INFLUENCES OF MID-HOLOCENE ALTITHERMAL CLIMATES ON MAMMALIAN FAUNAS AND HUMAN SUBSISTENCE IN EASTERN WASHINGTON

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ABSTRACT.—Palynological data indicate climates in eastern Washington between 8000 and 4000 B.P. were warmer and drier than before or after that time. It has been hypothesized that this mid-Holocene warm-dry interval, typically called the Altithermal, would have resulted in decreased mammalian biomass and prompted prehistoric hunter-gatherers in eastern Washington to shift subsistence pursuits to focusing on fish and plants, increasing reliance on small mammals, a broader range of mammalian taxa being exploited, or some combination of these. Mammalian faunal data compiled from 11 sites in one area and 28 sites in another area do not conform with these hypotheses. Small mammals used as food resources decrease in relative abundance continuously through the last 10,000 years in both areas, fish remains are more abundant after 4000 B.P. than before that time in one area, and ungulates steadily become more abundant over the last 10,000 years in both areas. Indications of natural faunal turnover are masked by sample size effects, and shifts in mammalian biomass are obscured by varying intensity of human occupation.

RESUMEN.—Los datos palinológicos indican que, entre 8000 y 4000 años antes del presente, el clima en el este del Estado de Washington (Estados Unidos de Norteamérica) fue más cálido y más seco que antes o después de dicho tiempo. Se ha aventurado la hipótesis de que este intervalo caliente y seco de mediados del holoceno, llamado tipicamente el altitermal, habría resultado en una biomasa reducida de mamíferos y habría provocado que los cazadores-recolectores en el este de Washington modificaran su subsistencia para enfocarse en peces y plantas, incrementar su dependencia de mamíferos pequeños, explotar un rango más amplio de taxa de mamíferos, o alguna combinación de estas posibilidades. Los datos compilados sobre mamíferos de 11 sitios en un área y 28 sitios en otra, sin embargo, no concuerdan con estas hipótesis. La abundancia relativa de mamíferos pequeños usados como alimento disminuye continuamente durante los últimos 10,000 años en ambas áreas, los restos de peces son más abundantes despues de 4,000 años antes del presente en un área, y los ungulados se vuelven más y más abundantes a lo largo de los últimos 10,000 años en ambas áreas. Las evidencias de la rotación natural de existencias de fauna son disfrazadas por efectos del tamaño de las muestras, y los cambios en la biomasa de mamíferos son oscurecidos por la intensidad variable de la presencia humana.

RÉSUMÉ.—Les données palynologiques indiquent que les climats dans l'Est de Washington, entre 8000 et 4000 B.P. etaient plos chauds et secs qu'arant et oprès cette période. On a proposé que cet interval chaud et sec du Moyen Holocène, l'Altiehermal, aurait pu déclancher un déclinement de la faune mammifère. En conséquent, les chasseurs collecteurs préhistoriques de l'Est de Washington auraient modifier leur existence en diminvant l'importance des grands mammifèrs et en accentuant l'importance du poisson, des plantes, et des petits mammifèrs, ou un plus grand rayon d'exploitation de types de mammifères, ou pent-être une combination de ceux-ci. Les donne'es recueillies peur la faure mammifère de 11 sites dans une région et 28 sites d'une autre région ne supportent pos ces hypothèses. Les petits mammifères utilizés comme denrée alimentaire diminuent continuellement en abendance relative pendant les dernieres 10,000 années pour les 2 régions. Les restes de poissons sont plus abondants après 4000 B.P. dans une région, et les ongulés augmentent constament pendant les dernieres 10,000 années dans les 2 régions. Les indications de renversements de faune naturels sont masquées par les petites dimension des groupes étudiés, et les changements de faune mammifère sont voilés par les variations dans l'intènsité d'occupation humaine.

INTRODUCTION

Palynological data for Holocene deposits in eastern Washington (summarized in Barnosky et. al. 1987; Mehringer 1985) suggest that climates 10,000 years ago were cooler and moister than at present. Evidence of increased aridity appears as early as 9000 B.P. or slightly later. Maximal aridity seems to have occurred between approximately 8000 B.P. and 5000 to 4500 B.P. during the climatic interval called the Altithermal, with essentially cooler and moister to modern conditions prevailing after 4000 B.P. Potential impacts of the mid-Holocene warm, dry climatic interval on human occupants of the area have long been the subject of discussion (e.g., Baumhoff and Heizer 1965; Bense 1972). Fryxell and Daugherty (1963:14) suggested large game would decrease in abundance and force prehistoric peoples to rely on fishing and gathering rather than hunting during the mid-Holocene. Schalk (1983:145) argued xeric climatic conditions would decrease ungulate biomass due to decreased biomass of forage and "would probably exclude ungulates other than pronghorn (*Antilocapra americana*)" from the more xeric areas of eastern Washington (see Van Vuren 1987 for similar arguments concerning bison [*Bison bison*]).

Previous studies of the mammalian history of eastern Washington indicate some taxa apparently responded to climatic change during the Holocene by modifying their distributions (Lyman 1986a, 1986b, 1991a, 1991b; Lyman and Livingston 1983; McCorquodale 1985). Other studies suggest changes in relative taxonomic abundances occurred during the Holocene (Gustafson 1972; Van Vuren 1987). Research at Marmes Rockshelter (site number 45FR50) suggested to Gustafson (1972:105) that mammalian faunas in eastern Washington remained taxonomically stable throughout the last 8000 years. He detected an increase in the abundance of large mammals during the Altithermal occupation of Marmes Rockshelter which he felt resulted from the fact that the faunal remains were humanly deposited

and thus reflected both the number of animals killed for human consumption rather than natural biomass, and a mid-Holocene increase in human occupational intensity of the site. In this paper I review the known Holocene record of mammals in two geographically distinct areas of eastern Washington in an attempt to find evidence of changes in the mammalian fauna and the contribution of that fauna to human subsistence. Simultaneously I search for sample-size effects as it has been well documented that sample size can adversely influence the measurement of faunal turnover (e.g., Badgley and Gingerich 1988; Koch 1987) and estimates of faunal biomass (e.g., Grayson 1984). I also monitor the intensity of human occupation because increases in such occupation could result in higher rates of deposition of animal remains in sites.

STUDY AREA, MATERIALS, AND METHODS

The Columbia Basin of eastern Washington is diverse physiographically and vegetationally (Franklin and Dyrness 1973) and contains several vegetation zones that Daubenmire (1970) has characterized generally as steppe. Mean annual precipatation is 20 cm in the southern (Lower Snake River) part of the basin and 33 cm in the northern (Upper-Middle Columbia River) part (Fig. 1). Mean temperature in January is –5° C in the southern part and –9° C in the northern part; mean temperature in July is about 32° C in the southern part and 30° C in the northern part.

To date, few data on the Holocene mammals of eastern Washington have been derived from natural bone accumulations such as natural traps, carnivore dens, or raptor or owl roosts. The single such studied fauna was recovered from deflated areas in a dune field and is of unclear but probably late Holocene age (Miller 1977). Well over 95% of the available mammalian data derive from archaeological sites that have been excavated by numerous individuals over the past 35 years. Because humans were responsible for selectively accumulating and depositing many of the bones in such sites, care is warranted when attempting to derive paleoenvironmental meaning from these bone assemblages. The sites I have used in this analysis are, with one exception (Marmes Rockshelter), open sites, but some are villages (i.e., have clear evidence of substantial structures) while others appear to be camps (i.e., lack evidence of structures), suggesting between-site variation in season of occupation, duration of occupation, or both. Assemblages of artifacts and plant remains indicate that activities performed by human occupants of the sites were similar but not identical, with some between-site variation in resources procured, procurement techniques used, and resource processing. Geological data indicate between-site variation in postdepositional histories of the faunal remains. On one hand, these data indicate that while interpretation of the mammalian fauna from a single site might be significantly influenced by the human activities and postdepositional proccesses that, respectively, produced and affected the faunal remains, summing the faunas from a series of sites should serve to mute such influences and produce a general indication of trends in the natural faunal history of the area (Lyman 1987). On the other hand, the muting effects of summing multiple archaeological faunas will produce only general indications of trends in human subsistence pursuits,
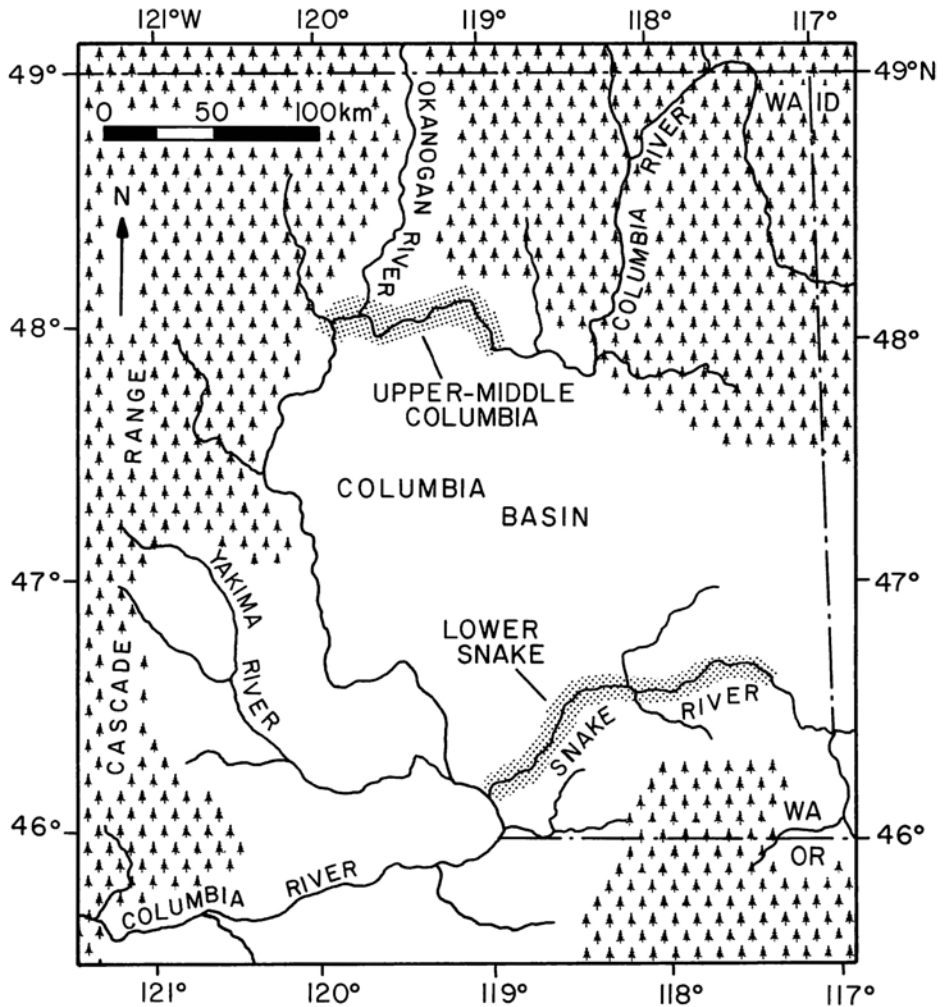
FIG. 1.—Locations of the Columbia Basin (circumscribed by the Columbia and Snake Rivers), the Lower Snake River area, and the Upper–Middle Columbia River area in eastern Washington.

given that some sites seem to have been occupied by humans that were more specialized in subsistence pursuits than the occupants of other sites. This seems preferable to site-specific studies at this time; once general trends are established in both the cultural or subsistence pursuits of people and the natural faunal history of the area, site-specific faunas from both cultural and natural deposits can be used to fine-tune the trends indicated.

Data were compiled from published and unpublished archaeological reports for two areas: the western two-thirds of the Lower Snake River, and the Wells Dam Reservoir and Chief Joseph Dam Reservoir areas of the Upper-Middle

Columbia River (Fig. 1). These two areas were chosen for study because the former is the geographic location from which data leading to discussions of Altithermal-induced faunal change originated, and the latter area contains the largest sample of mammalian remains of any area in eastern Washington similar in geographic size to the Lower Snake River area.

Mammalian faunal data from 11 archaeological sites along the lower Snake River and 28 archaeological sites along the Upper-Middle Columbia River were compiled (Tables 1 and 2). Data from the former 11 sites span the last 10,000 years while data from the latter 28 sites span the last 7000 years. Well over half of the Upper-Middle Columbia River data derive from the Chief Joseph Dam Reservoir area. These data were originally reported by three temporal periods: 7000 to 4000 B.P., 4000 to 2000 B.P., and 2000 to 100 B.P. (see Livingston 1985 for a summary of the data). Thus I tallied all other faunal data for this area by those three temporal periods despite the fact that many of these data had been assigned to much briefer temporal spans (Chatters 1984a, 1984b, 1986; Lyman 1988). I tallied the Lower Snake River data by 2000 year increments for the entire Holocene to make them readily comparable to those from the Upper-Middle Columbia River area. While such arbitrary definitions of temporal periods may mask significant turnover events or instances of fluctuating biomass (e.g., Peterson 1977; Schindel 1980), by lumping site-specific samples I hoped to eliminate sample size-effects such as larger samples typically being taxonomically richer than smaller samples.

TABLE 1.—Sample size (number of identified specimens [NISP]) per time interval and site in the Lower Snake River area.

Site	Years B.P.					Reference
	10,000–8000	8000–6000	6000–4000	4000–2000	2000–100	
45FR50	289	269	158	57	57	Caulk 1988; Gustafson 1972
45WT2		42	17	17	38	Gustafson 1972
45CO1		44		222		Bense 1972; Nelson et al. 1968
45GA61					648	Lyman, unpubl.[1]
45WT39					808	Yent 1976
45GA17				571		Lyman, unpubl.[1]
45WT41		324	41	161	65	Gustafson 1972
45FR36				53		Schalk 1983
45FR5					4,749	Schalk and Olson 1983; Olson 1983
45FR40					35	Kenaston 1966
45WT134				283.5	296.5	Lyman 1990

[1]Unpublished lab data in possession of the author.

TABLE 2.—Sample size (number of identified specimens [NISP]) per temporal interval and site in the Upper–Middle Columbia River area.

Site	Years B.P. 7000–4000	4000–2000	2000–100	Reference
45DO189		452		Lyman 1988
45DO190/191		109		Chatters 1984b
45DO204	31			Livingston 1985
45DO211		479		Livingston 1985
45DO214		189	400	Livingston 1985
45DO242		609	50	Livingston 1985
45DO243	53	94		Livingston 1985
45DO273	48			Livingston 1985
45DO282	426			Livingston 1985
45DO285		326	196	Livingston 1985
45DO326	283	79	276	Livingston 1985
45DO372		496	42	Chatters 1986
45DO394		31		Chatters 1984b
45OK2		661	1401	Livingston 1985
45OK2A	45	294		Livingston 1985
45OK4	131	790	97	Livingston 1985
45OK11	3,034	540		Livingston 1985
45OK18		31		Livingston 1985
45OK69		104		Chatters 1986
45OK165		31		Chatters 1984b
45OK197			1253	Chatters 1984b
45OK207	105			Chatters 1984b
45OK208	68			Chatters 1984b
45OK250	213	666		Livingston 1985
45OK258		2,332	1,986	Livingston 1985
45OK287/288	182	451	200	Livingston 1985
45OK382	50			Chatters 1986
45OK383		241		Chatters 1986

Taxonomic abundances were tallied as numbers of identified specimens (NISP). While there are sound theoretical reasons for using NISP rather than a different quantitative unit in my analysis (Grayson 1984), the practical reason is that quantitative data are only regularly reported in the form of NISP for the materials I analyze. It is difficult to estimate biomass directly from NISP values,

but traditional interpretations in the geographic area under consideration have used NISP as a fiat measure of animal biomass, and I follow that tradition here.

For both areas only temporally fine-scale assemblages that include more than 30 NISP were used to remove some of the effects of excessively small samples. The total NISP from a site might be 59, but if those specimens were stratigraphically distributed in such a manner that 28 specimens dated between 2000 and 1500 B.P. and 31 specimens dated between 3000 and 2000 B.P., generally only the latter 31 specimens were included in my analysis. By summing site-specific data within each area, I hoped to compile an area-specific faunal history for both areas and to avoid the effects of site-specific depositional hiatuses and temporally fine-scale but small assemblages on my analyses. In a few cases site-specific faunal assemblages span time periods greater than 2000 yr or overlap a temporal boundary. For example, one stratigraphically defined faunal assemblage was dated between 5000 and 3000 B.P. This assemblage was simply halved, with exactly half the NISP per taxon being tallied for the 6000 to 4000 B.P. period and the other half being tallied for the 4000 to 2000 B.P. period. Only one stratigraphically defined fauna (45WT2) that was split into two faunas, each with fewer than 30 NISP, was used in my analysis (Table 1).

I noted the temporal occurrence of each taxon represented at each site in both areas and compiled two tables, one for each geographic area (Tables 3 and 4). A taxon was deemed present for an entire temporal period if its remains dated to any part of that period. I then tallied the total NISP per taxon per area, the number of sites in which a taxon was found per area, the taxonomic richness per temporal period per area, and the total NISP per temporal period per area. Because zooarchaeological data are often at best ordinal scale (Grayson 1984), I use Spearman's rho (r_S) to assess the strength of correlations between selected pairs of variables.

Measures of human occupational intensity such as depositional rates of artifacts are only available for some of the sites I consider. I use such measures when available, and also use frequencies of radiocarbon dates and frequencies of dated sites as measures of occupational intensity. I fully realize such frequencies are at best indirect measures of human occupational intensity because frequencies of dates and dated sites often reflect an archaeologist's research design or preservation of dateable materials (Rick 1987). I therefore supplement these data when possible with information on sites dated by the presence of temporally diagnostic artifacts.

HYPOTHESES AND IMPLICATIONS

Palynological data alone lead to the following hypotheses:

1) Animal biomass should be at its lowest level during the mid-Holocene of eastern Washington.

2) Ungulates such as bison, deer (*Odocoileus* spp.), wapiti (*Cervus elaphus*), and bighorn sheep (*Ovis canadensis*) should display their lowest abundance (and may not be present) during the mid-Holocene.

3) The number of taxa and the frequency of individual taxa, particularly those adapted to relatively moist conditions, should both be at their lowest levels during the mid-Holocene.

4) Changes in taxonomic composition through time should be contemporaneous with changes in climate. However, as noted, available faunal data are from archaeological contexts wherein the human selection of prey may significantly influence the faunal record. It is important, therefore, to consider the possible combined influences of human behaviors and increased aridity on faunal abundances.

Human responses to climatic change.—Resources can become scarce through an actual decrease in frequency or through the effect of increasing competition for resources as the relative frequency of predators/consumers increases. Ecologists believe that niche breadth tends to increase as resource availability decreases (Pianka 1978:256) and that when high-value prey are rare, diet expands to include more low-value prey (Pulliam 1981:65). Anthropological research indicates human hunter-gatherers tend to respond in such manners (e.g., Belovsky 1987, 1988; Bettinger 1991; Colson 1979; Earle 1980; Keene 1985; Hayden 1981; O'Connell and Hawkes 1981; Simms 1987; Winterhalder 1986). Thus, small mammal resources should be most abundant relative to large mammal resources during the mid-Holocene when the latter were supposedly depleted. Secondly, the diversity of mammalian resources should be highest during the mid-Holocene as all resources were exploited with more or less equal intensity rather than a selected few.

The effect of increased intensity of human occupation on hypotheses (1), (2), and (3) is for those hypotheses to have reverse implications; that is, frequencies of animal remains and taxonomic richness should increase as people shift adaptive strategies in response to increased aridity despite the fact that naturally available mammalian biomass may be decreasing in abundance. As dietary breadth increases, number of taxa (richness):NISP ratios should increase (e.g., from 1:10 to 2:10). If there are also indications that fewer sites were occupied during the mid-Holocene, and that those sites that were occupied were more intensively occupied during the mid-Holocene than before or after that time, then, given the argument presented here, these kinds of changes in these ratios can be taken as evidence for a decrease in naturally available biomass. However, if sites were occupied with a lower level of intensity during the mid-Holocene than before or after that time, the ratios described above may be similar between time periods if animal biomass was relatively high during the early and late Holocene and low during the mid-Holocene. That is so because lower occupational intensity suggests a lower level of competition than does high occupational intensity.

Faunal turnover should be indicated by discontinuous or incomplete temporal representation of taxa through the Holocene. However, if sample size, measured as the number of sites producing remains of a taxon or measured as the NISP per taxon, is influencing the apparent temporal range over which a taxon is found, then I expect to find statistically significant positive correlations between such variable pairs as taxonomic richness per temporal increment and NISP per

temporal increment, NISP per taxon per temporal increment and number of temporal increments in which a taxon is found, and number of sites producing remains of a taxon and number of temporal increments in which a taxon is found. Significant negative correlations between the number of gaps in the temporal distribution of a taxon and NISP per taxon are also expected if the available faunal data tend to monitor sample size rather than faunal turnover.

Faunal responses to drought.—Van Vuren (1987: see also Van Vuren 1984; Van Vuren and Bray 1983, 1985, 1986) suggests that the amount and distribution of herbaceous vegetation were the most significant factors controlling the abundance of bison during the Holocene of eastern Washington. Decreases in abundance of herbaceous vegetation, increased space between patches of herbaceous vegetation, or both, would result in a decrease in the population of bison and perhaps their local extirpation. McCorquodale et al. (1986) report that wapiti typically do not occupy arid areas void of extensive thermal cover (typically forest) due to the high cost of thermoregulation. They indicate, however, that wapiti can occupy big sagebrush *(Artemisia tridentata)* steppe habitats where adequate forage is available and they are not frequently disturbed. Increased hunting pressure brought on by decreases in other large mammals might, then, prompt wapiti to abandon the sage-steppe vegetation zone. The size and distribution of populations of bighorn sheep in southeastern Washington and southern British Columbia today seem closely related to forage quality (Estes 1979; Pitt and Wikeem 1978). Drought-induced reduction in forage quantity and quality has been shown to correlate with higher than normal lamb mortality (Johnson 1983), and thus populations probably would decrease significantly if arid conditions were to persist over many years. Pronghorn do not require free-standing water when forbs are abundant and have high moisture content, but during dry periods water consumption by pronghorn is high (Beale and Smith 1970). When drought reduces the quality of forage, pronghorn populations decline (Kitchen and O'Gara 1982).

Deer are polytypic in eastern Washington (both *Odocoileus hemionus* and *O. virginianus* are present), and while probably reduced in abundance during prolonged periods of aridity, this taxon would perhaps not have completely disappeared from that region during the mid-Holocene. Large carnivores such as bears *(Ursus* spp.) and cougars *(Felis concolor)* are so rare in archaeological assemblages from eastern Washington that it is difficult to determine if their absence is due to environmental conditions or to the fact that they were rarely taken by prehistoric hunters (e.g., Lyman 1986b). When their remains are recovered from archaeological contexts, they may thus be rather unreliable indicators of faunal change. At least some small mammalian taxa, such as the pygmy rabbit *(Brachylagus idahoensis)*, seem to have increased in abundance and range during the mid-Holocene, while other small taxa, such as the pocket gopher *(Thomomys talpoides)* seem to have decreased in abundance at that time (Lyman 1991a).

Finally, if mammalian herbivores decreased in abundance during the mid-Holocene Altithermal climatic interval, it seems likely that the frequency of non-human mammalian carnivores would have similarly decreased. That is so because of lowered food supplies for the latter taxa, some of which feed not only on prey they have hunted and killed, but also on carrion. However, because mammalian

carnivores tend to occur high in trophic levels, they are naturally rare, and interpretations of prehistoric changes in their abundance must be viewed with caution.

RESULTS AND DISCUSSION

Lower Snake River. —Intensity of occupation of sites in the Lower Snake River area is difficult to assess because the volume excavated per stratigraphic unit has seldom been reported. Interestingly, the single site that spans the entire Holocene (Marmes Rockshelter) produced a series of radiocarbon dates that has been interpreted by Sheppard et al. (1987) as indicating minimal occupation of that site between 6700 and 1900 B.P. I compiled all radiocarbon dates from sites in the Lower Snake River area known to me. Ten of the eleven sites producing faunal data have associated radiocarbon dates (45GA61 does not), and four additional sites not contributing faunal data to my analysis but found in this area have associated radiocarbon dates (45FR39, 45FR47, 45WT36, 45WW61). The frequency distribution of the 76 total dates, by 2000 year period, is shown in Fig. 2. Dates on charcoal are distinguished from those on freshwater mussel shell due to the debate concerning the validity of the latter (Chatters 1986; Sheppard et al. 1987). In this paper I presume shell dates are valid. Frequencies of dates per 2000 year period suggest stability of human occupational intensity until the last 2000 years, after which the intensity of occupation increased markedly.

Frequencies of dated sites per 2000 year period suggest slightly lower occupational intensity between 10,000 and 8000 B.P. and between 6000 and 4000 B.P. relative to the 10,000 to 8000 B.P. and 4000 to 2000 B.P. periods (Fig. 2). I suspect this results from the small sample of radiometrically dated sites for the early Holocene as there are three undated assemblages of artifacts temporally diagnostic of the early Holocene in this area (Brauner et al. 1990; Rice 1972). Thus there is no strong indication in the archaeological record for the Lower Snake River area of fluctuation in occupational intensity until the latest Holocene. Evidence of mid-Holocene change in occupational intensity may eventually be found in the Lower Snake as Chatters (1982) and Galm et al. (1981) present evidence indicating that the mid-Holocene absence of reliable water sources in the central, most arid part of the Columbia Basin resulted in human abandonment of that area during the Altithermal, and they suggest people moved to the canyons of major rivers at this time.

The total NISP per taxon correlates with both the number of temporal increments in which a taxon is found ($r_S = 0.66$, $p = 0.0005$) and with the number of sites producing remains of a taxon ($r_S = 0.76$, $p = 0.0001$), suggesting any apparent faunal turnover is probably a function of sample size (Table 3). The number of breaks in temporal continuity is correlated inversely with the total NISP per taxon ($r_S = -0.42$, $p = 0.02$) but perhaps not significantly with the number of sites producing remains of a taxon ($r_S = -0.30$, $p = 0.09$). These latter two coefficients also suggest caution is warranted before concluding faunal turnover took place. For example, taxa such as the western harvest mouse *(Reithrodontomys megalotis)* and the western jumping mouse *(Zapus princeps)*, both of which occur only during the latest Holocene, and pygmy rabbits, wolves *(Canis latrans)*, river
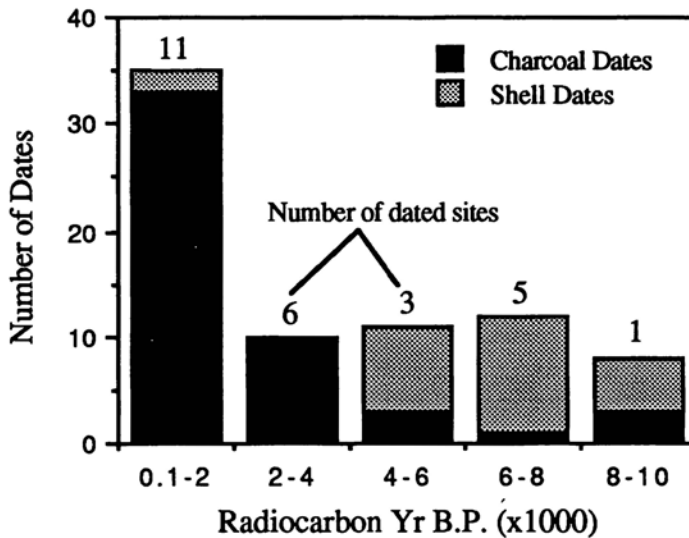
FIG. 2.—Frequencies of radiocarbon dates and dated sites in the Lower Snake River area.

otters *(Lutra canadensis)*, and raccoons *(Procyon lotor)*, which are reported only for the last 4000 years may not be represented in earlier time periods because 87.2% of the total Holocene NISP dates to the last 4000 years.

Further evidence that sample size is creating indications of faunal turnover is found in the fact that adding the data in Table 4 to that in Table 3 results in the omission of mid-Holocene gaps in the occurrence of beaver *(Castor canadensis)*, vole *(Microtus* sp.), Great Basin pocket mouse *(Perognathus parvus)*, deer mouse *(Peromyscus maniculatus)*, bobcat/lynx *(Lynx* sp.), marten *(Martes americana)*, badger *(Taxidea taxus)*, and bighorn sheep. Other data indicate the red fox *(Vulpes vulpes)* also was present in eastern Washington throughout the Holocene (Lyman 1991b). While summing the two areal samples significantly increases the geographic area represented, it indicates Holocene faunal turnover in eastern Washington was probably minimal. Thus, instances of faunal turnover might be found in Table 3, but those are masked by the number of faunal specimens identified (NISP) and the number of sites sampled. The only clear evidence that faunal turnover took place involves the arctic fox *(Alopex lagopus)*, which is recorded only for the early Holocene even though only 3.1% of the total Holocene NISP for the Lower Snake River area falls in that time period.

Taxonomic richness per temporal period ranges from a high of 30 between 2000 and 100 B.P. to a low of 15 between 6000 and 4000 B.P. (Table 3). In fact, taxonomic richness decreases steadily across the three temporal periods spanning the early and mid-Holocene, increasing only after 4000 B.P. This temporal synchrony with first increased aridity and then with decreased aridity conforms with hypothesis (4). Richness is lowest between 8000 and 4000 B.P., coincident with the Altithermal period, precisely when hypothesis (3) suggests richness

should be lowest. Before those hypotheses are accepted, however, sample-size effects must be considered.

TABLE 3.—Mammalian fauna for Lower Snake River. Values are number of identified specimens (NISP).

	Years B.P.						
Taxon	10,000–8000	8000–6000	6000–4000	4000–2000	2000–100	NISP	N of Sites
SMALL MAMMALS NOT USED AS FOOD							
Spermophilus washingtoni (Washington ground squirrel)		17	15	94.5	132.5	259	8
Spermophilus columbianus (Columbian ground squirrel)		72	4	86	10	172	2
Thomomys talpoides (northern pocket gopher)	68	55	32	216	177	548	9
Perognathus parvus (Great Basin pocket mouse)	38			1.5	190.5	230	5
Reithrodontomys megalotis (Western harvest mouse)					165	165	1
Peromyscus maniculatus (deer mouse)	35	2		1	5	43	4
Neotoma cinerea (bushy–tailed woodrat)	23	3	4	2.5	13.5	46	4
Microtus spp. (vole)	14	2		12	17	45	9
Lagurus curtatus (sagebrush vole)	4	4	3	15.5	13.5	40	5
Zapus princeps (western jumping mouse)					2	2	1
CARNIVORES							
Canis cf. *latrans* (coyote)	5	36	5	37.5	85.5	169	10
Canus lupus (gray wolf)				1	2	3	2
Alopex lagopus (arctic fox)	6					6	1
Vulpes vulpes (red fox)	5			0.5	0.5	6	2
Ursus americanus (black bear)					1	1	1

| Taxon | Years B.P. | | | | | NISP | N of Sites |
	10,000–8000	8000–6000	6000–4000	4000–2000	2000–100		
Procyon lotor (raccoon)				1	1	2	2
Martes americana (marten)	3					3	1
Mustela frenata (long–tailed weasel)	4				3	7	3
Taxidea taxus (badger)		1		3	12	16	4
Lutra canadensis (river otter)				1.5	1.5	3	3
Lynx sp. (bobcat/lynx)	1	1		5.5	5.5	13	6
MAMMALS USED AS FOOD							
Brachylagus idahoensis (pygmy cottontail)				1	47	48	2
Sylvilagus nuttallii (Nuttall's cottontail)	2	23	13	34	258	330	8
Lepus sp. (jackrabbit)	12	36	5	5	2,808	2,866	7
Marmota cf. *flaviventris* (yellow-bellied marmot)	14	10	1	3.5	3.5	32	4
Castor canadensis (beaver)	2		1	22.5	3.5	29	6
Ondatra zibethicus (muskrat)	2	4	2	2	7	17	3
Cervus elaphus (wapiti)	6	99	8	47.5	479.5	640	11
Odocoileus spp. (deer)	29	226	57	284.5	937.5	1,534	11
Antilocapra americana (pronghorn antelope)	16	84	65.5	112.5	1,247	1,525	10
Bison bison (bison)			0.5	367.5	28	396	7
Ovis canadensis (mountain sheep)		4		5.5	39.5	49	6
NISP	289	679	216	1,364.5	6,696.5	9,245	
N of Sites	1	4	3	7	8		
Richness	20	18	15	26	30		
Diversity	2.469	2.167	1.962	2.158	1.873		

TABLE 4.—Mammalian fauna for Upper–Middle Columbia River. Values are number of identified specimens (NISP).

| | Years B.P. | | | | |
Taxon	7000–4000	4000–2000	2000–100	NISP	N of Sites
SMALL MAMMALS NOT USED AS FOOD					
Sorex sp. (shrew)		4		4	3
Aplodontidae (mountain beaver)		2		2	1
Eutamias sp. (chipmunk)		1		1	1
Spermophilus sp. (ground squirrel)	12	85	22	119	13
Glaucomys sp. (flying squirrel)		1		1	1
Thomomys talpoides (northern pocket gopher)	1,201	1,576	253	3,031	24
Perognathus parvus (Great Basin pocket mouse)	341	429	198	968	20
Reithrodontomys megalotis (western harvest mouse)		1	1	2	1
Peromyscus maniculatus (deer mouse)	22	87	25	134	17
Neotoma cinerea (bushy–tailed woodrat)	3	9	8	20	7
Microtus spp. (vole)	23	82	35	140	18
Lagurus curtatus (sagebrush vole)	21	73	65	159	15
CARNIVORES					
Canis cf. *latrans* (coyote)	44	131	45	220	18
Canis lupus (gray wolf)	3	5	1	9	4
Vulpes vulpes (red fox)		7		7	3
Ursus americanus (black bear)	8	9	4	21	5
Ursus arctos (grizzly bear)		1		1	1

Taxon	Years B.P.			NISP	N of Sites
	7000–4000	4000–2000	2000–100		
Procyon lotor (raccoon)		1		1	1
Martes americana (marten)	2	6		8	3
Martes pennanti (fisher)		3	4	7	1
Mustela frenata (long–tailed weasel)		4	4	8	4
Taxidea taxus (badger)	55	4	5	64	7
Mephitis mephitis (striped skunk)	8	2		10	2
Lutra canadensis (river otter)			7	7	2
Felis concolor (cougar)		4		4	1
Lynx cf. *rufus* (bobcat)	5	3	1	9	2
MAMMALS USED AS FOOD					
Sylvilagus cf. *nuttallii* (Nuttall's cottontail)	11	5	17	33	9
Lepus sp. (jackrabbit)	16	30	9	55	13
Marmota cf. *flaviventris* (yellow–bellied marmot)	397	315	194	906	24
Castor canadensis (beaver)	10	44	15	69	12
Ondatra zibethicus (muskrat)	17	4	2	23	4
Erethizon dorsatum (porcupine)	68	8	1	77	4
Cervus elaphus (wapiti)	47	102	95	244	17
Odocoileus spp. (deer)	1,837	4,692	3,838	10,367	26
Antilocapra americana (pronghorn antelope)	95	146	490	731	17

TABLE 4.—Mammalian fauna for Upper–Middle Columbia River. Values are number of identified specimens (NISP). (continued)

Taxon	Years B.P.			NISP	N of Sites
	7000–4000	4000–2000	2000–100		
Bison bison (bison)	11	26	2	39	5
Ovis canadensis (mountain sheep)	411	1,103	560	2,074	24
NISP	4,669	9,005	5,901	19,575	
N of Sites	13	21	10		
Richness	25	36	27		
Diversity	1.868	1.643	1.138		

Both taxonomic richness per temporal period and the number of sites producing faunal remains per temporal period in the Lower Snake River area are correlated with the total NISP per temporal period (for both, $r_S = 0.90$, $p = 0.07$). These coefficients suggest richness may be a function of sample size and thus cannot be used in any straightforward manner to infer natural faunal change or change in human subsistence. As suggested earlier, if richness was lower during the mid-Holocene, human foragers may broaden their niche and take additional animal resources, a more diverse array of mammalian resources, more smaller mammalian resources, or some combination of these. Shannon diversity index values for the total mammalian fauna per temporal period for the Lower Snake and Upper-Middle Columbia faunas (Tables 3 and 4), when considered together, correlate with sample size ($r_S = -0.738$; $p = 0.05$), indicating mid-Holocene diversities appear to be more even than early or late Holocene diversities simply because the mid-Holocene assemblages are small. Diversity of mammalian faunas, then, provides no trustworthy evidence for changes in mammalian faunas or human subsistence strategies.

Prehistoric hunters probably did not, however, take all of the taxa listed in Tables 3 and 4, but it is difficult to determine from the published record precisely which taxa were regularly taken and which specimens listed in the tables were accumulated and deposited by human hunters. It seems likely that many specimens of the fossorial taxa such as gophers and ground squirrels (*Spermophilus* sp.) were naturally deposited, and perhaps some of the carnivore remains represent individuals that died of natural causes on the sites. Marmots (*Marmota flaviventris*), hares (*Lepus* sp.), rabbits (*Brachylagus idahoensis* and *Sylvilagus nuttallii*), beavers, and muskrats (*Ondatra zibethicus*) were clearly exploited by prehistoric peoples in eastern Washington, as were ungulates, based on archaeological evidence such as butchering marks. Considering only those non-carnivorous taxa which I believe were exploited by people (see Table 3), relative abundances of

the small taxa, from earliest to latest temporal period, are: 11.1%, 10.8%, 10.2%, 5.1%, and 46.7%. These proportions do not correlate with the NISP per temporal period ($r_S = 0.3$; $p > 0.2$) or with the number of sites producing faunal remains per temporal period ($r_S = 0.1$, $p > 0.2$), suggesting they are not a function of sample size. These relative abundances thus provide circumstantial evidence that prehistoric peoples did not shift to taking more smaller mammals during the mid-Holocene, but in fact decreased the frequency with which they were taken until the last 2000 years when, apparently, increased human populations (as indicated by measures of occupational intensity) resulted in increased competition and such small mammals became very important in the subsistence quest.

The NISP of carnivore remains per temporal period is correlated with both the total NISP per time period ($r_S = 1.0$, $p = 0.05$) and the number of sites producing mammal remains per time period ($r_S = 0.90$, $p = 0.10$), suggesting frequencies of carnivore remains are a function of sample size. (Note that in all cases the arctic fox is not included.) The diversity of carnivore taxa per time period is not correlated with the carnivore NISP per time period ($r_S = 0.20$, $p > 0.20$). Carnivore diversity is highest during the 10,000 to 8000 B.P. period (diversity = 1.507), and lowest from 8000 to 6000 B.P. (diversity = 0.241). It then increases between 6000 and 4000 B.P. (diversity = 0.688), and is higher still in the late Holocene (4000 to 2000 B.P. diversity = 0.987; 2000 to 100 B.P. diversity = 1.099). Carnivore richness per period is not correlated with carnivore NISP per period or the number of sites producing mammal remains per period ($r_S = 0.825$, $p > 0.1$ for both). The carnivore remains make up, from earliest to latest temporal period, 6.2%, 5.6%, 3.0%, 3.7%, and 1.8% of the total mammal remains. I suspect that these statistics are reflecting (a) relatively low carnivore biomass during the middle Holocene, and (b) decreased hunting of carnivores during the late Holocene, especially during the last 2000 years, as human foragers turned to other resources due to competition (see below).

Relative frequencies of ungulates increase through the Holocene (until 2000 B.P.) when only taxa utilized as food are considered; from earliest to latest these are: 88.9%, 89.2%, 89.8%, 94.9%, and 53.3%. This does not necessarily indicate that hypothesis (2) is wrong, but only that humans were not responding to hypothesized changes in the biomass of large mammals by taking such mammals in proportion to their hypothesized lower natural abundance. The drop in relative abundance of ungulates between 2000 and 100 B.P. corresponds to the increase in small mammal resources at that time. Again, this could well reflect the increased competition for resources that may have occurred as a result of increased intensity of human occupation at this time (refer to Fig. 2).

Ungulate NISP per temporal increment is correlated with total NISP of all mammals per temporal increment ($r_S = 0.90$, $p = 0.07$), suggesting ungulate NISP may be a function of sample size. From earliest to latest temporal period, ungulate remains make up 17.6%, 60.8%, 60.6%, 59.9%, and 40.8% of the total mammalian NISP. These proportions are precisely the *opposite* of that indicated in hypothesis (2); they do not correlate with total NISP ($r_S = 0.2$; $p > 0.2$) and thus do not seem to be a function of sample size. Apparently Gustafson (1972) was correct in noting that relatively more ungulate remains were deposited during the mid-Holocene than prior or subsequent to that time, but contrary to his belief those higher

frequencies do not appear to be attributable to increased human occupational intensity. I can offer no empirically warranted explanation for the changing frequencies of ungulate remains relative to the total mammalian fauna, but wonder if they might be attributable to a shift in human subsistence practices resulting in small mammals being gradually replaced by plants and fish during the mid-Holocene, which would result in fewer small mammal remains being deposited, especially during the mid-Holocene. There are, however, too few botanical and fish data to assess this possibility directly. Archaeological evidence indicates there was an increase in the relative abundance of plant processing and fishing tools during the mid-Holocene (e.g., Bense 1972; Galm et al. 1981) which could be taken as circumstantial evidence for low availability of mammalian biomass, especially small taxa (and carnivores?), during the mid-Holocene. After 4000 B.P., people continued to increase their exploitation of plants and fish, largely omitting small mammals and focusing more on large mammals, particularly ungulates.

Shannon diversity index values for only those mammals clearly exploited as food resources are, from earliest to latest: 1.725, 1.478, 1.349, 1.471, and 1.362. These do not correlate with NISP per temporal period (r_S = -0.4, $p>0.2$), and thus seem to indicate decreasing diversity and increasing specialization on mammals between 10,000 and 4000 B.P., with only slightly more diversity between 4000 and 2000 B.P. after which diversity decreases again, perhaps, as suggested, due to increasing utilization of fish and plant resources.

Upper-Middle Columbia River.—Miss (1985:274) suggests that rates of accumulation of bone and lithic artifacts (measured as density of each per 1000 year temporal period) are "consistent after 4000 yr B.P." in the aggregated Chief Joseph Dam Reservoir sites. Prior to that time accumulation of artifacts was slower. If those accumulation rates are indicative of occupational intensity, then such intensity was lower prior to 4000 B.P. than after that time. Similar analyses of the Wells Reservoir materials cannot be performed, but the total radiocarbon dates for the Upper-Middle Columbia River area seem to conform to Miss's (1985) interpretation. As with the lower Snake River radiocarbon record, I compiled all radiocarbon dates for sites in the Upper–Middle Columbia River area known to me regardless of whether or not those dates were from sites producing faunal remains for this study. That resulted in 229 dates from 53 sites; 25 of the 28 sites contributing faunal data to my analysis have radiocarbon dates. As shown in Fig. 3, the frequency of radiocarbon dates is lowest between 7000 and 4000 B.P., but those frequencies are essentially equal for the 4000 to 2000 B.P. and 2000 to 100 B.P. time periods. As well, the frequencies of dated sites per temporal period suggest fewer sites were occupied prior to 4000 B.P. than after that time, and that the number of occupied sites was essentially the same for the latest two temporal periods. Thus I take occupational intensity to have been somewhat lower between 7000 and 4000 B.P. than subsequent to 4000 B.P.

The total NISP for this area is larger than that for the Lower Snake River area, but the Upper-Middle Columbia River faunal record spans only the last 70% of the Holocene. Presuming this means that the Upper-Middle Columbia River sample is more representative of the mid- and late Holocene than the Lower Snake

River sample is, there should be less evidence of sample-size effects in this set of assemblages. NISP per taxon is, however, correlated with the number of sites producing remains of a taxon (r_S = 0.97, $p<0.0001$) and with the number of temporal periods in which a taxon is represented (r_S = 0.85, $p<0.0001$). Similarly, the number of sites producing remains of a taxon is correlated with the number of temporal periods in which a taxon is found (r_S = 0.81, $p<0.0001$). These correlations suggest the appearance of faunal turnover in Table 4 may be the result of sample size. The single possible exception is the occurrence of river otter between 2000 and 100 B.P. because only 30% of the total NISP dates to that time period and the 4000 to 2000 B.P. sample is almost 53% larger than the 2000 to 100 B.P. sample.
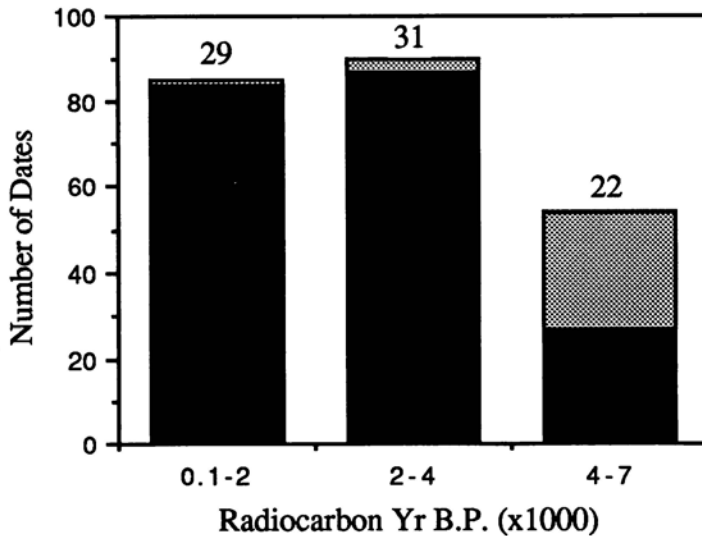
FIG. 3.—Frequencies of radiocarbon dates and dated sites in the Upper–Middle Columbia River area. See legend for Figure 2.

Three taxa represented in the two latest samples are not represented in the 7000 to 4000 B.P. sample: western harvest mouse, fisher *(Martes pennanti)*, and long-tailed weasel *(Mustela frenata)*. As well, two taxa represented in the earliest samples are not represented between 4000 and 100 B.P.: striped skunk *(Mephitis mephitis)* and marten. Five of the six taxa (including river otters) mentioned thus far are mustelids, and it is perhaps significant, then, that one of the Wells Reservoir sites not included in my analysis or in Table 4 due to small sample size (NISP <30) produced a single specimen of wolverine *(Gulo luscus)* dating between 7000 and 4000 B.P. (Chatters 1986). The significance of this is probably not that six of these seven taxa are mustelids, but rather that they are carnivores, taxa which are typically rare in eastern Washington archaeological sites. For example, four of the eight taxa represented only in the 4000 to 2000 B.P. assemblage are carnivores: cougar *(Felis concolor)*, raccoon, grizzly bear *(Ursus arctos)*, and red fox. That

is, of the 14 taxa not continuously represented between 7000 and 100 B.P., nine (64%) are carnivores (10 of 15, or 67%, if the wolverine is included). Thus if faunal turnover took place along the Upper-Middle Columbia River during the last 7000 years, I do not believe it is clearly reflected in Table 4. What appears to be faunal turnover in this table is more likely a reflection of sample size effects.

Carnivore NISP per temporal period does not reflect the total NISP per temporal period (I did not calculate correlation coefficients because there are only three cases), but carnivore NISP per period does reflect the number of sites sampled per period. Neither carnivore richness per period nor carnivore diversity per period mirrors carnivore NISP per period. Carnivore diversity is greatest between 7000 and 4000 B.P. (diversity = 1.366), and progressively decreases through time (diversity between 4000 and 2000 B.P. = 1.223; diversity between 2000 and 100 B.P. = 1.101). As in the Lower Snake River area samples, carnivores decrease in abundance from the middle Holocene (7000 to 4000 B.P.) when they account for 2.7% of all mammalian remains, to 2.0% between 4000 and 2000 B.P. and 1.2% between 2000 and 100 B.P. Faunal turnover and changes in biomass are not apparent here, but the decreased abundance of carnivores may reflect changes in human subsistence (see below).

While I did not calculate correlation coefficients here because there are only three cases, it is important to note that taxonomic richness per temporal period is perfectly correlated with total NISP per temporal increment (Table 4). This suggests richness per temporal period may be an effect of sample size. Recall that optimal foraging theory suggests dietary breadth (richness and/or diversity) will increase as resources become scarce or as competition for resources increases. Thus, during the mid-Holocene along the Upper-Middle Columbia, if resources were scarce but occupational intensity was relatively low, dietary breadth at that time may have been similar to dietary breadth during the late Holocene (last 4000 years) when resources were more abundant but occupational intensity was relatively high. But the diversity of mammalian food resources decreases from the mid-Holocene to the latest Holocene; Shannon diversity index values for only those taxa used as food (same taxa as for Lower Snake), from earliest to latest are: 1.084, 0.925, 0.935. That could be taken as evidence that mammalian biomass was low during the mid-Holocene, and people broadened their niche by taking a more diverse set of mammalian resources during this time, but those index values are perfectly inversely correlated with the NISP of taxa used as food per temporal period, indicating that the smaller the NISP the greater the diversity index value.

The proportions of mammals used as food that are small taxa are from earliest to latest 9.7%, 4.4%, and 4.0%. These relative frequencies do not correlate with the total NISP per temporal period, suggesting they are not a function of sample size. They indicate more small mammals were used as food between 7000 and 4000 B.P. than subsequently, and this might be taken as circumstantial evidence for a mid-Holocene decrease in naturally available mammalian biomass. These proportions do not seem to be a result of intensity of human occupation as occupational intensity was apparently low during the mid-Holocene. And, as with the Lower Snake River sample, when only mammalian taxa used as food are con-

sidered, the relative abundance of ungulates increases from earliest to latest suggesting that a more specialized economy focusing on ungulates emerged in the last 4000 years, at least in terms of mammalian resources.

It was suggested that in the Lower Snake River area, fish and plants became more important resources with the emergence of Altithermal climates and that these resources retained some importance after 4000 B.P. Of the 10,362 fish remains identified from sites in the Upper-Middle Columbia River area, 32% date between 7000 and 4000 B.P., 57.3% date between 4000 and 2000 B.P., and 10.7% date between 2000 and 100 B.P. (fish data compiled like mammalian data, but without regard for specific site sample sizes). Presuming fish were used as food by prehistoric human occupants of the area (fish were important ethnographically), from earliest to latest fish make up 28%, 47.9%, and 38.8% of the summed food mammal and fish remains. These proportions suggest fish were a more important food resource after 4000 B.P. than during the mid-Holocene, but their importance during the early Holocene in this area is unknown. Thus it seems small mammals decreased in importance while large mammals, especially ungulates, and fish increased in importance in the Upper-Middle Columbia River area after the mid-Holocene.

Absolute frequencies of ungulate remains per temporal period are perfectly correlated with the total mammalian NISP, but their relative frequencies in the complete faunas are, from earliest to latest, 51.4%, 67.4%, and 84.5%, and these do not correlate with the total mammalian NISP. These values align with hypothesis (2), that ungulate biomass was at its lowest during the mid-Holocene. Why these frequencies increase through time probably has to do with competition. The low occupational intensity and perhaps low mammalian biomass between 7000 and 4000 B.P resulted in ungulates representing only about half of the deposited mammalian remains. After 4000 B.P., human occupational intensity increased, competition increased, and ungulate biomass increased as well. The relative frequencies of ungulate remains suggest the latter may have out-paced the former two variables, permitting an increasingly specialized mammalian subsistence base consisting largely of ungulates.

CONCLUSIONS

The possible responses of mammalian communities to changing Holocene climates and of human hunter-gatherers to fluctuating resource abundances led researchers working 30 years ago in eastern Washington to suggest that (a) mammalian biomass was at its lowest level during a mid-Holocene period of relative aridity and (b) that humans would respond by taking a broader range of resources. Those suggestions are easily phrased as hypotheses, but in order to be tested they must take into account the effects of sample size on measures of taxonomic richness, diversity, and turnover, and the effects of human occupational intensity on measures of animal abundances.

Frequencies of radiocarbon dates and of dated sites indicate human occupational intensity of the Lower Snake River area was relatively stable from 10,000 B.P. until about 2000 B.P. Faunal turnover during the Holocene there is largely

obscured by sample-size effects but minimally entailed loss of the arctic fox in the early Holocene. Mammalian biomass appears to have been at its lowest level between 6000 and 4000 B.P., having decreased steadily since the end of the Pleistocene, much as was suggested 30 years ago, but problems of sample size make such a conclusion tenuous. Human occupational intensity does not account for a perceived steady increase in the relative abundance of ungulate remains between 10,000 and 2000 B.P.; rather, that increase may be a function of decreased deposition of the remains of non-ungulate mammals, especially those small mammals such as leporids and marmots that were humanly exploited. Gradually and throughout the Holocene human foragers took fewer and fewer small mammals. Archaeological data indicate the gradually increasing focus on ungulates seems to have accompanied a shift in subsistence pursuits to increased reliance on plant and fish resources in the last 4000 years.

Rates of artifact deposition and frequencies of radiocarbon dates and dated sites indicate the Upper-Middle Columbia River area was less intensively occupied between 7000 and 4000 B.P. than after that time. Indications of faunal turnover there involve mostly carnivores, which are rare naturally and archaeologically, and thus seem to provide poor indications of change in the taxonomic composition of the mammalian community. Stability in abundances of faunal remains relative to site frequencies and taxonomic richness can be accounted for by a combination of low occupational intensity and low mammal biomass during the mid-Holocene, and by a combination of higher occupational intensity and higher mammalian biomass during the last 4000 years. As with the Lower Snake River fauna, human foragers living along the Upper-Middle Columbia River seem to have slowly shifted their mid-Holocene subsistence pursuits to taking more ungulates and fish in the late Holocene.

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BOOK REVIEW

The Mixe of Oaxaca. Religion, Ritual, and Healing. Frank J. Lippo. Austin, Texas: University of Texas Press, 1991. Pp. xx, 253. $35.00 (clothbound). ISBN 0-292-76517-7.

The product of extensive field work spanning five trips (one of which lasted 16 months) and thorough bibliographic research, this book is indeed a welcome contribution to ethnobotany and anthropology of Oaxaca and particularly of one of the most poorly known native cultures of Mexico. It is not frequent that an Indian group of 76,000 individuals living in some 50 villages in a country where so much anthropological work has been carried on for so long has escaped such dedicated study as that apparent in this volume. As Dr. Munro Edmonson, anthropologist at Tulane University, states: "Mixe culture and Lippo's description of it stands alone in the Middle American ethnography ... . This work fills a gap in the literature for which there is no alternative and no competition."

A long introduction acquaints the reader to the methodology used in the field studies. Then follows nine chapters: Social Organization and Kinship; Subsistence Agriculture; Religious Belief System; Calendrical System; Ritual Behaviour; Rites of Passage; Village Festivals; Medical Concepts and Behaviour; Postscript. There are three appendices: Mixe Region; Mixe Phonemes; Mixe Texts. Fifteen pages are devoted to two lists of names: one of Mixe terms, the other Spanish and Nahuatl words. The bibliography of literature cited enumerates 306 items. There is a detailed index.

This masterly book is beautifully published and conservatively priced.

Richard Evans Schultes
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