

MAKING CULTURAL ECOLOGY RELEVANT TO MESOLITHIC RESEARCH – III: PERSPECTIVES FOR ECONOMIC RECONSTRUCTION BASED ON FAUNA REFUSE AND SUBSISTENCE EQUIPMENT FROM TWO IÑUPIAT HOUSES AT UTQIAGVIK (ALASKA)

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Abstract: The comparative analyses of fauna assemblages and suites of subsistence equipment from the systemic context, the catastrophically terminated Mound 44 house, and the archaeological context, the normally abandoned houses of Mound 8, Utqiagvik, Alaska, indicate that both provide resolution of prehistoric economic systems. While the former is more sensitive and behaviourally reliable than the latter, an integration of both is needed for an optimal reconstruction of prehistoric economies.

KEYWORDS: Cultural ecology, archaeozoology, subsistence equipment, Alaska Eskimo, ethno-archaeology, Utqiagvik.

1. INTRODUCTION

Reconstructing prehistoric economic systems from archaeological remains has proven both elusive and controversial (Binford, 1978a; Jochim, 1976). Essentially three, sometimes combined, approaches have been used: 1. fauna remains; 2. extant subsistence equipment; and 3. land-use patterns/traditional occupancy coupled with an explicit or implicit reliance on the carrying capacity model (Dewar, 1984; Glassow, 1978) and/or the 'optimal foraging strategy' (Horn, 1968; Heffley, 1981; Pyke et al., 1977; Smith, 1983; Winterhalder, 1981; 1983) and/or 'site catchment analysis' (Roper, 1979; Vita-Finzi & Higgs, 1970). Each of these approaches, individually or in combination, has its theoretical limitations and practical difficulties, which have led some cultural ecologists to despair of ever finding reliable and replicable resolution of the economies of prehistoric peoples. One source of this desperation is the growing realization of the disparity between the on-going living situation in the life cycle and therefore the economic cycle, of a prehistoric people and that which is left behind, preserved and later recovered by archaeologists as artifacts for analysis and interpretation. This difference has been identified and labelled by Schiffer as the systemic context vs. the archaeological context (Schiffer, 1972). The mechanisms and means by which the former is transformed into the latter are the site formation processes, which have been the subject of much recent study in order to gain analytic control of the hierarchical role played by causative variables (Binford, 1972; 1978b; 1980; 1982; 1983; 1987; Binford & Bertram, 1977; Gifford, 1978; 1980;

Hall, 1981; Newell, 1981a,b; 1984; 1986; 1987; in press a and others).

Despite the considerable progress made to date in interpreting the archaeological record in terms of human behaviour and activities at the intra-site level (Binford, 1980; 1981a,b; 1987), reliable reconstructions of prehistoric economies have remained elusive in their development.

The primary reason for this deficiency is the paradigmatic cul-de-sac into which much of archaeozoological studies have manoeuvred themselves, while pursuing geographic/environmental deterministic arguments (e.g. Aaris-Sørensen, 1980; Degerbøl, 1933; 1964; Møhl, 1971; 1979; see Andersen et al., in press; Newell, in press b) or propagating their craft as an independent discipline (Clason, 1975). Secondly, subsistence equipment, following a long period of benign neglect as an economically relevant class of material culture, has only recently become the subject of scientific interest and analysis (Oswalt, 1976) and following his lead Newell & Constandse-Westermann (1984) and Torrence (1983). In none of the above cases was the link to the total economy of a particular society investigated. Another reason for this deficiency is the scarcity of comparative archaeological contexts in which relevant variables between the living situation and the archaeological context are measurable through analytical control over the site-formation processes and direct historically continuous cultural-historical processes which account for diachronic change. Such a fortunate controlled context is provided by the excavations conducted by the S.U.N.Y. Binghamton Utqiagvik Archaeology Project (U.A.P.) at the late prehistoric/proto-historic and historic Iñupiat villa-

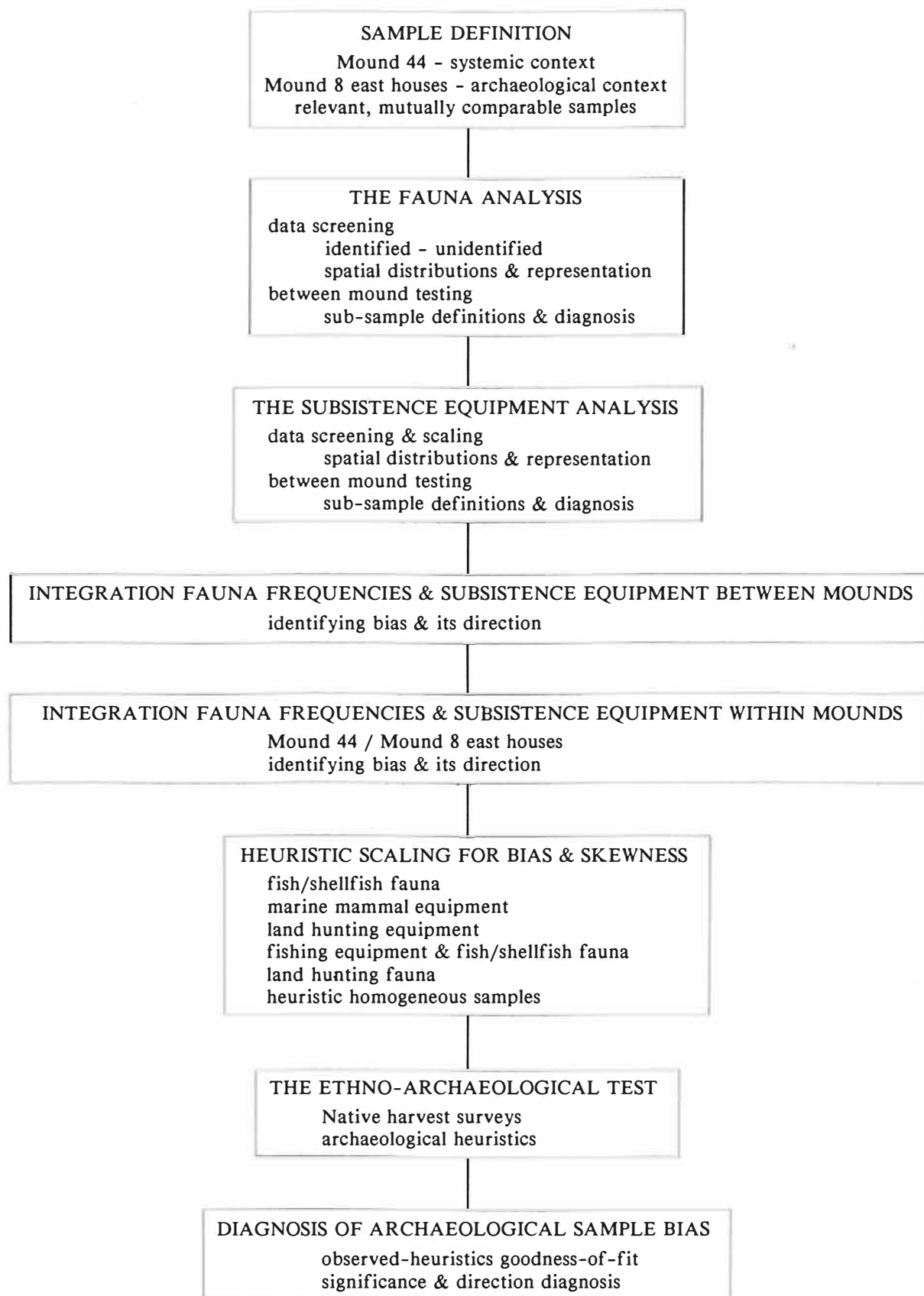


Fig. 1. Flow-diagram of the analysis of fauna refuse and subsistence equipment.

ge of Utqiagvik (BAR-002), Barrow, Alaska.

From those excavations we will use the catastrophically terminated house on Mound 44 (Kilmarx, in press; Polglase, in press; Turcy, in press; Newell, 1984; 1986; 1988) as the living context and the stratigraphically successive Mound 8 east houses (Smith, 1981) as representative of the normally abandoned archaeological context. We will demonstrate that the two house assemblages are comparable samples within the context of the posed archaeological problem. By comparing Mound 44 and Mound 8 we can provide one answer to the question of what constitutes a representative sample and how much skewing, smearing and blending (Longacre & Ahres, 1968) and differential data reduction transpires between the living situation and the normally abandoned, taphonomically transformed archaeological context. We will demonstrate that we can measure the hierarchical effect of the causative factors and provide meaningful statements about the archaeological resolution of reconstructions of prehistoric economic systems.

The analytical strategy is to partition the two house samples into statistically homogeneous subsamples, which we will argue are behaviourally and/or taphonomically meaningful. We will establish a hierarchy of controlled quantitative variability between the fauna assemblages and the suites of subsistence equipment of both samples and test the resulting patterning for inter-dependence. After obtaining full analytical control of the effects of site formation processes on the fauna assemblages and the subsistence equipment artifacts and tool-kits we will make a reliable and replicable reconstruction of temporal change within the Kakligmiut economic system from the two sources of archaeological data and corroborative information provided by ethnography and ethno-history. As the requisite sequence of analysis is somewhat complex, it was deemed prudent to synthesize and present same in the form of a flow-diagram to orient and guide the reader through the numerous steps in the solution of the archaeological problem (fig. 1).

2. THE SAMPLES

2.1. Mound 44

Mound 44 is a single component autumn-winter-spring occupation of a traditional *kataligaaq iglu*, dating between 440 ± 70 BP (Beta 6167)/ 420 ± 84 BP (Alpha 557) and 1826, the date of white contact. Stylistic considerations of chronologically sensitive artifacts, oral history and the close agreement of the combustion ^{14}C date on human bone and the thermoluminescence date on pottery indicate an occupation in the earlier part of the given range. The fortuitous

combination of ice-override (*ivu*), the season of the accident and Iñupiat cosmology resulted in the near perfect preservation of the whole house, its inventory and most/all? of its inhabitants at the moment of its collapse. The integration of diverse data sources suggests that the habitation, most probably by two related families, was terminated early one morning between early October and end November or between the end of April and May/June (Newell, 1984). Compared to other catastrophically terminated Eskimo houses, the Mound 44 *iglu* constitutes an optimal representation of a living context, frozen in time.

2.2. Mound 8 east houses

The Mound 8 east houses constitute two successive building phases of the *iglu* proper and one for the tunnel/entrance. The occupations, which appear to show a short discontinuity, date from c. 1600 AD (according to the stylistic seriation of the artifacts) to c. 1920 (the date of the abandonment of that part of the prehistoric/protohistoric/historic village in favour of Barrow proper). Ethnographically related and ethnohistorically documented signs of purposeful and systematic abandonment were observed during the excavation of both building phases. As is usual in abandoned houses in an archaeological context, insufficient diagnostic artifacts were left behind and found for the archaeologists to formulate a meaningful assessment of the household compositions of the various occupations (Smith, 1981). All that can be said is that the ethnographic range recorded in the Ray (1892) census must have included Mound 8 east house and is consistent with that observed and reconstructed on Mound 44.

2.3. Conclusion

The excavation and sampling of thirty two of the remaining c. 60 houses investigated by the U.A.P. confirm our interpretation of Mound 8 east houses as a systematically abandoned Iñupiat house. As such it is representative of the usual archaeological context, normatively used in archaeological analyses and interpretations. Sharply contrasting with that context is Mound 44, which is the best approximation of the systemic context available in the arctic. The fact that both occur within the same village and represent chronologically contiguous or partially overlapping occupations increases the cogency of the following analyses. The presence of permafrost directly under the modern surface guarantees equivalent preservation of organic artifacts. Excavation strategies and techniques conducted by the Utqiagvik Archaeology Project were the same for both houses, making the samples mutually comparable.

$$\Sigma X^2 = 9.120 \quad df = 1 \quad .01 > p > .001$$

Table 2. Chi-square test of the total fauna bone composition by architectural partition in Mound 44 and Mound 8 east houses.

	Obs.	Mound 44 Exp.	X ² coeff.	Obs.	Mound 8 east houses Exp.	X ² coeff.
House	67	132.791	32.597	389	323.209	13.392
Tunnel/entr. *	128	64.648	62.081	94	157.352	25.506
Kitchen	123	120.560	.049	291	293.440	.020

$$\Sigma X^2 = 133.645 \quad df = 2 \quad p < .001$$

discriminated by MacLean et al. (in press). Unfortunately many of the resulting species frequencies were too small for effective and reliable statistical analysis. Therefore the *katak* anteroom, tunnel and its storage alcoves, and the entrance structure were combined into their closest proximal unit, the tunnel/entrance. This led to an analytical structure of three partitions, i.e. house, tunnel/entrance, and kitchen plus kitchen passage. These analyses provided resolution of the identified/unidentified bone disparity and aided in the definition and interpretation of mutually homogeneous sub-samples. The total bones by area analysis is presented in table 2.

The foregoing analysis indicates that the total sample is not proportionally distributed in a similar manner through all partitions of the respective houses. Only the kitchens display sufficiently small Chi-square coefficients to suggest proportional uniformity between the two samples. Testing same against the summed house and tunnel/entrance partitions produced a probability of uniformity of $.80 > p > .70$ ($\Sigma X^2 = .112$). In all cases, pair-wise testing of the foregoing data structure produced significant differences (appendix 2), confirming that the $\Sigma X^2 = 133.645$ is caused by the inverse proportional frequencies of the two house samples vs. the two tunnel/entrance samples. Appendix 3 shows that the four distributions of identified/unidentified bone over the major partitions of both houses show statistically significant differences. The respective Chi-square coefficients indicate that the Mound 44 tunnel/entrance is over-represented in the analysis of the identified bone and the unidentified bone, while for the latter the under-representation of the Mound 44 house proper accounts for 57.514/98.158 or 58.59% of ΣX^2 . The over-representation of the Mound 44 tunnel/entrance accounts for 33.80% of the ΣX^2 of unidentified bone. The greatest skewness in the Mound 8 bone proportions is that provided by the under-representation of identified bone and the over-representation of unidentified bone in the tunnel/entrance in that mound. These results demonstrate that not only are the total bone proportions differentially distributed over the respective partitions of the houses, but also that the identified/unidentified cohorts are differentially distributed. Clearly, fur-

ther partitioning of the total sample is necessary before we can gain analytical control over the spatial variability in the deposition of the fauna bones.

In order to discriminate the source of this patterned variation, the distribution of the constituent species over the three partitions was analyzed (table 3).

The 3x2 tests demonstrate that the species bear, bird, fox, and whale were similarly distributed throughout all three partitions. These tests demonstrate further that the species/categories walrus, seal, caribou, unidentified bone and fish/shellfish did not display uniform or homogeneous proportional distributions over all three main partitions of the *iglu* in Mound 44 and Mound 8 east houses. More detailed testing of the distributions, executed by pair-wise multiple contingency or Chi-square testing according to architectural partition, yielded the patterning rendered in table 4. Unfortunately the low frequencies observed for musk ox and fox precluded their statistical analysis. However, we will

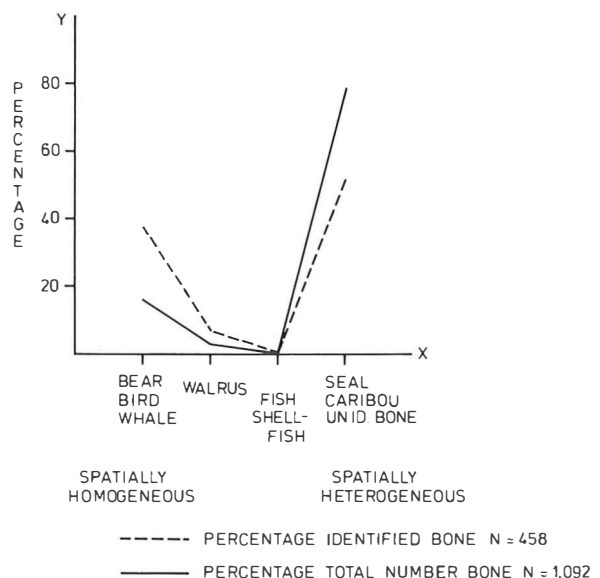


Fig. 2. Bimodal continuum from homogeneity to total heterogeneity in species/category by architectural partition.

Table 3. Analyses of fauna bone frequencies by species/category and major architectural partition (multiple contingency and Chi-square tests).

Species	Mound 44	Mound 8 east houses	
<i>Bear</i>			-
House	-	3	
Tunnel/entrance	-	2	$p = .667$
Kitchen	1	9	
House vs. tunnel/entrance	$p = 1.000$ house vs. kitchen $p = .769$		
Tunnel/entrance vs. kitchen	$p = .833$		
House = kitchen			
\\ //			
Tunnel/entrance			
<i>Musk ox</i>			
House	-	-	
Tunnel/entrance	2	-	untestable
Kitchen	-	-	
House vs. tunnel/entrance	untest house vs. kitchen untest		
Tunnel/entrance vs. kitchen	untest		
House ? kitchen			
?			
Tunnel/entrance			
<i>Bird</i>			
House	15	38	
Tunnel/entrance	5	6	$p = .182$
Kitchen	13	51	
House vs. tunnel/entrance	$p = .298$ house vs. kitchen $p = .386$		
Tunnel/entrance vs. kitchen	$p = .120$		
House = kitchen			
\\ //			
Tunnel/entrance			
<i>Fox</i>			
House	1	2	
Tunnel/entrance	-	-	$p = .600$
Kitchen	-	2	
House vs. tunnel/entrance	untest house vs. kitchen $p = .600$		
Tunnel/entrance vs. kitchen	untestable		
House = kitchen			
\\ //			
Tunnel/entrance			
<i>Whale</i>			
House	8	2	
Tunnel/entrance	12	2	$p > .990$
Kitchen	5	1	
House vs. tunnel/entrance	$p = .385$ house vs. kitchen $p = .480$		
Tunnel/entrance vs. kitchen	$p = .479$		
House = kitchen			
\\ //			
Tunnel/entrance			
<i>Fish/shellfish</i>			
House	-	6	
Tunnel/entrance	2	-	$p = .036$
Kitchen	-	-	
House vs. tunnel/entrance	$p = .036$ house vs. kitchen $p = .032$		
Tunnel/entrance vs. kitchen	untestable		
House \neq kitchen			
\neq ?			
Tunnel/entrance			

Table 3. (Cont.).

Species	Mound 44	Mound 8 east houses	
<i>Walrus</i>			
House	2	13	
Tunnel/entrance	7	2	$p = .008$
Kitchen	1	9	
House vs. tunnel/entrance	$p = .003$ house vs. kitchen $p = .450$		
Tunnel/entrance vs. kitchen	$p = .004$		
Tunnel/entrance \neq House			
//			
Kitchen			
<i>Seal</i>			
House	1	65	
Tunnel/entrance	4	-	$p = .000$
Kitchen	6	14	
House vs. tunnel/entrance	$p = .000$ house vs. kitchen $p = .000$		
Tunnel/entrance vs. kitchen	$p = .010$		
House \neq Kitchen			
\neq			
Tunnel/entrance			
<i>Caribou</i>			
House	18	48	
Tunnel/entrance	7	5	$p < .001$
Kitchen	1	67	
House vs. tunnel/entrance	$p = .030$ house vs. kitchen $p < .001$		
Tunnel/entrance vs. kitchen	$p = .000$		
House \neq Kitchen			
\neq			
Tunnel/entrance			
<i>Unidentified bone</i>			
House	22	212	
Tunnel/entrance	89	77	$p < .001$
Kitchen	96	138	
House vs. tunnel/entrance	$p = .001$ house vs. kitchen $p < .001$		
Tunnel/entrance vs. kitchen	$.02 > p > .000$		
House \neq Kitchen			
\neq			
Tunnel/entrance			

Table 4. Synthesis of the species/category-major architectural analyses.

House = kitchen	: bear, bird	
\\ //	whale	N= 173
Tunnel/entrance		
Tunnel/entrance \neq House	: walrus	N= 34
//		
Kitchen		
House \neq Kitchen	: fish/shellfish	N= 8
?		
Tunnel/entrance		
House \neq kitchen	: seal	N= 870
\neq \neq	caribou	
Tunnel/entrance	unid. bone	

The smaller mode, displaying spatial proportional homogeneity, is not affected by that bias, which first manifests itself in walrus, then fish/shellfish and finally attains its larger modal peak in seal and caribou, which follow the dispersal of the unidentified bone. Quantitatively, c. 38% of the identified bone has a proportionally uniform distribution within the three architectural partitions, while an additional 9% show some internal variability, moving toward the largest bloc of identified bone, seal and caribou (51.53%). That bloc groups with unidenti-

These conclusions by species/category and partition were then tested between the respective provenience units of both houses. In order to obtain the requisite statistically valid Chi-square test, fox and bear had to be excluded from the analysis of the houses. The tests of the tunnel/entrances and the kitchens were executed with multiple contingency

	Mound 44			Mound 8 east houses		
Species	Obs.	Exp.	X ² coeff.	Obs.	Exp	X ² coeff.
<i>House</i>						
Caribou	18	9.811	6.836	48	56.189	1.194
Walrus	2	2.230	.002	13	12.770	.004
Seal	1	9.811	7.913	65	56.189	1.382
Whale	8	1.486	28.541	2	8.514	4.983
Bird	15	7.878	6.438	38	45.122	1.124
Unid. bone	22	34.784	4.698	212	199.216	.820
			$\Sigma X^2 = 63.956$	df = 5	$p < .001$	
<i>Tunnell/entrance</i>	Obs.	Residual		Obs.	Residual	
Bear	0	-1.2		2	1.2	
Caribou	7	.1		5	-.1	
Walrus	7	1.8		2	-1.8	
Seal	4	1.7		0	-1.7	
Fish/shellfish	2	.8		0	-.8	
Whale	12	3.9		2	-3.9	
Bird	5	-1.3		6	1.3	
Musk ox	2	.8		0	-.8	
Unid. bone	89	-6.7		77	6.7	
			$p \leq .021$			
<i>Kitchen</i>						
Bear	1	-2.0		9	2.0	
Caribou	1	-19.2		67	19.2	
Fox	0	-.6		2	.6	
Walrus	1	-2.0		9	2.0	
Seal	6	.1		14	-.1	
Whale	5	3.2		1	-3.2	
Bird	13	-6.0		51	6.0	
Unid. bone	96	26.5		138	-26.5	
			$p \leq .000$			

table analysis and are rendered with their respective residuals. The results are presented in table 5.

The results presented in table 5 demonstrate that in all provenience units the constituent species/categories are not distributed equally between Mound 44 and Mound 8 east houses. As we will demonstrate below, this spatial bias is diagnostic of the abandonment behaviours we are in the process of monitoring and measuring.

From table 3, it is clear that for the caribou the kitchen is the most heterogeneous area, with Mound 44 displaying a significantly low frequency of one. For the unidentified bone the house is the most heterogeneous, with the Mound 8 east houses having significantly more bones. More walrus bones occurred in the Mound 44 tunnel/entrance than in that of Mound 8. Finally, the seal displays totally different distributions over all partitions in both houses. These observations suggest that Mound 44 displays over-representation of walrus in the tunnel/entrance area, perhaps indicating that that area had not yet been cleaned out, i.e. following the winter period of occupation. In Mound 8 over-representation obtains for caribou in the kitchen, unidentified bones in the house and seal bones in the house and the kitchen. This is what one would expect from multiple occupations, longer total duration of occupation and more complete abandonment behaviours.

From the foregoing discussion it is clear that spatial variability exists between our two samples and between the species/categories of the fauna remains. We will argue below that a diagnosis of that variability is made easier and more conclusive when the fauna remains are studied within the context of the provenience unit from whence they came. As Speth & Johnson (1976) have so cogently argued, behaviourally relevant resolution of the archaeological record is optimally obtained from natural provenience units.

3.2. Conclusion to data screening

Bias is present in the fauna sample with the skewness largely caused by higher frequencies generally in Mound 8 and the over-representation of seal, caribou and unidentified bone in that Mound, all of which are spatially heterogeneous. Following the data screening for mutual comparability and analyses per provenience unit in order to gain analytical control over variability, the bone counts per species for both samples were expressed as a cross-table for subsequent analysis (table 6).

3.3. Statistical testing between mounds and sub-sample definitions

Unfortunately the full cross-table produced an invalid result because one of the expected values for musk ox was less than one and 6/20 of the cells had expected values less than the requisite five (appendix 4). Only after musk ox and fox had been removed from the analysis did a valid structure obtain. This

Table 6. Screened fauna assemblages from Mound 44 and Mound 8 east houses.

Species	Mound 44	Mound 8 east houses
Bear	1	14
Caribou	26	120
Musk ox	2	-
Fish/shellfish	2	6
Bird	33	95
Fox	1	4
Walrus	10	24
Whale	25	5
Seal	11	79
Unident. bone	207	427
Totals	318	774

Table 7. Statistically valid analysis of screened fauna assemblages from Mound 44 and Mound 8 east houses: after the removal of musk ox and fox.

Species	Mound 44			Mound 8 east houses		
	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
Bear	1	4.355	2.584	14	10.645	1.057
Caribou	26	42.387	6.335	120	103.613	2.592
Fish/shellfish	2	2.323	.045	6	5.677	.018
Bird	33	37.161	.466	95	90.839	.191
Walrus	10	9.871	.002	24	24.129	.001
Whale	25	8.710	30.469	5	21.290	12.465
Seal	11	26.129	8.760	79	63.871	3.584
Unid. bones	207	184.065	2.858	427	449.935	1.169

$$\Sigma X^2 = 72.595 \quad df = 7 \quad p < .001$$

statistically valid structure of bear, caribou, fish/shellfish, bird, walrus, whale, seal and unidentified bone was analyzed and found to be significantly different in the two contexts (table 7).

Whereas Chi-square expects random or equal variation around the expected values, the foregoing test demonstrates highly skewed Chi-square coefficients for the species whale followed by seal and caribou. The rest show an apparent bi-partite proportional partitioning, i.e. bear and unidentified bone vs. fish/shellfish, bird and walrus. Pursuing our attempts to discriminate mutually consistent/homogeneously proportioned sub-samples within the total cross-table (table 7), we then tested paired combinations by means of Chi-square or multiple contingency tests, as appropriate, for proportional affinities. The results of these tests are given in table 8.

The foregoing results and approximations can be rendered graphically in a Venn-diagram which depicts the statistical affinities between the species (fig. 3).

The internal consistency and homogeneity of each group or sub-sample was tested by five Chi-square and multiple contingency tests, all of which produced non-significant results ranging from $p = .708$ to $.20 > p > .10$ (appendix 5). In conclusion the fauna assemblages from Mound 44 and Mound 8 east houses consist of five proportionally homogeneous sub-samples. The analytically discriminated and partially overlapping sub-samples are tabulated below (table 9).

In order to interpret the nature of the five sub-samples and to understand their morphogenesis better, it is necessary to assess their respective sums in terms of site formation processes. The Mound 8 total of Sub-Sample I is significantly higher than that of Mound 44, i.e. 223 vs. 41. This is a reflection of the longer period and multiple occupations of the Mound 8 east houses and possibly their use, in an abandoned

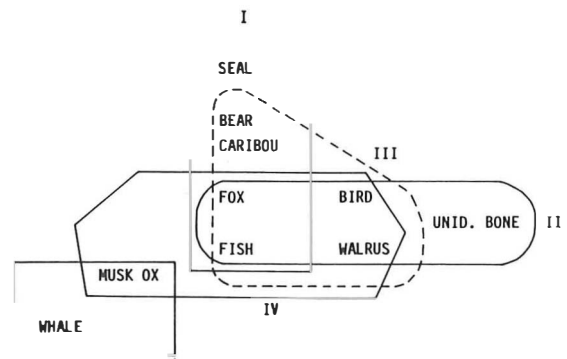


Fig. 3. Venn-diagram of statistical affinities of species proportions between Mound 44 and Mound 8 east houses fauna assemblages.

state, as a disposal area. The numerically largest components of this sub-sample have already been discriminated in the data screening, where caribou and seal displayed significantly different spatial distributions between Mound 44 and Mound 8 east houses, contra the less variable fish/shellfish, the homogeneous bear and the non-diagnostic fox. The minimal fox frequency in Mound 44, i.e. 1 vs. 4, is striking and may be a reflection of change in the cultural pattern and economic strategies of the Mound 8 inhabitants, caused by the fur trade and/or changing butchering and consumption practices. Proceeding from the ethnohistoric and historic literature as well as contemporary ethnographic accounts (Burch, 1980; Libbey, 1981), this difference is most probably a reflection of the increased importance of the fur trade, paralleling the longer and later tenure of Mound 8. The apparent core of this sub-sample, around which three of the other sub-samples seem to revolve, is formed by the low N species/categories

Table 8. Chi-square or multiple contingency analyses of paired frequencies by species and house.

Bear										
Caribou	.324									
Musk ox	.022	.035								
Fish/shellfish	.237	.638	.133							
Bird	.120	.20 > p > .10	.071	1.000						
Fox	.395	1.000	.143	1.000	1.000					
Walrus	.068	.153	.105	1.000	.827	1.000				
Whale	.000	.000	1.000	.004	.000	.001	.000			
Seal	.692	.275	.019	.592	.016	1.000	.032	.000		
Unid. bone	(.05 > p > .02)	<.001	(.05 > p > .02)	(.70 > p > .50)	.20 > p > .10	(.70 > p > .50)	.70 > p > .50	<.001	<.001	
	Bear	Caribou	Musk ox	Fish/shellfish	Bird	Fox	Walrus	Whale	Seal	Unid. bone

The marginal totals of the following combinations precluded the use of multiple contingency tables, while their data structures rendered Chi-square statistically invalid, i.e. unidentified bone with bear, musk ox, fish/shellfish and fox. These Chi-square results must be viewed only as descriptive approximations.

Table 9. Proportionally homogeneous sub-samples of Mound 44 and Mound 8 east houses fauna assemblages.

Sub-Sample I	Sub-Sample II	Sub-Sample III	Sub-Sample IV	Sub-Sample V
Seal Bear Caribou Fox Fish/shellfish	Fox Fish/shellfish Walrus Bird Unid. bone	Bear Caribou Fox Fish/shellfish Walrus Bird	Fox Fish/shellfish Walrus Bird Musk ox Whale	Musk ox
N = 264	N = 809	N = 336	N = 177	N = 32
Md 44 = 41 Md 8 = 223	253 556	73 263	48 129	27 5

fox and fish/shellfish. The mutually equivalent proportions of bear (1-14), seal (11-79) and caribou (26-120) in Mound 44 and Mound 8 would suggest that these three species form the stable part of the economy on the long term. Those remains are not differentially affected by taphonomic reduction processes. The greater Mound 8 frequencies are consistent with its longer duration of occupations and use, relative to Mound 44.

In Sub-Sample II, Mound 8 has the higher total number of bones, i.e. 556 vs. 253, whereby the proportional skewness is lower than in Sub-Sample I. This sub-sample, with five species/categories represented, is the largest. It emanates from the core of fox and fish/shellfish to include walrus, bird and unidentified bone. The largest component, unidentified bone, was discriminated in the data screening as being spatially heterogeneous, together with seal and caribou (table 4), which form the largest component of Sub-Sample I. The salient element is the opposition of walrus to seal to whale in the different sub-samples, possibly indicating the presence of a seasonal factor in the cohorts of this sub-sample. The affinity of bird to walrus may be another indication of seasonality, both activities traditionally following whaling in the late spring and early summer. The explanation of the statistical affinities of bird and walrus to unidentified bone is not yet clear, especially as these three species/categories display different patterns of spatial distribution within the respective houses. Fox and fish are represented by minimal frequencies and occur in Sub-Sample I also.

Sub-Sample III with six species is the second largest sub-sample (N= 336) and differs from Sub-Sample II by the addition of bear and caribou and the absence of unidentified bone. It displays the second largest proportional difference between the mounds, i.e. 73 vs. 263. This sub-sample emphasizes the

pivotal but numerically equivocal nature of fox and fish/shellfish. Despite the difference in spatial distribution, i.e. tunnel/entrance is discriminated by walrus, the statistical affinities of bird, walrus and bear may be seen as indicators of seasonality. Bear, bird and perhaps fox have the same spatial patterning, but walrus, caribou and perhaps fish/shellfish are spatially more variable (table 3). Despite the observed spatial bias, their numerical affinities with bird, bear and fox prevail.

Sub-Sample IV is the second smallest in the dataset, i.e. N= 177. It continues the trend of Mound 8's numerical dominance, i.e. 48 vs. 129, but again at a lower ratio, <3x vs. >5x in Sub-Sample I. Its most diagnostic element, musk ox, is tied to the low frequency and nearly ubiquitous species fox and fish/shellfish, despite its reversed proportions. As we will argue below, the diagnostic species of this sub-sample, musk ox, more properly belongs to Sub-Sample V. If that argument is accepted, Sub-Sample IV then becomes a spurious sub-sample, totally dependent upon the statistical limitations of testing low frequency cells in a multiple contingency table.

Sub-Sample V has the smallest number of species and the smallest frequencies of all the sub-samples. Its most diagnostic element is the reversed proportions between the mounds, with Mound 8 having the smaller and Mound 44 the larger total, i.e. 5 vs. 27. The difference is largely due to the greater number of whale bones in Mound 44. This may be indicative of seasonality, i.e. the catastrophe occurred during or directly after the whaling season, or it may indicate that the Mound 44 hunters butchered and consumed more whale than did their Mound 8 successors, consistent with Murdoch's (1892) suggestions. The presence of musk ox in Mound 44 and its absence in Mound 8 is consistent with its ethnohistorically documented over-exploitation and local extinction

in the early historic period in the North Slope area (Spencer, 1959). Its presence only in Mound 44 indicates a possible chronological causation of this sub-sample. Therefore these figures are also indicative of a shift in the economic strategy of the inhabitants of Mound 8 versus the earlier Mound 44.

3.4. Discussion

The variability in the spatial distributions of species/category frequencies, observed in table 4, figure 2 and more diagnostically rendered by natural provenience unit in tables 3 and 5, can be used to explain some of the patterning found in the sub-sample partitioning of the fauna assemblages (tables 7 and 8, fig. 3). The significant proportional difference between the assemblages from the *houses* of Mound 44 and Mound 8 east houses (table 5) was largely due to the larger component of Sub-Sample V, i.e. whale, in Mound 44. Secondly, subsequent analysis indicated a further two-fold partitioning of the fauna assemblages of both houses. Walrus, seal, unidentified bone and perhaps fish/shellfish are proportionally equivalent (Mound 8 6–65 times greater than Mound 44), but differ from bear, fox, caribou and bird, which themselves form an internally homogeneous group, varying from the Mound 8 numbers being two to three times greater than those in Mound 44. The three constituent parts of the fauna assemblages of both houses may be interpreted hierarchically as follows. Contrary to the rest of the house samples, whale is numerically and proportionally greater in Mound 44 than in Mound 8 east houses. This difference is consistent with ethnographic reports of greater numbers of whales caught and consumed in the pre-contact/early contact period and is further suggestive of a temporal shift in the Iñupiat economy. Secondly, the higher proportional differences and greater frequencies in Mound 8 of seal, unidentified bone, walrus and fish/shellfish are a reflection of the longer duration of occupation of the Mound 8 houses, different abandonment processes (e.g. dumping) and possibly a temporal change in the economic basis of Mound 8. The higher frequencies and proportions of seal and walrus may reflect a compensatory economic strategy, aimed at replacing the reduced input of whale. The third partition of the houses sample, i.e. bear, caribou, bird, and fox, displays a closer proportional parity between Mound 44 and Mound 8 east houses. The first three would then seem to form the most stable and temporally consistent elements of the Utqiagvik economy. That Mound 8 is numerically superior to Mound 44 is a reflection of its longer duration of occupation.

Higher frequencies of unidentified bone and then whale in the *tunnel/entrance* of Mound 44 accounted for that significant difference (table 5). Unidentified bone is the principal component of Sub-Sam-

ple II while whale forms that of Sub-Sample V. The significantly greater frequency of unidentified bone, as well as total bone, in the tunnel/entrance of Mound 44 is the result of different site-formation processes and abandonment behaviours. Mound 44 was catastrophically terminated near the end of its seasonal habitation. The usual process of tunnel cleaning had not taken place (see walrus section 3.1). Moreover, the Iñupiat proscription against entering such houses would have militated against any post-abandonment scavenging. The Mound 8 figures also indicate that eventual post-abandonment dumping did not or hardly affect the frequencies in that tunnel/entrance. The greater frequency of whale bone in the Mound 44 tunnel/entrance may be further interpreted in the same fashion as the house, above.

The difference between the respective *kitchens* was first due to unidentified bone, i.e. Sub-Sample II, then to caribou, the largest component of Sub-Samples I and III, to bird and finally to whale (table 5). Although numerically smaller, the unidentified bone in Mound 44 is proportionally greater, i.e. 78.05% vs. 47.42% in Mound 8. The greater numbers in Mound 8 reflect the longer period of occupation, the formation of 'clinker' and possibly post-abandonment dumping. The higher proportion of unidentified bone in the Mound 44 kitchen is probably a reflection of the catastrophic termination of that habitation rather than systematic abandonment, i.e. the kitchen was not yet cleaned out. The higher numbers, i.e. 67 vs. 1, and higher proportions of caribou bones, i.e. 23.02% vs. .81%, in the Mound 8 kitchen are too great to ascribe those differences wholly to the longer duration of that habitation and/or the systematic abandonment of that mound. They also stand in sharp contrast to the proportional equivalence of caribou bones in the house and tunnel/entrance provenience units of Mound 8. The bird bones show more variation in the kitchens than in the other two partitions, with Mound 8 having the highest frequency (51 vs. 13) and the higher proportion (17.53% vs. 10.57%). In their numerical and proportional patterning, they follow caribou and contrast with unidentified bone and whale. Hierarchically, the fourth source of significant variability between the kitchens of the two house mounds is that of whale, with Mound 44 being both numerically, i.e. 5 vs. 1, and proportionally, i.e. 4.07% vs. .34%, greater. As with the tunnel/entrance, interpretation of this difference follows that given for the house. In conclusion, the fauna assemblages in the kitchen provenience units consist of five components, arranged hierarchically: 1. unidentified bone; 2. caribou; 3. bird; 4. whale; and 5. bear, fox, walrus and seal. Synthesizing the foregoing, the fauna assemblages per provenience unit display similar internal patterning (table 10).

From table 10 we conclude that whale is the most

Table 10. Component partitioning of fauna assemblages of Mound 44 and Mound 8 east houses by natural provenience unit.

<i>House</i>			
	Unid. bone	Bear	Whale
	Seal	Fox	
	Walrus	Caribou	
	Fish/shellfish	Bird	
<i>Tunnel/entrance</i>			
	Unid. bone	Bear	Whale
		Caribou	
		Bird	
		Seal	
		Walrus	
		Fish/shellfish	
		Musk ox	
<i>Kitchen</i>			
Caribou	Unid. bone	Bear	Whale
Bird		Fox	
		Seal	
		Walrus	

consistently anomalous element in the respective partitions of the fauna assemblages. This is followed by unidentified bone and then to a lesser extent by seal, walrus and fish/shellfish on the one hand, and on the other hand, caribou. The most consistent and stable elements are bear, bird, fox and perhaps to a lesser extent seal, walrus, fish/shellfish and musk ox, whereby the latter two species/categories and fox suffer from low sample N's. On the strength of the foregoing patterning, we would suggest that bear, fox, bird, caribou and perhaps fish/shellfish constitute the temporally consistent, long term elements of the Iñupiat economy. The whale and musk ox remains in Mound 44 represent more reliably the aboriginal, pre-contact manifestation of same. When acculturation through intensive western contact altered the procurement strategy of the first and eradicated the supply of the second, adjustment would appear to have been made by intensifying the emphasis on seal and walrus and, judging from the kitchens, perhaps caribou.

Mound 8 east houses, the 'normal' abandoned site, provides a poorer seasonal resolution of the Iñupiat economic strategy because the fauna assemblage is homogenized over all seasons and through its longer duration of multiple occupations. Abandonment behaviours distorted the distribution of faunal elements within the constituent architectural partitions of Mound 8.

Therefore spatial bias, per se, in our samples did not account for the observed variability. Instead that observed variability is diagnostic of:

1. Differential duration of occupation/site-formation processes;
2. Differential abandonment processes;
3. Differential practices in the subsistence economy.

However, before accepting these interpretative conclusions to the analyses of the Mound 44 and Mound 8 east houses fauna assemblages, we would do well to examine the variability within the scaled samples of subsistence equipment.

4. THE SUBSISTENCE EQUIPMENT ANALYSIS

4.1. Data screening and scaling

Having recognized the nature and magnitude of the inherent skewness in our respective fauna samples, we will perform the same exercise on the respective suites of subsistence equipment. Contra the bone frequencies, Mound 44, representing the systemic context, has more pieces of subsistence equipment than does Mound 8. The total numbers of artifacts directly related to the subsistence quest found in Mound 44 and in Mound 8 east houses are 314 and 137, respectively. The frequencies by house, type and major architectural partition are presented in appendix 6. The internal distribution of those frequencies within the three architectural partitions of the *iglut* of Mound 44 and Mound 8 east houses is presented and tested in table 11, below. For statistical reasons, i.e. the avoidance of spurious results due to hyperprobability, discrete and functionally ambiguous artifact categories, e.g. one cartridge,

Table 11. Analysis of subsistence equipment frequencies by house and major architectural partition.

	Mound 44			Mound 8 east houses		
	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
House	100	117.663	2.651	69	51.337	6.078
Tunnel/entrance	206	185.894	2.175	61	81.106	4.984
Kitchen	8	10.443	.572	7	4.557	1.310

$$\Sigma X^2 = 17.770 \quad df = 2 \quad p < .001$$

have been removed from the sample.

From the foregoing analysis it is clear that the greatest variation is, as with the fauna (table 2), to be found in the opposition between the house and the tunnel/entrance partitions of the two houses. The respective kitchens contributed minimally to the ΣX^2 , i.e. $1.882/17.770 = 10.59\%$. Combining the frequencies of the first two partitions and testing same against those from the kitchens suggested a non-significant difference ($\Sigma X^2 = 1.947$.20 > $p > .10$ see appendix 7), although the data structure produced a statistically invalid result. This indication parallels that obtained from the analysis of the total number of bones per partition, above. Pairwise testing has indicated that house and tunnel/entrance differ significantly ($\Sigma X^2 = 15.992$ $p < .001$) and that the tunnel/entrance and kitchen differ marginally ($\Sigma X^2 = 4.404$.05 > $p > .02$). However, the low expected value for the Mound 8 kitchen (3.617) renders the test invalid. Contrasting with the pattern observed for the total fauna assemblage (table 2 and appendix 2), the house to kitchen test produced a non-significant proportional difference ($\Sigma X^2 = .194$.70 > $p > .50$).

From the identical provenience units of both mounds, the frequencies of the full range of subsistence equipment were counted and tabulated. As many of the cell frequencies were minimal, i.e. half varied from 0 to 2, and in the interests of obtaining behaviourally significant results from our analysis and following the lead provided by Kilmarx (in press) on the taskonomic (Doughtery & Keller, 1982) partitioning of the subsistence equipment into functional tool-kits, it was deemed prudent to combine the type categories into more activity/functionally oriented groups. Oswalt's (1976) functional taxa of instruments, weapons, tended facilities and untended facilities provided only a global fit to the emically constituted tool-kits for the subsistence activities of Land Hunting, Passive Fishing, Active Fishing, Fowling and Marine Mammal Hunting. As is apparent from table 12, the wristguard, the ice pick, ice scoop and seal call would be considered anomalous in the Oswalt scheme. The resulting analytical structure of five functional categories is presented in table 12.

Contrasting sharply with the picture obtained from the respective fauna samples by species/categories, the Mound 44 subsistence equipment has significantly greater frequencies in the taskonomic categories Fowling and Land Hunting. The three remaining categories are numerically larger, relative to Mound 8, but not significantly so, according to single-sample Chi-square tests or the binomial test (Siegel, 1956). If we combine the Active Fishing and the Passive Fishing categories, a significant difference obtains, leaving only Marine Mammal Hunting as numerically homogeneous.

Table 12. Frequencies of taskonomic categories of subsistence equipment by house.

	Mound 44	Mound 8 east houses
<i>Land hunting</i>	94	64
Projectile point		
Dart		
Arrow/shaft		
Bow		
Wristguard		
<i>Active fishing</i>	21	11
Line weight		
Fish jig		
Fish lure		
Fish spear		
<i>Passive fishing</i>	7	2
Net		
Net float		
Net sinker		
<i>Marine mammal hunting</i>	36	26
Harpoon		
Ice pick		
Ice scoop		
Seal call		
Socket/toggle/drag handle		
Nozzle		
<i>Fowling</i>	156	34
Bolas weights		
Bird blunt		
Totals	314	137

As in the analysis of the distribution of the constituent species of animal bone, partitioning by main architectural provenience provided increased resolution of the transformation from the 'living context' to the 'archaeological context'. A parallel analysis of the functional categories of subsistence equipment increased our understanding of and ability to interpret the foregoing variation. The relevant analyses are presented in table 13.

From the table 13, it is clear that the first three taskonomic categories display statistically equivalent proportional distributions among the three major architectural partitions between Mound 44 and Mound 8. The marginally different Marine Mammal Hunting proportions display the greatest variation in the house vs. tunnel/entrance combination, although that result is not significant. The variation in the category Fowling occurs primarily in the house-tunnel/entrance combination, whereby the overrepresentation occurs in Mound 44 with 103 bolas weights in the tunnel/entrance. Iterative pair-wise testing of the totals in each taskonomic category confirmed the above (appendix 8). The results are rendered in the Venn-diagram of figure 4.

In his study of the tunnel artifacts, J. Kilmarx (in

Table 13. Analyses of subsistence equipment frequencies by taskonomic category and major architectural partition (multiple contingency analysis).

Category	Mound 44	Mound 8 east houses	
<i>Land hunting</i>			
House	28	24	
Tunnel/entrance	60	35	$p = .500$
Kitchen	6	5	
House vs. tunnel/entrance $p = .295$ house vs. kitchen $p = .259$			
Tunnel/entrance vs. kitchen $p = .744$			
House = kitchen			
\ \ //			
Tunnel/entrance			
<i>Active fishing</i>			
House	12	7	
Tunnel/entrance	8	3	$p = .861$
Kitchen	1	1	
House vs. tunnel/entrance $p = .702$ house vs. kitchen $p = .495$			
Tunnel/entrance vs. kitchen $p = .462$			
House = kitchen			
\ \ //			
Tunnel/entrance			
<i>Passive fishing</i>			
House	-	-	
Tunnel/entrance	7	2	$p = .090$
Kitchen	-	-	
House vs. tunnel/entrance $p = .190$ house vs. kitchen untest			
Tunnel/entrance vs. kitchen $p = .180$			
House = kitchen			
\ \ //			
Tunnel/entrance			
<i>Marine mammal hunting</i>			
House	11	14	
Tunnel/entrance	25	11	$p = .048$
Kitchen	-	1	
House vs. tunnel/entrance $p = .065$ house vs. kitchen $p = .577$			
Tunnel/entrance vs. kitchen $p = .324$			
House = kitchen			
\ \ //			
Tunnel/entrance			
<i>Fowling</i>			
House	49	24	
Tunnel/entrance	106	10	$p = .000$
Kitchen	1	-	
House vs. tunnel/entrance $p = .000$ house vs. kitchen $p = .676$			
Tunnel/entrance vs. kitchen $p = .915$			
House = kitchen			
= / = //			
Tunnel/entrance			

press) could establish that 28 of the 103 bolas weights constituted five complete bolas sets, found together in a leather bag. A number of other categories of subsistence equipment was similarly stored together in the *suuvik*, the storage area opening onto the tunnel. This leads us to suspect that the cause of the analytically observed over-representation of bolas weights was due to the exceptional preservation of complete tool-kits in Mound 44. Therefore we took the 5 tool-

Land Hunting	Passive Fishing	Fowling
Active Fishing		
Marine Mammal Hunting		

Fig. 4. Venn-diagram of statistical affinities of taskonomic category proportions between Mound 44 and Mound 8 east houses.

Table 14. Analysis of scaled frequencies of taskonomic category fowling and major architectural partition (multiple contingency analysis).

Category	Mound 44	Mound 8 east houses	
<i>Fowling</i>			
House	12	24	
Tunnel/entrance	21	10	$p = .007$
Kitchen	1	-	
House vs. tunnel/entrance $p = .007$ house vs. kitchen $p = .351$			
Tunnel/entrance vs. kitchen $p = .688$			
House = / = tunnel/entrance			
\ \ //			
Kitchen			

kit/28 bolas weights fraction as a scaling factor for the raw frequencies of weights in each architectural partition. This scaling produced 18 bolas sets in the tunnel/entrance, eight in the house and one in the kitchen of Mound 44.

Re-testing with the scaled frequencies of complete bolas units for Mound 44, we find that a large measure of the spatial homogeneity, as observed in the other categories of subsistence equipment, obtains (table 14).

Analysis has demonstrated that when the Fowling equipment is scaled into tool-kits, the best fit is when the scaled Mound 44 data are compared to the Mound 8 raw data for Fowling (appendix 9). When applied to Mound 8, the scaling failed, indicating that in the systemic context of Mound 44 the tool-kit integrity was retained and that in the abandoned, archaeological context of Mound 8, this emic integrity of subsistence equipment was largely disrupted, disturbed and destroyed. The Mound 8 frequencies more closely represent each of the tool-kits of which they formed a part, so that something approximating a one-to-one relationship obtains. The Mound 44 frequencies retain a closer constituent relationship to the complete tool-kits, of which they formed a part. With the data scaled in this manner, the frequencies of the taskonomic categories of subsistence equipment per major architectural partition (= natural provenience unit) were analyzed between the mounds. In all three cases, the multiple

contingency table probabilities were ≥ 100 , indicating that extant spatial variation is between partitions and not between mounds. The results are presented in table 15.

Contrary to the patterned variability observed in the respective samples of fauna bones (table 5), the

Table 15. Analyses of categories of subsistence equipment by provenience unit between Mound 44 and Mound 8 east houses.

	Mound 44		Mound 8 east houses	
	Obs.	Residual	Obs.	Residual
<i>House</i>				
Land hunting	28	3.2	24	-3.2
Active fishing	12	2.9	7	-2.9
Fowling	12	-5.2	24	5.2
Marine mammal hunting	11	- .9	14	.9
$p \leq .100$				
<i>Tunnel entrance</i>				
Land hunting	60	-3.2	35	3.2
Active fishing	8	.7	3	- .7
Passive fishing	7	1.0	2	-1.0
Fowling	21	.4	10	- .4
Marine mammal hunting	25	1.1	11	-1.1
$p \leq .100$				
<i>Kitchen</i>				
Land hunting	6	.1	5	-.1
Active fishing	1	-.1	1	.1
Fowling	1	.5	0	-.5
Marine mammal hunting	0	-.5	1	.5
$p \leq .144$				

Table 16. Screened and scaled subsistence equipment inventory from Mound 44 and Mound 8 east houses.

	Mound 44	Mound 8 east houses
Land hunting	94	64
Active fishing	21	11
Passive fishing	7	2
Fowling	34	34
Marine mammal hunting	36	26

Table 17. Analysis of scaled frequencies of taskonomic categories of subsistence equipment by house.

	Mound 44			Mound 8 east houses		
	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
Land hunting	94	92.207	.003	64	65.793	.049
Active fishing	21	18.675	.290	11	13.325	.406
Passive fishing	7	5.252	.582	2	3.748	.815
Fowling	(34)	39.684	.814	34	28.316	1.141
Marine mammal hunting	36	36.182	.000	26	25.818	.001

$$\Sigma X^2 = 4.133 \quad df = 4 \quad .50 > p > .30$$

foregoing analyses indicate no significant differences between the house mounds when their inventories are analyzed by constituent provenience unit. The homogeneity per provenience unit indicates that the small amount of significant variability observed in tables 13 and 14 is not the most diagnostic, but rather that the difference between the provenience units in the respective mounds contains the most depositionally and/or behaviourally diagnostic information.

The subsistence equipment, with Fowling scaled according to observed tool-kit proportions, is largely spatially homogeneous in terms of proportions, but numerically skewed toward Mound 44 (table 16). From the difference in the directionality in the respective biases, conclusions can be drawn about abandonment behaviours and site-formation processes. Using the tool-kit concept enables us to scale the raw data and correct the numerical bias in the Fowling equipment of Mound 44.

As we will see below, the tool/tool-kit relationships in Mound 44 will continue to manifest themselves in subsequent analyses. Once these have been identified and measured, the analytical residuals will permit some conclusions regarding human behaviour in the systemic context and trends in the cultural history of the late prehistoric Iñupiat village of Utqiagvik.

4.2. Statistical testing between mounds and sub-sample definitions

The Chi-square analysis of the scaled frequency data from five taskonomic/functional categories produced a $\Sigma X^2 = 4.133$ $df = 4$ $.50 > p > .30$ (table 17), indicating proportionally homogeneous frequencies.

From the respective Chi-square coefficients it is apparent that the category Fowling accounted for 1.955/4.133 or 47% of the ΣX^2 , indicating some bias still extant in the screened and scaled data. In order to evaluate eventual internal partitioning, potentially paralleling that observed in the fauna sample (tables 7 and 8), further iterative pair-wise analyses were executed and yielded the following results (table 18).

Table 18. Chi-square or multiple contingency analyses of paired and scaled frequencies by taskonomic category and house.

Land hunting					
Active fishing	.558				
Passive fishing	.322	.693			
Fowling	.192	.162	.196		
Marine mammal hunting	.880	.512	1.000	.383	
	Land hunt.	Pas. fish	Act. fish	Fowling	M.H.

4.3. Discussion

When the Mound 44 scaled data on taskonomic categories of subsistence equipment are compared to the Mound 8 east houses raw frequencies, greater spatial homogeneity and proportional compositional homogeneity obtain. These regularities are contra those observed from the analyses of the fauna data. In Mound 8 curation behaviours at abandonment probably reduced the subsistence equipment component, so that eventual temporal change in equipment and/or procurement strategies, paralleling changes in the fauna component have been lost, just as in the tool/tool-kit relation. In Mound 44, on the other hand, we expect more specific seasonal resolution due to its particular site formation processes and the Iñupiat proscription on entering catastrophically terminated houses. Therefore it should provide a better and more sensitive resolution of the economic system than does Mound 8. The more complete suite of subsistence equipment should also be closer to the functional and emic tool-kits, of which they formed a part. We also expect a better rendition of systemic storage behaviours, particularly of the tool-kits in the *suuvik*. The fact that these differences yield so little variation in the subsistence equipment leads us to suspect that subsistence equipment alone yields less behaviourally relevant patterning in its variability than does the fauna data. In order to test this hypothesis, we must integrate the two independent data sources and test same for independence, first between mounds and then within each mound.

5. INTEGRATION OF FAUNA FREQUENCIES AND SUBSISTENCE EQUIPMENT BETWEEN MOUNDS

Having identified the biases inherent in the two data-sets and having been able to use one set to scale the taskonomic category of Fowling equipment, we are now in a position to assess the relationships between both data-sets and to use same for the identification of inherent bias and then correct those proportions through scaling in order to produce mutually comparable heuristic samples.

The synthesis and integration consists of a statistical comparison of the taskonomic categories of subsistence equipment, using the most behaviourally relevant data, with the summed frequencies of the resources (prey species/categories) thereby procured. The question is to what extent the categories of subsistence equipment display a relationship with the fauna frequencies which is similar in both houses. If agreement is found, we would propose that that category of subsistence equipment contains no analytically significant bias and that the fauna-equipment cohort constitutes a more reliable reflection of that segment of the total economy than do those cases where significant differences obtain. If agreement is not to be found, we would suggest that the analytically identified over-representation or under-representation is due to bias still extant in the subsistence equipment sample and that the fauna remains constitute the more reliable reflection of the subsistence base of this foraging society. The between mounds analyses are presented in table 19.

The only combinations for which statistical homogeneity obtains are those between Active Fishing-fish/shellfish and Passive Fishing-fish/shellfish. The respective multiple contingency probabilities are .053 and .057. If both taskonomic categories are combined, in order to better parallel the taskonomically undifferentiated bone/shell counts, a minimal significant difference obtains, i.e. $p = .043$. These results lead us to suspect that the apparent statistical agreement between the two suites of fishing equipment and the fauna remains is largely a function of the small sample N's of the latter. On the other hand, the numerically superior Active Fishing equipment does display a different storage behaviour (inside the house) than that observed for Passive Fishing and the other categories of subsistence equipment.

Significant proportional heterogeneity between subsistence equipment and the bone counts for their categories of prey is seen in the Land Hunting-land mammal, Fowling-birds and Marine Mammal Hunting-marine mammals combinations. In the first, the Chi-square coefficients are nearly equally distributed between the over-representation of subsistence equipment in Mound 44 ($30.864/59.891 = 51.53\%$) and the over-representation of fauna remains in Mound 8 ($29.027/59.891 = 48.47\%$). The same causality obtains for the combination Fowling-birds, but the result is more clearly skewed toward the over-representation of equipment in Mound 44 ($7.561/11.577 = 65.31\%$). The largest divergence is that between Marine Mammal Hunting and marine mammals, whereby the over-representation of the Mound 44 subsistence equipment accounts for 71.29% of the sum of Chi-square. This is probably because there is still some manifestation of the tool/tool-kit relationship in the Mound 44 equipment, which is largely lost in Mound 8. There is also bias

Table 19. Analyses of fauna frequencies and subsistence equipment cohorts between Mound 44 and Mound 8 east houses.

Resource remains/ taskonomic category	Mound 44			Mound 8 east houses		
Fish/shellfish	2	-	-	6	-	-
Passive fishing	7	-	-	2	-	-
multiple contingency $p = .057$						
Fish/shellfish	2	-	-	6	-	-
Active fishing	21	-	-	11	-	-
multiple contingency $p = .053$						
Fish/shellfish	2	-	-	6	-	-
Σ Fishing	28	-	-	13	-	-
multiple contingency $p = .043$						
Land mammals	30	63.902	17.986	138	104.098	11.041
Land hunting	94	60.098	19.124	64	97.902	11.740
$\Sigma X^2 = 59.891$ $df = 1$ $p < .001$						
Birds	33	43.755	2.644	95	84.245	1.373
Fowling	34	23.245	4.976	34	44.755	2.585
$\Sigma X^2 = 11.577$ $df = 1$ $p < .001$						
Marine mammals	46	58.463	2.657	108	95.537	1.626
Marine mammal hunting	36	23.537	6.599	26	38.463	4.038
$\Sigma X^2 = 14.920$ $df = 1$ $p < .001$						

due to differential abandonment behaviours still extant in the sample. A further examination of this heterogeneity consisted of two sets of analyses wherein the frequencies per taskonomic category were compared with those from the relevant summed resource categories per house.

6. INTEGRATION OF FAUNA FREQUENCIES AND SUBSISTENCE EQUIPMENT WITHIN MOUNDS

Executed by means of Chi-square so that we may make diagnostic use of the constituent Chi-square coefficients, the analyses were done on the full data structure of four taskonomic categories and their prey species and then iteratively by pairs. The results are presented in tables 20 and 21.

From these tests, a number of observations recur. In all tests concerning Fishing, the results are significant and the Chi-square coefficients consistently indicate an under-representation of fish bones (22.33%-63.78% of ΣX^2) and an over-representation of Fishing equipment (16.73%-65.26%). Secondly, when Fowling and bird bones are analyzed against Land Hunting, both houses display an over-representation of bird bones (18.10%-43.51%) and

an under-representation of Fowling equipment (21.41%-42.91%). In Mound 8, however, the skewness is not significant when compared to Land Hunting-land mammals. Thirdly, when Marine Mammal Hunting-marine mammal bones are tested against Land Hunting-land mammals, the marine mammal bones are over-represented in both houses (16.11%-37.99%) and Marine Mammal Hunting equipment is under-represented (22.21%-44.02%). Finally, the Fowling-bird bone/Marine Mammal Hunting-marine mammal bones analyses show non-significant differences for both houses. However, Mound 8 retains some skewness in its Chi-square coefficients with Fowling equipment being slightly over-represented (39.34%) and Marine Mammal Hunting equipment again being under-represented (37.84%). These results confirm the diagnosis of the 2x4 analysis, wherein Marine Mammal Hunting and then Σ Fishing in Mound 44 and the reverse order in Mound 8 east houses display disproportionately large Chi-square coefficients.

This analytical patterning may be interpreted as follows. In the first instance the consistent under-representation of fish bones, despite the differences in archaeological context and taphonomy between the two samples leads to the conclusion that the fish fauna component of both sites is a less reliable

Table 20. Chi-square analyses of the relationships between four taskonomic categories of subsistence equipment and their prey resources in Mound 44.

	Taskonomic category			Prey resource		
	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
Σ Fishing	28	19.001	4.252	2	10.990	7.354
Land hunting	94	78.574	3.028	30	45.426	5.238
Fowling	34	42.455	1.684	33	24.545	2.913
Marine mammal hunting	36	51.960	4.902	46	30.040	8.480
$\Sigma X^2 = 37.852$ df = 3 $p < .001$						
Σ Fishing	28	23.766	.754	2	6.234	2.875
Land hunting	94	98.234	.182	30	25.766	.696
$\Sigma X^2 = 4.508$ df = 1 $.05 > p > .02$ $V = .171$ fish bones under-represented $2.875/4.508 = 63.78\%$ fishing equip. over-represented $.754/4.508 = 16.73\%$						
Σ Fishing	28	19.175	4.061	2	10.825	7.194
Fowling	34	42.825	1.818	33	24.175	3.221
$\Sigma X^2 = 16.295$ df = 1 $p < .001$ $V = .410$ fish bones under-represented $7.194/16.295 = 44.15\%$ fishing equip. over-represented $4.061/16.295 = 24.92\%$						
Σ Fishing	28	17.143	6.876	2	12.857	9.168
Marine mammal hunting	36	46.857	2.516	46	35.143	3.354
$\Sigma X^2 = 21.914$ df = 1 $p < .001$ $V = .442$ fish bones under-represented $9.168/21.904 = 41.84\%$ fishing equip. over-represented $6.876/21.904 = 31.38\%$						
Land hunting	94	83.099	1.430	30	40.901	2.905
Fowling	34	44.901	2.646	33	22.099	5.377
$\Sigma X^2 = 12.358$ df = 1 $p < .001$ $V = .254$ bird bones over-represented $5.377/12.358 = 43.51\%$ fowling equip. under-represented $2.646/12.358 = 21.41\%$						
Land hunting	94	78.252	3.169	30	45.748	5.421
Marine mammal hunting	36	51.748	4.792	46	30.252	8.197
$\Sigma X^2 = 21.579$ df = 1 $p < .001$ $V = .324$ marine mammal equip. under-represented $4.792/21.579 = 22.26\%$ marine mammal bones over-represented $8.197/21.579 = 37.99\%$						
Fowling	34	31.477	.202	33	35.523	.179
Marine mammal hunting	36	38.523	.165	46	43.477	.146
$\Sigma X^2 = .693$ df = 1 $.50 > p > .30$ $V = .068$ symmetrical distribution of Chi-square coefficients						

indicator of the role of fishing in the total economy than is the subsistence equipment. This may be the product of an additional source of variation, not operating on the depositional patterns of the rest of the fauna sample, i.e. the greater part of the fish catch was used to feed the dogs, which were kept and fed outside. The fact that Fishing almost groups with the more stable Land Hunting ($.05 > p > .02$) in Mound 44, the more behaviourally intact sample, throws some light upon the seasonality of subsistence acti-

vity scheduling. Fowling and Marine Mammal Hunting are complementary spring and early summer subsistence activities, while Fishing and Land Hunting are primarily summer and autumn activities, conducted away from the village in a different structural pose (Burch, 1980; Murdoch, 1892; Ray, 1885; Spencer, 1959). Secondly, the under-representation/over-representation relationships between Fowling equipment and bird bones in both houses, when compared to Land Hunting, is indicative of the

Table 21. Chi-square analyses of the relationships between four taskonomic categories of subsistence equipment and their prey resources in Mound 8 east houses.

	Taskonomic category			Prey resource		
	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
Σ Fishing	13	5.378	10.802	6	13.622	4.265
Land hunting	64	57.178	.814	138	144.822	.309
Fowling	34	36.505	.173	95	92.486	.068
Marine mammal hunting	26	37.930	3.752	108	96.070	1.481
$\Sigma X^2 = 21.677$ $df = 3$ $p < .001$						
Σ Fishing	13	6.620	6.149	6	12.380	3.288
Land hunting	64	70.380	.578	138	131.620	.309
$\Sigma X^2 = 10.325$ $df = 1$ $.01 > p > .001$ $V = .216$ fishing equip. over-represented $6.149/10.325 = 59.55\%$ fish bones under-represented $3.288/10.325 = 31.85\%$						
Σ Fishing	13	6.034	8.043	6	12.966	3.743
Fowling	34	40.966	1.185	95	88.034	.551
$\Sigma X^2 = 13.521$ $df = 1$ $p < .001$ $V = .302$ fishing equip. over-represented $8.043/13.521 = 59.49\%$ fish bones under-represented $3.743/13.521 = 27.68\%$						
Σ Fishing	13	4.843	13.738	6	14.157	4.700
Marine mammal hunting	26	34.157	1.948	108	99.843	.666
$\Sigma X^2 = 21.052$ $df = 1$ $p < .001$ Invalid $V = .371$ fishing equip. over-represented $13.738/21.052 = 65.26\%$ fish bones under-represented $4.700/21.052 = 22.33\%$						
Land hunting	64	59.807	.294	138	142.193	.124
Fowling	34	38.193	.460	95	90.807	.194
$\Sigma X^2 = 1.072$ $df = 1$ $.50 > p > .30$ $V = .057$ fowling equip. under-represented $.460/1.072 = 42.91\%$ bird bones over-represented $.194/1.072 = 18.10\%$						
Land hunting	64	54.107	1.809	138	147.893	.662
Marine mammal hunting	26	35.893	2.727	108	98.107	.998
$\Sigma X^2 = 6.194$ $df = 1$ $.02 > p > .01$ $V = .136$ marine mammal equip. under-represented $2.727/6.195 = 44.02\%$ marine mammal bones over-represented $.998/6.195 = 16.11\%$						
Fowling	34	29.430	.710	95	99.570	.210
Marine mammal hunting	26	30.570	.683	108	103.430	.202
$\Sigma X^2 = 1.805$ $df = 1$ $.30 > p > .20$ $V = .083$						

fact that neither data source alone provides behaviourally meaningful resolution of the role of fowling in the prehistoric economy. Even when the taphonomic context permitted optimal scaling into tool-kits of bolas, the relationship obtained. Where that artifact/tool-kit relationship is lost, Mound 8, we see statistical homogeneity with the most stable element of the economy, i.e. Land Hunting-land mammals ($.50 > p > .30$).

The over-representation of marine mammal bones vs. the under-representation of Marine Mammal

Hunting equipment can be explained by differential storage behaviours. It has been documented ethnographically and ethno-historically that the larger pieces of subsistence equipment were stored outside the house, i.e. on the boat rack and on the scaffold rack. For very different taphonomic reasons, both the Mound 44 and the Mound 8 east houses samples of this outside-stored material have been lost to the respective archaeological records. Because that which is retained in the record is so consistent, we would suggest that the bone proportions are the better

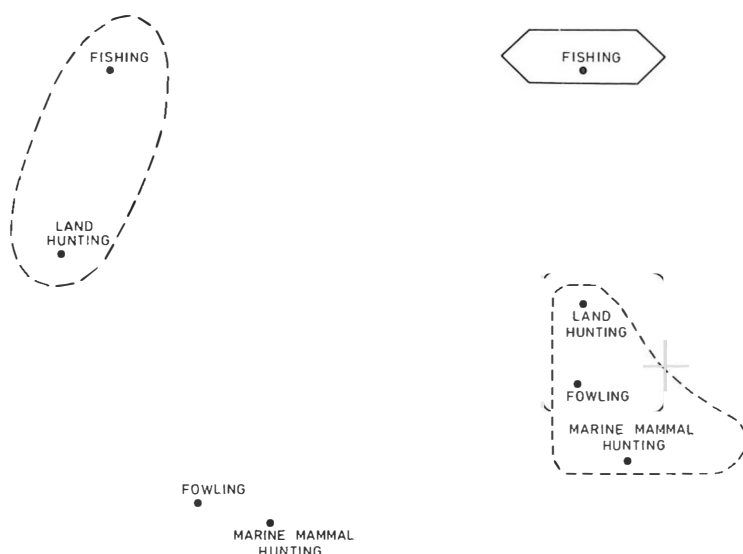


Fig. 5. Venn-diagrams of statistical affinities between taskonomic categories of subsistence equipment and their prey resources in Mound 44 and Mound 8 east houses.

reflection of the role played by Marine Mammal Hunting in the total economy. The marginally significant difference between Marine Mammal Hunting and Land Hunting in Mound 8 ($.02 > p > .01$) is indicative of a greater homogeneity than that observed in Mound 44. The statistical affinities of Marine Mammal Hunting and Fowling in both houses retain some of the same systematic bias relative to the under-representation of Marine Mammal Hunting equipment vs. some over-representation of Fowling equipment in Mound 8. These differences are best presented in the form of Venn-diagrams (fig. 5). Non-significant differences, i.e. statistically homogeneous clusters, are rendered with solid lines, while minimally significant differences ($.05 > p > .02$ and $.02 > p > .01$) are rendered by broken lines. The linear distances between all constituents of the figure are scaled according to their correlation coefficients (Cramer's V).

In both house mounds (samples), Fowling and Marine Mammal Hunting display a mutually consistent relationship between their respective suites of subsistence equipment and the remains of their prey resources. This homogeneous unit is significantly different from its most distant category and prey resource, Fishing, in both houses. The main difference between the two samples is the independent status of Land Hunting in Mound 44 vs. its affinity with Fowling in Mound 8. Secondly, the marginally significant difference ($.05 > p > .02$) between Fishing and Land Hunting in Mound 44 is significant in Mound 8, while the relatively close relationship between Land Hunting and Marine Mammal Hunting in Mound 8 ($.02 > p > .01$ $V = .136$) is totally absent in Mound 44. We interpret this patterning as

a manifestation of seasonality in the systemic context of Mound 44 and as a reflection of homogenization in the archaeological context of Mound 8. The seasonal difference between Fishing and Land Hunting vs. Fowling and Marine Mammal Hunting have been indicated above. That Land Hunting, Fowling and Marine Mammal Hunting form an overlapping continuum or possibly a homogeneous unit in Mound 8 is the result of the loss of behavioural resolution through abandonment behaviours during the longer duration and multiple occupations of that mound.

7. HEURISTIC SCALING FOR BIAS IN SITE-FORMATION PROCESSES AND SKEWNESS OF ARCHAEOLOGICAL SAMPLES

Proceeding from the observed disparity between fauna remains and subsistence equipment of the Fishing and Marine Mammal Hunting activities, most obviously manifest in the Fishing and Marine Mammal Hunting remains, we have elected to proceed with a diagnostic scaling of the frequencies by mound, in order to gain analytical control over the role played by the bias extant in both samples. The basis for the scaling is the proposition that there is some knowable quantitative relationship between the items of material culture used in a particular subsistence activity and the archaeologically observed products of that activity, the residues of the prey resources. To be sure the relationships will not be equivalence and most probably not even linear. Also, we should expect a different relationship for each suite of procurement equipment and the residue

Once scaling has produced proportional homoge-

From the foregoing analyses, we have established that fish bones are significantly under-represented in both houses. If we substitute closest integers of the expected values of 10.999 and 13.622 from the 2x4 tests on tables 20 and 21 for the observed frequencies of 2 and 6, respectively, the fit of the subsistence equipment and prey resource remains improves considerably (table 22).

Next in hierarchical order of divergence is the re-

	Taskonomic category			Prey resources		
	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
Mound 44						
Σ Fishing	28	29.190	.049	11	9.810	.144
Land hunting	94	92.810	.015	30	31.190	.045
$\Sigma X^2 = .254 \quad df = 1 \quad .70 > p > .50 \quad V = .039$						
Σ Fishing	28	22.811	1.180	11	16.187	1.663
Fowling	34	39.189	.687	33	27.811	.968
$\Sigma X^2 = 4.498 \quad df = 1 \quad .05 > p > .04 \quad V = .206$						
Σ Fishing	28	20.628	2.635	11	18.372	2.958
Marine mammal hunting	36	43.372	1.253	46	38.628	1.407
$\Sigma X^2 = 8.252 \quad df = 1 \quad .01 > p > .001 \quad V = .261$						
Mound 8 east houses						
Σ Fishing	13	9.079	1.694	14	17.921	.858
Land hunting	64	67.921	.226	138	134.079	.115
$\Sigma X^2 = 2.893 \quad df = 1 \quad .10 > p > .05 \quad V = .112$						
Σ Fishing	13	8.135	2.910	14	18.865	1.255
Fowling	34	38.863	.609	95	90.135	.263
$\Sigma X^2 = 5.037 \quad df = 1 \quad .05 > p > .02 \quad V = .180$						
Σ Fishing	13	6.540	6.380	14	20.460	2.039
Marine mammal hunting	26	32.460	1.285	108	101.540	.411
$\Sigma X^2 = 10.116 \quad df = 1 \quad .01 > p > .001 \quad V = .251$						

Table 23. Chi-square analyses of relationships between scaled values of Marine mammal hunting subsistence equipment and prey resources in Mound 44 and Mound 8.

	Taskonomic category			Prey resources		
	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
Mound 44						
Marine mammal hunting	52	57.226	.477	46	40.774	.670
Σ Fishing	28	22.774	1.199	11	16.226	1.683
$\Sigma X^2 = 4.030$ df = 1 .05>p>.02 V = .172						
Marine mammal hunting	52	51.079	.017	46	46.921	.018
Fowling	34	34.921	.024	33	32.079	.026
$\Sigma X^2 = .085$ df = 1 .80>p>.70 V = .023						
Marine mammal hunting	52	64.450	2.405	46	33.550	4.620
Land hunting	94	81.550	1.901	30	42.450	3.652
$\Sigma X^2 = 12.528$ df = 1 p>.001 V = .238						
Mound 8 east houses						
Marine mammal hunting	38	43.040	.590	108	102.960	.247
Σ Fishing	13	7.960	3.192	14	19.040	1.334
$\Sigma X^2 = 5.363$ df = 1 .05>p>.02 V = .176						
Marine mammal hunting	38	38.225	.001	108	107.775	.000
Fowling	34	33.775	.002	95	95.225	.001
$\Sigma X^2 = .004$ df = 1 p>.95 V = .004						
Marine mammal hunting	38	42.793	.537	108	103.207	.223
Land hunting	64	59.207	.388	138	142.793	.161
$\Sigma X^2 = 1.308$ df = 1 .30>p>.20 V = .238						

Table 24. Results of the continued heuristic scaling.

Subsistence equipment (scaled)	Mound 44 vs. Mound 8	ΣX^2 3.712 .30>p>.20
Fauna remains (scaled)	Mound 44 vs. Mound 8	ΣX^2 11.278 .02>p>.01
Subsistence equipment	Mound 44 vs. fauna remains Mound 8	ΣX^2 24.763 p<.001
Fauna remains	Mound 44 vs. subsistence equipment Mound 8	ΣX^2 4.0234 .02>p>.01

relationship of subsistence equipment to procured bones of the strategic complex Marine Mammal Hunting. Both mounds show a statistical under-representation of subsistence equipment, while their proportions of that equipment category are nearly identical. The fauna bones show greater proportional diversity. Therefore, if we substitute the expected value of 51.96 for the observed 36 pieces of subsistence equipment in Mound 44 and 38 for the observed frequency of 26 in Mound 8 and repeat the testing, we find that the fit again improves (table 23).

The foregoing two-step data scaling produced a

considerable improvement in the fauna remains-subsistence equipment proportions within the respective mounds, i.e. from ΣX^2 37.852 in table 20 to 18.550 ($p < .001$) for Mound 44 and from ΣX^2 21.677 in table 21 to 6.428 (.10>p>.05) for Mound 8 east houses. Additional cross-sample checks also indicated the success of the heuristic scaling (table 24; see appendix 10).

Inspection of the respective Chi-square coefficients led to the conclusion that residual heterogeneity was primarily caused by a tertiary over-representation of Land Hunting Subsistence Equipment in both mounds, a trend also to be seen in tables 20

Table 25. Results of the continued heuristic scaling.

Subsistence equipment (scaled)	Mound 44 vs. Mound 8	ΣX^2 3.514 .50> p >.30
Subsistence equipment	Mound 44 vs. fauna remains Mound 8	ΣX^2 23.299 p <.001
Fauna remains	Mound 44 vs. subsistence equipment Mound 8	ΣX^2 8.280 .05> p >.02.

Table 26. Results of the continued heuristic scaling.

Mound 44 equipment vs. Mound 44 fauna	ΣX^2 11.485 .01> p >.001,
Mound 8 equipment vs. Mound 8 fauna	ΣX^2 3.234 .50> p >.30,
Subsistence equipment (scaled) Mound 44 vs. Mound 8	ΣX^2 1.234 .80> p >.70,
Fauna remains (scaled) Mound 44 vs. Mound 8	ΣX^2 8.739 .05> p >.02,
Subsistence equipment Mound 44 vs. fauna remains Mound 8	ΣX^2 5.577 .20> p >.10,
Fauna remains Mound 44 vs. subsistence equipment Mound 8	ΣX^2 8.280 .05> p >.02.

Table 27. Results of the final heuristic scaling.

Mound 44 equipment vs. Mound 44 fauna	ΣX^2 5.047 .20> p >.10,
Mound 8 equipment vs. Mound 8 fauna	ΣX^2 3.234 .50> p >.30,
Subsistence equipment (scaled) Mound 44 vs. Mound 8	ΣX^2 1.234 .80> p >.70,
Fauna remains (scaled) Mound 44 vs. Mound 8	ΣX^2 3.396 .30> p >.20,
Subsistence equipment Mound 44 vs. fauna remains Mound 8	ΣX^2 5.577 .20> p >.10,
Fauna remains Mound 44 vs. subsistence equipment Mound 8	ΣX^2 3.289 .50> p >.30.

and 21. As this taskonomic category has not yet been corrected or scaled for its inherent tool/tool-kit relation, the frequencies were scaled down to the closest integer of their expected values in the foregoing tests in this fashion the Mound 44 frequency of 94 was scaled down to 79 and that of Mound 8 east house from 64 to 59. Subsequent testing (appendix 11) demonstrated increased proportional homogeneity within the mounds, between the mounds and in the cross-sample checks.

The Mound 44 ΣX^2 was reduced to 13.530 (.01> p >.001) as was that for Mound 8, i.e. 5.971 (.20> p >.10). The same set of cross-sample checks demonstrated the improved fit (table 25).

The Fauna Remains (scaled) Mound 44 vs. Mound 8 test was not affected by this tertiary step in the heuristic scaling. A diagnosis of significant over-representation of the Chi-square coefficients of that analysis as well as the results of the foregoing analyses which yielded significant differences, i.e. Subsistence Equipment Mound 44 vs. Fauna Remains Mound 8, Subsistence Equipment Mound 44 vs. Fauna Remains Mound 44 and Fauna Remains Mound 44 vs. Subsistence Equipment Mound 8, suggests that these are caused by an over-representation of Fishing Equipment in Mound 44 and an under-representation of fish/shellfish fauna remains in Mound 8, a trend also seen in earlier tests. Therefore we scaled the Mound 44 Fishing Equipment from 28 down to 15 and the Mound 8 fish/shellfish remains from 14 up to the previously observed value

of 19. The resulting tests showed an increased statistical homogeneity (table 26; appendix 12).

While the foregoing step in the heuristic scaling displays a considerable improvement in the achievement of statistical homogeneity, significant differences are observed for the combinations Mound 44 Equipment vs. Mound 44 Fauna, Mound 44 Fauna vs. Mound 8 Fauna and Fauna Remains Mound 44 vs. Subsistence Equipment Mound 8. In all cases the failure to attain a non-significant result lies in the under-representation of Land Hunting Fauna in Mound 44. In order to correct for this bias, the observed frequency of 30 was scaled up to 42, approximating the mean of its expected values in previous analyses (appendix 12). The data on this fifth stage testing are to be found in appendix 13. The results, presented below, show the attainment of complete proportional homogeneity (table 27).

Proceeding from the figures which produced these results, the iterative analyses of subsistence equipment-fauna remains cohorts, which led to the generation of figure 5, was repeated (appendix 14). The results, graphically rendered according to the respective Cramer's V correlation coefficient distances are presented in figure 6.

The foregoing Venn-diagram demonstrates a considerably greater degree of statistical affinity than figure 5. In conclusion, this exercise in heuristic scaling has produced an internally consistent and homogeneous sample whereby the optimal proportional balance between the tool-kits of subsistence

Table 28. Final heuristically scaled homogeneous frequencies of Inupiat subsistence equipment and fauna remains for Mound 44 and Mound 8 east houses.

	Mound 44				Mound 8 east houses			
	Equipment		Faunal remains		Equipment		Faunal remains	
Fishing	15	8.3 %	11	8.3 %	13	9.0 %	19	5.3 %
Land hunting	79	43.9 %	42	31.8 %	59	41.0 %	138	38.3 %
Marine mammal hunting	52	28.9 %	46	34.8 %	38	26.4 %	108	30.0 %
Fowling	34	18.9 %	33	25.0 %	34	23.6 %	95	26.4 %
	180		132		144		360	

Final percentages Iñupiat economy

Fishing	5.3 - 9.0 %
Land hunting	31.8 - 43.9 %
Marine mammal hunting	26.4 - 34.8 %
Fowling	18.9 - 26.4 %

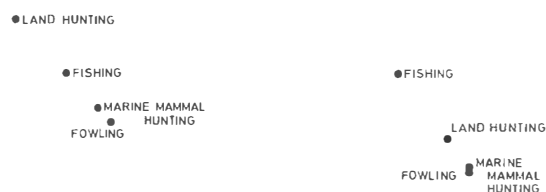


Fig. 6. Venn-diagrams of statistical affinities between heuristically scaled values of subsistence equipment and prey resources in Mound 44 and Mound 8 east houses.

equipment and the derived products of the execution of those subsistence activities has been established. Furthermore, this has been accomplished by scaling only eight of the sixteen cohort cells in such a fashion that the minimum deviation from the original (real) figures was employed. In order to demonstrate the efficacy of this exercise, the final scaled figures are rendered as percentages and then compared with relevant ethnographic data. This form of ethno-archaeological testing will demonstrate the goodness-of-fit between our scaled frequencies and those observed from Native harvest survey figures. The final heuristically scaled figures are presented in table 28.

8. THE ETHNO-ARCHAEOLOGICAL TEST

Having scaled the subsistence equipment and fauna remains in Mound 44 and Mound 8 east houses to correct for inherent bias in the data, it remains to test that result for relevance and efficacy. This was done by looking at recent historical and modern Native

harvest survey figures recorded for Iñupiat hunting societies on the Chukchi and Beaufort Sea coasts of the North Slope of Alaska. Bearing in mind the limitations and mutual comparability of such surveys (Usher & Wenzel, 1987) as well as the variation potentially caused by the temporal and subsistence technological differences (Sonnenveld, 1960) between the survey data and our archaeological samples, we nevertheless are confident that the regularities observed within the three geographically proximate surveys provide reliable representations of the Iñupiat subsistence economy. Extant surveys come from Kaktovik (Nielson, 1977) and Barrow (Nielson, 1977; Braund et al., 1988). Expressed in terms of numbers of individuals harvested, the percentages (when partitioned into our four main subsistence activity categories) provide a poor fit with the heuristically scaled data, see table 29. However, when the original survey data are converted into dressed weights, a much better fit obtains.

The scaled archaeological percentages fit well within the ranges observed in our analogous samples. The only deviation is that for the category Fowling, where the archaeological data indicate higher proportions, in fact proportions more in keeping with the number of individuals harvested. Nevertheless, on the strength of this fit we would suggest that the scaled figures of the archaeological sample provide a reliable resolution of the composition of the Iñupiat economy. Therefore in our final analysis we will use those figures as base-line data to test for and diagnose the hierarchy of sample bias inherent in the original observed figures, i.e. tables 6 and 16. The testing will be executed by means of Chi-square tests of goodness-of-fit, using the scaled data as the point of departure.

Table 29. Comparison of archaeological resolution of Iñupiat subsistence economy and that provided by historical Native subsistence survey data.

Activity	Percentage scaled archaeological data	Percentage number individuals harvested			Percentage by dressed weights		
		Kaktovik	Barrow 1977	Barrow 1987	Kaktovik	Barrow 1977	Barrow 1987
Land hunting	31.8 - 43.9	6.18	15.04	3.59	83.72	94.98	33
Marine mamm. hunting	26.4 - 34.8	1.24	2.72	1.57			54
Fowling	18.9 - 26.4	23.15	14.52	19.02	2.10	.56	3
Fishing	5.3 - 9.0	69.44	67.72	75.82	14.18	4.46	10

Table 30. Chi-square goodness-of-fit tests of the observed unscaled fauna and equipment data.

Subsistence category	Obs.	Exp.	X ² coeff.
<i>Mound 44 fauna</i>			
Land hunting	30	35.30	.796
Marine mammal hunting	46	38.63	1.406
Fowling	33	27.75	.993
Fishing	2	9.21	5.644
Total	111		
		$\Sigma X^2 = 8.839$	df = 3 .05> p >.02
<i>Mound 8 fauna</i>			
Land hunting	138	132.90	.196
Marine mammal hunting	108	104.10	.146
Fowling	95	91.61	.125
Fishing	6	18.39	8.348
Total	347		
		$\Sigma X^2 = 8.815$	df = 3 .05> p >.02
<i>Mound 44 subsistence equipment</i>			
Land hunting	94	137.85	13.949
Marine mammal hunting	36	90.75	33.031
Fowling	156	59.35	157.392
Fishing	28	26.06	.144
Total	314		
		$\Sigma X^2 = 204.516$	df = 3 p <.001
<i>Mound 8 subsistence equipment</i>			
Land hunting	64	56.17	1.091
Marine mammal hunting	26	36.17	2.860
Fowling	34	32.33	.086
Fishing	13	12.33	.036
Total	137		
		$\Sigma X^2 = 4.073$	df = 3 .30> p >.20

9. DIAGNOSIS OF THE HIERARCHY OF ARCHAEOLOGICAL SAMPLE BIAS

Execution of this final set of tests proceeds from the original, observed and unscaled frequencies of fauna and subsistence equipment cohorts from Mound 44 and Mound 8, as given in tables 3 and 12, and

from the percentages of final scaled frequencies, given in the respective right-hand columns of table 28. For each of the four tests, i.e. Mound 44 Fauna, Mound 44 Subsistence Equipment, Mound 8 Fauna and Mound 8 Subsistence Equipment, the observed frequencies are summed and then divided by the respective percentage figure to produce the expected value for the Chi-square goodness-of-fit testing (table 30). Goodness-of-fit is called for here because we wish to examine the degree and direction of variation between the skewed archaeologically observed data and what those data should be if that bias, identified by the foregoing scaling, were absent or removed. Because the structure of all four tests is identical, i.e. 2x4, and because the basis for the calculation of the expected values is the set of mutually homogeneous scaled proportions of all four data-sets, the resulting X² coefficients are mutually comparable. In the second instance, the X² coefficients will be ordered in descending order and analyzed for modality along the underlying continuum of quantified bias/deviation from the null hypothesis of homogeneity. This hierarchical ordering and significant modality will be used to formulate a diagnosis of that bias. The respective tests are presented in table 30.

Three of the four foregoing tests yielded statistically significant results. In all cases, it is obvious that the constituent X² coefficients are not uniformly distributed through all the cells of their testing structures. On the contrary, they display great variability, i.e. 157.392-.036. Arranged hierarchically in descending order, they are listed in the left-hand column of table 31, together with their respective proveniences. The third column contains the actual observed frequencies, in bold, and the expected numbers from table 30. The last column records the direction of the analytically discriminated skewness, i.e. over-representation or under-representation (see table 31).

As all the tests presented in table 30 and whose results are ranked in table 31 have the same data structure, i.e. 2x4, we can establish the .05 significance threshold for each of the constituent X²

Table 31. Hierarchical order and diagnosis of X² coefficients measuring deviation from expected heuristic homogeneity.

X ² Coeff.	Test cell provenience			Obs.		Exp. diagnosis	Directionality
157.392	Mound 44	Fowling	Equip.	156	vs.	59.35	Over-represented
33.031	Mound 44	Marine mammal	Equip.	36	vs.	90.75	Under-represented
13.949	Mound 44	Land hunting	Equip.	94	vs.	137.85	Under-represented
8.348	Mound 8	Fishing	Fauna	6	vs.	18.39	Under-represented
5.644	Mound 44	Fishing	Fauna	2	vs.	9.21	Under-represented
2.860	Mound 8	Marine mammal	Equip.	26	vs.	36.17	Under-represented
1.406	Mound 44	Marine mammal	Fauna	46	vs.	38.63	Over-represented
1.091	Mound 8	Land hunting	Equip.	64	vs.	56.17	Over-represented
.993	Mound 44	Fowling	Fauna	33	vs.	27.75	Over-represented
.796	Mound 44	Land hunting	Fauna	30	vs.	35.30	Under-represented
.196	Mound 8	Land hunting	Fauna	138	vs.	132.90	Over-represented
.146	Mound 8	Marine mammal	Fauna	108	vs.	104.10	Over-represented
.144	Mound 44	Fishing	Equip.	28	vs.	26.06	Over-represented
.125	Mound 8	Fowling	Fauna	95	vs.	91.61	Over-represented
.086	Mound 8	Fowling	Equip.	34	vs.	32.33	Over-represented
.036	Mound 8	Fishing	Equip.	13	vs.	12.33	Over-represented

Table 32. Fisher exact probability test of the differences from table 27.

	Under-represent.	Over-represent.
Significant difference	5	1
Non-signif. difference	1	9
	$p = .007$	
Fauna Equipment		
Significant difference	2	4
Non-signif. difference	6	4
	$p = .245$	
Mound 44 Mound 8 east houses		
Significant difference	4	2
Non-signif. difference	4	6
	$p = .245$	

coefficients. At the .05 level we expect that each cell will have a X² coefficient of 1.955 or less (7.82÷4). Any coefficient greater than that figure identifies a data-set whose observed frequency deviates significantly from the null hypothesis. That significance threshold is rendered in table 31 by the horizontal dotted line, indicating that the first six ranked coefficients, i.e. 157.392-2.860, are statistically significant while the latter ten are not. We would also like to call the reader's attention to the fact that five of the first six coefficients record under-representation, while nine of the ten deviations of the non-significant X² coefficients show over-representation. This relationship is in itself statistically significant, see table 32, while the differential distributions of deviations between Mound 44 and Mound 8

east houses or between fauna and Subsistence Equipment are not.

Again because of the uniformity of the data structure, i.e. four tests of 2x4 contingency tables, we may multiply the .05 significance level of 7.82 by four in order to establish the maximum sum of totalled deviation for all the tests, i.e. 31.280, permitted under the null hypothesis. Adding the X² coefficients obtained from the four analyses in table 30, we obtain a sum of 226.243, a figure somewhat in excess of the expected maximum of 31.280. The observed hierarchy of significantly deviating X² coefficients may then also be expressed as percentages of the total skewness, irrespective of direction, i.e. over-representation (71.425) or under-representation (28.575). Such percentages will be used in the subsequent diagnoses.

In order to organize that diagnosis, the foregoing hierarchy of X² coefficients was examined for modality along the underlying continuum of deviation from the null hypothesis. Single-sample Chi-square analysis (Siegel, 1956) was able to discriminate at least three modes, see table 33.

The single-sample testing reveals that the significant X² coefficients are distributed in at least three modes, i.e. 157.392, 33.031 and 13.949-2.860. The untestable non-significant coefficients 1.406-.036 may constitute a fourth mode, but as they are not significant, they will not be analyzed further. In the following, the six significant departures from the null hypothesis of homogeneity will be diagnosed and interpreted in terms of the extant hierarchy of archaeological sample bias.

The greatest deviation from the expected proportional representation is that of Mound 44 Fowling equipment, which is over-represented and accounts

Table 33. Single-sample Chi-square testing for modality in the measured significant skewness in the archaeological resolution of Iñupiat subsistence cohorts.

X ² Coeff.			ΣX ² = 7.751 df=1	
157.392				
33.031				
13.949			ΣX ² =178.134 df=2 p<.001	
8.348	ΣX ² =488.489	ΣX ² = 45.466	.01>p>.001	
5.644	df = 5	df = 4	ΣX ² = 7.700	ΣX ² = 2.681
2.860	p <.001	p <.001	df = 3	df = 2
			.10>p>.05	30>p>.20
Decision				
Mode 1	157.392			
Mode 2	33.031			
Mode 3	13.949-2.860			

for 69.57% of the summed ΣX² of all four tests, i.e. 157.392/226.243. As we have seen above, this source of bias is largely due to the exceptional preservation of complete tool-kits in the systemic, non-abandoned context of Mound 44. The emic integrity of the tool-kits of subsistence equipment is retained because the normal processes of pre-abandonment, abandonment and post-abandonment have not transformed the systemic context into an archaeological context. Curation and storage behaviours are represented reliably in the archaeological record of the non-abandoned, catastrophically terminated Mound 44 house. Such patterns are largely lost in Mound 8, where we have seen that the tool/tool-kit relationship has been destroyed, e.g. the obtained better fit when the Mound 8 raw data for Fowling equipment are used contra those data scaled according to the proportions established by Kilmarx (in press) for Mound 44.

The second largest deviation is that provided by Mound 44 Marine Mammal Hunting Equipment, which is under-represented and accounts for 14.60% of the summed X²s. Again we can quantify the bias caused by differential archaeological resolution of curation and storage behaviours in the systemic vs. the archaeological (abandoned) context. Size dependent differential storage behaviours, i.e. outside storage of large and bulky items of subsistence equipment vs. inside storage of tool-kits of smaller items of subsistence equipment, has led to a bifurcation in the placement of that equipment. Due to the nature of the site formation process, *ivu*, the outside items of Marine Mammal Hunting Equipment have been lost to the archaeological record.

The constituents of the third mode are: 1. Mound 44 Land Hunting Equipment, 2. Mound 8 Fishing Fauna and 3. Mound 44 Fishing Fauna. Together they account for 30.801 or 13.61% of the total ΣX² and form the lower end of the statistically significant deviations from the null hypothesis. The largest

component of this mode, Mound 44 Land Hunting Equipment, clustered somewhat skewed to the main group in figure 6 and the proportionally lower frequencies for this category of subsistence equipment may reflect the season of the termination of Mound 44. In terms of the second and third, despite differences in taphonomic context, fish/shellfish bones are under-represented in both mounds. This may be due to the fact that the greater part of the fish catch was used to feed the dogs, which were normally kept and fed outside the *iglu*. The virtual absence of fish in the fauna bones found during the Mound 8 extra-mound test may be cited in support of this argument. Unfortunately, recent land-use above and proximal to Mound 44 precluded a reliable extra-mound test of the outsidespace associated with the 'frozen family' occupation. The last constituent, Mound 8 Marine Mammal Equipment displays under-representation, similar to that observed for Mound 44, the mode 2 deviation described above. This too is the result of differential storage behaviours in the form of outside storage of large and bulky items of subsistence equipment, compounded by the effects of curation of both outside and inside stored material as a result of abandonment behaviours.

The last mode of X² coefficients is not statistically significant, i.e. their deviations from the expected frequencies are within the accepted .05 limits of sample error, measuring error and analytical error. With one exception, Mound 44 Land Hunting Fauna, all ten deviations tend toward over-representation, significantly contrasting with the trend in the foregoing significant deviations (table 32). As one might expect, most are the mirror image of the significant deviations, e.g. the significant deviation of Mound 44 Marine Mammal Equipment is mirrored by the non-significant variation of Mound 44 Marine Mammal Fauna, etc. An exception is formed by the Mound 8 Fowling Fauna and Equipment diad, both of which are non-significant. However, when

Table 34. Chi-square test of the significant over-representation/under-representation proportions between Mound 44 and Mound 8 east houses.

	Obs.	Over-representation Exp.	X ² coeff.	Obs.	Under-representation Exp.	X ² coeff.
Mound 44	157.392	149.418	.426	52.624	60.598	1.049
Mound 8	0.000	7.974	7.974	11.208	3.234	19.622
$\Sigma X^2 = 29.111$ df = 1 $p < .001$ Invalid						

we look at the respective directions of the significant and non-significant deviations, only partial isomorphism obtains. Both cohorts of Mound 44 Fowling and Mound 8 Land Hunting display over-representation, while both cohorts of Mound 44 Land Hunting and Mound 8 Fishing show minimal under-representation. Complementary directionality is observed for both constituents of Mound 44 Marine Mammal Hunting, Mound 44 Fishing and Mound 8 Marine Mammal Hunting. This residual variation is distributed equally over both mounds and their subsistence activities, e.g. Fowling (Mound 44) over-represented, Fishing (Mound 8) under-represented and Land Hunting (Mound 44 and Mound 8) over-represented. This remaining variation is most probably indicative of a minimal amount of remaining bias carried over from the scaling exercise.

In conclusion, we have established and diagnosed the quantitative hierarchy of directional biases in the archaeological records of the systemic context (Mound 44) and the more usual, abandoned archaeological context (Mound 8). We have seen that significant over-representation in the former accounts for 69.57% of the total measured variability, while its significant under-representation accounts for 23.26% of same. As one might expect, significant over-representation in the normally abandoned archaeological context of Mound 8 is absent and explainable significant under-representation for but 4.95% of that variation. Table 34 suggests that the differences in these proportions are statistically significant.

Unfortunately the expected value of the under-representation cell of Mound 8 renders the test statistically invalid (Siegel, 1956). Nevertheless, the disparity in the proportions is clear. Armed with the analytical resolution behind these proportions, we can begin to understand the direction and degree of skewness inherent in the archaeological record and therefore to develop effective algorithms to correct for same. In this way we will be in a position to operationalize and test the relevance of results obtained from middle-range research (Binford, 1977; 1983). Armed with these results and with insights into the sources of archaeological variation and their algorithmic discrimination and measurement, we can return to the thornier problems of archaeological

contexts lacking any direct historical continuity or observable ethno-archaeological data base, e.g. hunter-fisher-gatherer societies in western Europe (Houtsma et al., in prep.; Newell & Andersen, in prep.), in order to pursue reconstructions of past subsistence strategies and economic systems.

10. CONCLUSION: PERSPECTIVES FOR ECONOMIC RECONSTRUCTION BASED ON SUBSISTENCE EQUIPMENT AND FAUNA REFUSE

From the foregoing analyses of the subsistence equipment and fauna refuse components from two taphonomically contrasting contexts (systematic vs. archaeological) within the same village of the prehistoric/early historic Kakligmiut society, the first and most important conclusion is that neither the one nor the other data-set provides a behaviourally reliable resolution of the economic system. The best approximation is achieved only when both sources of input are integrated and inherent bias is identified and diagnosed through rigorous analysis. Secondly, uncritical lumping of the diagnostic variability of natural provenience units into a single site fauna assemblage and ignoring the cultural/material component of the execution of the economic strategy which generated that assemblage leads to irrelevant homogenization and low-level resolution of the lowest common denominator of prehistoric economic systems. Such low-level resolution of lumped *prima facie* fauna data, divorced from its cultural, generative and depositional context constitutes an unnecessarily impoverished point of departure for inter-site comparisons.

Based on the foregoing, we would argue that archaeological reconstructions of prehistoric economic systems must proceed from both the cultural/material remains of that economy's execution and its indirect results, the fauna and/or flora assemblage(s). Secondly, both must be analyzed for sample bias and the potentially differential effects of site formation processes. It is our position that this can only be done effectively when both the subsistence equipment and the fauna/flora

assemblage(s) are partitioned into and analyzed within the context of their culturally relevant natural provenience units. The common archaeozoological practice of treating fauna assemblages as a single homogeneous and uniform entity, e.g. the 'minimum distinction' method of Grayson (1973; 1984) is to be eschewed, as is the arbitrary partitioning of that assemblage into 'excavation units', such as trenches, squares or arbitrary 'levels' within the same lithologic, depositional or cultural deposit. The effects and consequences of the imposition of an excavation grid upon a prehistoric settlement have been dealt with elsewhere (Newell, 1980; Newell & Dekin, 1978). In most cases such units fail to even approximate culturally relevant natural provenience units (*sensu* Speth & Johnson, 1976) and therefore cannot be expected to yield behaviourally relevant information on their own. Worse still is when stratigraphic disconformities and successive living-floors are ignored and many hundreds of years of discrete occupations are combined to produce one single 'fauna assemblage' (e.g. Clason, 1977; see Andersen et al., *in press*) so that eventual seasonal and/or subsistence strategic and/or structural pose (Gearing, 1958) variation becomes lost in the homogenization of the lowest common denominator, i.e. species harvested. This minimal, paleontological rendition of land-use tells us nothing about human behaviour and offers few perspectives for the interpretation of other sources of archaeological data. Only after the cultural mechanisms of economic strategy execution and the cultural and archaeological filters of consumption, storage, disposal and site-formation processes have been discriminated and brought under analytical control will the archaeologist be in a position to make meaningful statements about the reconstruction of prehistoric economic systems.

Proceeding from the core concepts of Linton (1936: p. 211), Sapper (1924: p. 96), Steward (1955: p. 125), and White (1959: p. 65), the ecological approach ignores the fact so well demonstrated by Burch (1980; 1981) and Burch & Correll (1972) that subsistence is a process of cultural choice. Its execution is the expression of a selection process from a range of possible alternatives. The social environment as much as, if not more than, imagined limitations or ceilings imposed by the ecosystem, defined the respective subsistence strategies (Dewar, 1984). Until the study of variation in patterns of consumption has been related to their archaeological residue (Binford, 1978a,b; 1981a,b; Binford & Bertram, 1977) and then combined with variation in patterns of exploitation, the human ecology paradigm will not become an effective or relevant vehicle for the explanation of cultural processes or the variability in the composition of the archaeological record.

Despite the work done in the past in all of the foregoing paradigms and approaches, they have, in

fact, brought us no closer to an understanding of prehistoric economic systems and level of adaptive success (Smith, 1976). Clearly, one needs an effective understanding of the properties, parameters, dynamics, and inter-relationships of cultural processes and mechanics (= the 'human factor') before they are uncritically related to human ecological observations, data, and phenomena in an attempt to provide causation or explanation. When resorting to the ecological paradigm to explain variation in those fauna assemblages, researchers would do well to recall the admonishments of Richerson (1977) and Winterhalder (1983):

"The purpose of this paper is to explore the relationship between modern biological ecology and the contemporary uses of ecological ideas by social scientists. Its major thesis is that past attempts to use the biological sciences as a foundation for human ecology have usually had two weaknesses. The first is a misunderstanding of the special role of evolutionary theory in ecology, and the second is the real difficulty of understanding how human cultural phenomena can be incorporated as a special case or by extensions of the biological theory. These weaknesses have arisen because some ideas in ecology which social scientists have considered particularly attractive have been largely rejected by biologists and because biologists have been slow to take the peculiar properties of culture seriously. Notwithstanding these problems, I suggest that a theory of human ecology can be readily developed from existing similarities between the theoretical constructs of social and biological sciences and that this approach is very promising."

(Richerson, 1977: p. 2)

and

"Particularities of the environment, of family composition, and of kinship relationships contribute elements missing from the generalized ecological hypothesis (Rogers & Black, 1976: 39-40). An essentially correct ecological prediction may still capture only a portion of the actual variability of a human situation."

(Winterhalder, 1983: p. 232)

The cultural or human factor in foraging based subsistence strategies has received very little attention in the European archaeological literature. This is understandable because such conceptual, ideological, and behavioural complexes leave few, if any, direct material expressions, which may become part of the interpretable archaeological record. Secondly, and because they are not demonstrable as primary data, the integration of these parts of the total equation demands and is dependent upon the acceptance of processual analogy (Binford, 1967; 1968; 1972; 1977; 1978a,b; 1983; Dalton, 1981). Therefore cultural ecologists using prehistoric fauna and subsistence equipment data to reconstruct past economic systems must be aware of and sensitive to these inherent biases in the presently available data base. Not until these identified lacunae have been filled and the total data base can be demonstrated to be

representative of prehistoric procurement, subsistence, consumption, and disposal behaviours will it be possible to evaluate the relevance or explanatory power of the cultural ecology paradigm in archaeological research.

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12. NOTES

1. Despite the statistical power of multiple contingency table analysis, Everett (1977) has demonstrated that there are limitations to the analytical resolution of small numbers, i.e. frequencies <3. Verbeek et al. (1983) suggest the use of hypergeometric probabilities as a partial solution to this problem.
2. In the interests of replicability, the following Utqiagvik provenience units, as coded in the excavation database, were used in the compilation of the data for this study.

Mound 8:	entr-low pit	katak-rm tun	sill-cache on-floor	kit-bin tun-alcove	kit-flr sblf-cache	kit-pass wall-cache
Mound 44:	black soil NW cache pit pit leg sm tun cache sblf-cache	katak ice e bin pit leg lg katak-rm tun flr sill cache	kit bin pit leg fl pit bds kitchen nw tun ice wall cache	pit leg kit ice entr-low tun tun crunge	kit flr se bin kit pass tun alcove tun trove	bursd8306 sw bin pit gut tun bag on-floor

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Appendix 3. Analyses of identified and unidentified fauna bone frequencies by house and major architectural partition.

	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
	Mound 44			Mound 8 east houses		
<i>Identified bone</i>						
House	45	53.804	1.440	177	168.197	.461
Tunnel/entrance	39	13.572	47.641	17	42.428	15.240
Kitchen	27	43.624	6.335	153	136.376	2.027
	ΣX ² = 73.143 df= 2 p<.001					
<i>Unidentified bone</i>						
House	22	76.401	38.736	212	157.599	18.778
Tunnel/entrance	89	54.199	22.346	77	111.801	10.833
Kitchen	96	76.401	5.028	138	157.599	2.437
	ΣX ² = 98.158 df= 2 p<.001					
<i>Mound 44</i>						
	Identified bone			Unidentified bone		
House	45	23.387	19.974	22	43.613	10.711
Tunnel/entrance	39	44.679	.722	89	83.321	.387
Kitchen	27	42.934	5.913	96	80.066	3.171
	ΣX ² = 40.878 df= 2 p<.001					
<i>Mound 8 east houses</i>						
	Identified bone			Unidentified bone		
House	177	174.397	.039	212	214.603	.032
Tunnel/entrance	17	42.142	15.000	77	51.858	12.190
Kitchen	153	130.461	3.894	138	160.539	3.164
	ΣX ² = 34.318 df= 2 p<.001					

Appendix 4. Full analysis of screened fauna assemblages from Mound 44 and Mound 8 east houses.

	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
	Mound 44			Mound 8 east houses		
Bear	1	4.368	2.597	14	10.632	1.067
Caribou	26	42.516	6.416	120	103.484	2.636
Musk ox	2	.582	3.450	0	1.418	1.418
Fish/shellfish	2	2.330	.005	6	5.670	.019
Bird	33	37.275	.490	95	90.725	.201
Fox	1	1.456	.143	4	3.544	.059
Walrus	10	9.901	.001	24	24.099	.000
Whale	25	8.736	30.277	5	21.264	12.439
Seal	11	26.209	8.826	79	63.791	3.626
Unidentified bone	207	184.626	2.711	427	449.374	1.114
	$\Sigma X^2 = 77.538$ df = 9 $p < .001$ INVALID					

Appendix 6. Subsistence equipment frequencies by house, type and major architectural partition.

Artifact type	House	Kitchen	Tunnel/entrance	Total
Mound 44				
Arrow	12	2	17	31
Projectile point	7	-	8	15
Dart	-	-	1	1
Shaft	9	4	31	44
Bow	-	-	2	2
Wristguard	-	-	1	1
Sub-total	28	6	60	94
Bolas weights	45	1	103	149
Bird blunt	4	-	3	7
Sub-total	49	1	106	156
Net	-	-	5	5
Net float	-	-	1	1
Net sinker	-	-	1	1
Sub-total	0	0	7	7
Fish spear	1	-	1	2
Line weight	2	-	2	4
Fish jig	2	-	-	2
Fish lure	7	1	5	13
Sub-total	12	1	8	21
Harpoon	4	-	18	22
Ice pick	4	-	-	4
Ice scoop	-	-	1	1
Seal call	1	-	1	2
Socket/toggle	1	-	2	3
Nozzle	1	-	3	4
Sub-total	11	0	25	36
Grand totals	100	8	206	314
Mound 8 east houses				
Arrow	10	2	20	32
Projectile point	6	-	2	8
Dart	1	-	1	2
Shaft	7	3	7	17
Bow	-	-	5	5
Wristguard	-	-	-	-
Sub-total	24	5	35	64
Bolas weights	20	-	7	27
Bird blunt	4	-	3	7
Sub-total	24	0	10	34
Net	-	-	1	1
Net float	-	-	-	-
Net sinker	-	-	1	1
Sub-total	0	0	2	2

Appendix 6. (Cont.).

Artifact type	House	Kitchen	Tunnel/entrance	Total
Fish spear	2	-	1	3
Line weight	2	-	-	2
Fish jig	1	-	-	1
Fish lure	2	1	2	5
Sub-total	7	1	3	11
Harpoon	9	1	9	19
Ice pick	1	-	-	1
Ice scoop	-	-	-	-
Seal call	2	-	-	2
Socket/toggle	1	-	1	2
Nozzle	1	-	1	2
Sub-total	14	1	11	26
Grand totals	69	7	61	137

Appendix 7. Pair-wise testing of subsistence equipment frequencies by major architectural partition.

	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
	Mound 44			Mound 8 east houses		
House + tunnel/entrance	306	303.557	.020	130	132.444	.045
Kitchen	8	10.443	.572	7	4.557	1.310
	$\Sigma X^2 = 1.947 \quad df = 1 \quad .20 > p > .10 \quad \text{INVALID}$					
House	100	118.610	2.920	69	50.390	6.873
Tunnel/entrance	206	187.390	1.848	61	79.610	4.350
	$\Sigma X^2 = 15.992 \quad df = 1 \quad p < .001$					
House	100	99.196	.007	69	69.804	.009
Kitchen	8	8.804	.073	7	6.196	.104
	$\Sigma X^2 = .194 \quad df = 1 \quad p < .001$					
Tunnel/entrance	206	202.617	.056	61	64.383	.178
Kitchen	8	11.383	1.005	7	3.617	3.164
	$\Sigma X^2 = 4.404 \quad df = 1 \quad .05 > p > .02 \quad \text{INVALID}$					

Appendix 8. Iterative pair-wise testing of taskonomic category frequencies between Mound 44 and Mound 8 east houses.

Land hunting	.558				
Active fishing	.322	.693			
Passive fishing	.880	.512	.308		
Marine mammal hunting	<.001	.037	1.000	<.001	
Fowling					
	Land hunting	Active fishing	Passive fishing	Marine mammal hunting	Fowling

Appendix 9. Testing the numerical and spatial homogeneity of scaled and raw frequencies of fowling equipment in Mound 44 and Mound 8 east houses.

	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
	Mound 44 (scaled)			Mound 8 east houses (scaled)		
Bird fauna bones	33	49.287	5.382	95	78.713	3.370
Fowling equip.	34	17.713	14.977	12	28.287	9.378
	$\Sigma X^2 = 33.107 \quad df = 1 \quad p < .001$					
Bird fauna bones	33	43.755	2.644	95	84.245	1.373
Fowling equip.	34	23.245	4.976	34	44.755	2.585
	$\Sigma X^2 = 11.577 \quad df = 1 \quad p < .001$					

Relationship between subsistence equipment suites in both mounds (fowling scaled in both house mounds)

Land hunting	94	98.814	.235	64	59.186	.392
Active fishing	21	20.013	.049	11	11.987	.081
Passive fishing	7	5.629	.334	2	3.371	.557
Fowling	34	28.769	.951	12	17.231	1.588
Marine mammal hunting	36	38.775	.199	26	23.225	.332
	$\Sigma X^2 = 4.718 \quad df = 4 \quad .50 > p > .30$					

Appendix 9. (Cont.).

	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
Fowling	34	12	Fowling	34	12	
Land hunting	94	64	Active fishing	21	11	
		$p = .084$			$p = .430$	
Fowling	34	12	Fowling	34	12	
Passive fishing	7	2	Marine mammal hunting	36	26	
		$p = .808$			$p = .088$	

Taskonomic categories: Mound 44 fowling (scaled) - Mound 8 fowling (raw data)

	Mound 44			Mound 8 east houses		
Land hunting	94	92.207	.003	64	65.793	.049
Active fishing	21	18.675	.290	11	13.325	.406
Passive fishing	7	5.252	.582	2	3.748	.815
Fowling	34	39.684	.814	34	28.316	1.141
Marine mammal hunting	36	36.182	.001	26	25.818	.001

$$\Sigma X^2 = 4.133 \quad df = 4 \quad .50 > p > .30$$

Fowling	34	34	Fowling	34	34
Land hunting	94	64	Active fishing	21	11
		$p = .192$		$p = .196$	
Fowling	34	34	Fowling	34	34
Passive fishing	7	2	Marine mammal hunting	36	26
		$p = .162$		$p = .383$	

	Mound 8 east houses (scaled)			Fauna bones	
Fishing	13	Equipment 4.730	14.463	6	14.271
Land hunting	64	50.281	3.743	138	151.719
Fowling	12	26.634	8.041	95	80.366
Marine mammal hunting	26	33.355	1.622	108	100.645

$$\Sigma X^2 = 37.105 \quad df = 3 \quad p < .001$$

Fishing	13	3.770	22.599	6	15.230	5.594
Fowling	12	21.230	4.013	95	85.770	.993

$$\Sigma X^2 = 33.199 \quad df = 1 \quad p < .001$$

Land hunting	64	49.683	4.126	138	152.317	1.346
Fowling	12	26.317	7.789	95	80.683	2.541

$$\Sigma X^2 = 15.801 \quad df = 1 \quad p < .001$$

Fowling	12	16.871	1.407	95	90.129	.264
Marine mammal hunting	26	21.129	1.123	108	112.871	.210

$$\Sigma X^2 = 15.801 \quad df = 1 \quad p < .001$$

Pair-wise multiple contingency testing of fowling equipment by major architectural partition: Mound 44 (scaled) vs. Mound 8 east houses (unscaled)

House	12	24	House	12	24	Tunnel/entr.	21	10
Tunnel/entr.	21	10	Kitchen	1	0	Kitchen	1	0
		$p = .007$			$p = .351$			$p = .688$

Mound 44

$$\Sigma X^2 = 13.530 \quad df = 3 \quad .01 > p > .001$$
$$\Sigma X^2 = 5.971 \quad df = 3 \quad .20 > p > .10$$
$$\Sigma X^2 = 3.514 \quad df = 3 \quad .50 > p > .30$$
$$\Sigma X^2 = 23.299 \quad df = 3 \quad p. < .001$$
$$\Sigma X^2 = 8.280 \quad df = 3 \quad .05 > p .02$$

Mound 44

Appendix 14. Final iterative analyses of subsistence equipment - fauna remains cohorts.

	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
<i>Mound 44</i>		Equipment			Fauna	
Fishing	15	16.626	.159	11	9.374	.282
Land hunting	79	77.374	.034	42	43.626	.06
		$\Sigma X^2 = .536$	df = 1	.50 > p > .30	V = .060	
Fishing	15	13.699	.124	11	12.301	.138
Fowling	34	35.301	.048	33	31.699	.053
		$\Sigma X^2 = .363$	df = 1	.70 > p > .50	V = .062	
Fishing	15	14.048	.064	11	11.952	.076
Marine mammal hunting	52	52.952	.017	46	45.048	.020
		$\Sigma X^2 = .177$	df = 1	.70 > p > .50	V = .038	
Land hunting	79	72.729	.541	42	48.271	.815
Fowling	34	40.271	.977	33	26.729	1.471
		$\Sigma X^2 = 3.804$	df = 1	.10 > p > .05	V = .142	
Land hunting	79	72.379	.606	42	48.621	.902
Marine mammal hunting	52	58.621	.748	46	39.379	1.113
		$\Sigma X^2 = 3.368$	df = 1	.10 > p > .05	V = .124	
Fowling	34	34.921	.024	33	32.079	.026
Marine mammal hunting	52	51.079	.017	46	46.921	.018
		$\Sigma X^2 = .085$	df = 1	.80 > p > .70	V = .023	

	Obs.	Exp.	X ² coeff.	Obs.	Exp.	X ² coeff.
<i>Mound 8 east houses</i>						
Fishing	13	10.061	.858	19	21.939	.394
Land hunting	59	61.939	.139	138	135.061	.064
		$\Sigma X^2 = 1.456$	df = 1	.30 > p > .20	V = .080	
Fishing	13	9.342	1.433	19	22.658	.591
Fowling	34	37.658	.355	95	91.342	.147
		$\Sigma X^2 = 2.525$	df = 1	.20 > p > .10	V = .125	
Fishing	13	9.169	1.601	19	22.831	.643
Marine mammal hunting	38	41.831	.351	108	104.169	.141
		$\Sigma X^2 = 2.736$	df = 1	.10 > p > .05	V = .124	
Land hunting	59	56.199	.140	138	140.801	.056
Fowling	34	36.801	.213	95	92.199	.085
		$\Sigma X^2 = .493$	df = 1	.50 > p > .30	V = .039	
Land hunting	59	55.711	.194	138	141.289	.077
Marine mammal hunting	38	41.289	.262	108	104.711	.103
		$\Sigma X^2 = .636$	df = 1	.50 > p > .30	V = .043	
Fowling	34	33.775	.002	95	95.225	.001
Marine mammal hunting	38	38.225	.001	108	107.775	.001
		$\Sigma X^2 = .004$	df = 1	.98 > p > .95	V = .004	