check other sources of seasonal data, some of which are cited above.

For Surprise Valley, Kelly's (1932: 81-91) information on hunting patterns among the Surprise Valley Paiute contains many references to seasonality. Although her informants mentioned hunting a wider range of species than were identified in the Surprise Valley sites, the concern here is only with the seasonal information of the Surprise Valley faunal remains. Deer were hunted year-round. Antelope, on the other hand, were taken in the fall and winter months in communal hunts. Similarly, jackrabbits were hunted during the fall and on into January in communal drives using long nets. It was also noted that rabbits were pursued in the snow with dogs. Bears were generally flushed out of their caves in the winter. Ground squirrels were hunted primarily in mid-summer, although as Wheat (1967: 8) points out, ground squirrels were also killed in mid-February when they emerged from hibernation. A similar situation was noted by Downs (1966: 13) regarding marmots killed in the early spring.

DISCUSSION

In the view taken by O'Connell (1975; O'Connell and Hayward 1972), the presence of immature elements, summer resident waterfowl, and hibernating rodents in the faunal assemblage was cited as evidence in support of year-round occupation at the valley-floor sites. This evidence has been shown here to be inconclusive. Immature elements first need to be qualified before they can be used as seasonality indicators due to the variability in season of birth, timing of epiphyseal closure, and maturity rates for each species. Simply stating, as O'Connell did, that the presence of immature elements from the Surprise Valley sites indicated spring-summer occupation was not sufficient to demonstrate this. From the reanalysis, it was actually the paucity of immature cottontail elements in the assemblages which could be used to infer winter occupation at King's Dog and Menlo Baths.

As for the waterfowl, most were resident species available throughout the year. The presence of Ross' goose in the assemblage, a non-resident species, suggested that they were only available during the fall and spring migrations. The other resident and migratory waterfowl were probably also killed at these times when they were the most concentrated.

For the hibernating rodents, their patterns were shown to be more variable than previously thought, for they sometimes appear above ground during winter months. This evidence implies that simply the presence of "hibernating mammals" in the faunal collection is not a very reliable indication that the valley-floor sites were occupied during the spring and summer seasons. Further, as indicated earlier in this paper, some hibernating rodents were probably the result of natural introduction, thus their presence in the sites may mean nothing in terms of the season of human occupation.

Several other lines of evidence point to late fall, winter, and early spring occupation at the valley-floor sites. For one, the migration patterns of ungulates recovered from the sites indicate that they were at their maximum concentrations during the fall and spring migrations and at their winter ranges in Surprise Valley. Occupation of the three valley-floor sites may have occurred during this period in order to take advantage of these concentrated ungulate populations.

Second, as indicated by ethnographic and ethnohistoric sources from the region, several species represented in the faunal assemblage were hunted during the late fall and winter. Marmots and ground squirrels were also available in late February and would have been a welcome addition to the aboriginal diet when stored winter foods were running low prior to the ripening of spring plants.

In sum, the faunal evidence from the King's Dog, Menlo Baths, and Rodriquez sites suggests that they were occupied from late fall to early spring. The evidence for year-round occupation is less convincing and could be accounted for in the faunal assemblage as a result of fall or early spring hunting.

CONCLUSIONS AND IMPLICATIONS

The evidence I have presented here substantially alters the interpretation of the Surprise Valley settlement-subsistence model proposed by O'Connell, thus making the pattern more consistent with the ethnographic data for the Great Basin. That is, the three valley-floor habitation sites were, instead, winter villages or camps, and a more dispersed settlement pattern away from these sites occurred throughout the spring and summer months. When the valley-floor sites are viewed in this manner, the settlement pattern does not seem as anomalous as it previously did, particularly since the pattern of year-round occupation in Surprise Valley was considered to be 5000 to 6000 years old and to have persisted until about 500 B.P.

If such a pattern was, indeed, present in the valley for this length of time, the implications of this for Great Basin prehistory and prehistory in general would be quite interesting. At the extreme, this would be a very early example of sedentary village life in the Great Basin based on hunting-gathering but without agriculture about the same time that year-round occupation appears in the Tehuacan Valley sequence in Mexico and only several millennia after the pattern of settled life occurred in southwest Asia. If such was the situation, one wonders why other similar villages have not been found elsewhere in the Great Basin and Columbia Plateau. Instead, as

I have attempted to show in the present paper, the faunal evidence does not seem to indicate that the sites were occupied throughout the year. To be more certain of this, however, only future excavations aimed at recovering a better faunal sample from these sites may help resolve the issue.

This brings up another matter concerning seasonality determinations. With the exception of Surprise Valley and several other sites in the Great Basin (e.g., Dansie 1979a, 1979b; James and Pecotte 1983; James, Brown, and Elston 1982; Miller 1979: 281-282; Thomas and Mayer 1983), seasonality of site occupation has been largely ignored in the analysis of faunal remains from Great Basin sites (for a different opinion, see Grayson and Thomas [1983]). As a result, the settlement-subsistence models proposed by Thomas (1971a, 1972, 1973) for the Reese River Valley, by Bettinger (1975, 1976, 1977, 1982) for the Owens Valley, and by Weide (1968, 1974) for the Warner Valley are not based on direct seasonality evidence from recovered faunal remains. Madsen (1981; cf. Bettinger 1981; Thomas 1981) has similarly criticized Bettinger and Thomas for relying mostly upon site location and tool assemblages to derive their regional settlement-subsistence models. As it stands now, the seasonality aspects of these settlement-subsistence models are essentially untested hypotheses. In the future, faunal remains from excavated sites in the Great Basin should be analyzed to test the seasons of site occupation proposed in these models, as has been demonstrated here for the Surprise Valley sites.

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