Why is the phrase "other things being equal" used when one generalizes, is developing causal arguments, or is engaged in theory building?

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Introduction

In this essay I pay particular attention to some of the strategies for learning that are implied by the phrase "other things being equal". I will begin with a common situation where a scientist offers generalizations from data and or experiences that were judged to be interesting, provocative, and or even germane beyond the case and/or particular experiences which prompted their consideration. One should recognize that such products would, of necessity, be "subjectively" derived generally thru inductive reasoning. Such reasoning is organized by their author, based on the knowledge and experience of that author. The logic or integration of such knowledge and experience was also a product of that author. In short, all was subjectively derived, in a technical sense, by their author.

It is not uncommon for readers of generalizations, provocative inferences etc., to call for their dismissal as "subjectively derived" or not "proven" by formal statistics or not warranted logically with statistical strategies. Only a little reflection should force us to realize that by these standards we should dismiss the contents of a book called "The Origins of Species", and most others that have, over time, changed the way we

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understand our world. The above type of short sighted involvement in our field fails to address the reality that many of the techniques which critics believe provide "objective" ways for evaluating intellectual products did not exist at the time of Darwin's authorship of "The Origin of Species"! Instead, many were invented to treat the kinds of population based problems which his ideas of evolution demanded (See Darwin 1876: 80,111-112). What if the problem being addressed by a contemporary researcher is analogous to those which Darwin faced, namely to synthesize know-ledge and observations about a subject not previously addressed so comprehensively and/or with different learning goals?

Most formal statistical methods are produced to treat particular kinds of problems. In the case of Darwin's work variability within and among populations and samples thereof was an important phenomenon to evaluate as regards the "significance" of actually observed differences. In my analytical experience with synthesized natural history information the problem is not so much about populations, but about the phenomenal boundaries developed by the researcher for the inclusion and/or exclusion of cases or "units of observation" from a class of cases, or as more commonly spoken of, the observational units chosen for comparative study.

What if the research issue is simply recognizing new variables as possible conditioners of potential relevance, with respect to some observed property or characteristic of experience? This would be particularly important in the context of thinking about the issue of "what caused this to be here and not there?" Why does a given observational characteristic of the world differ from place to place? We might also wonder why a property appears scattered in one context and clustered in another, etc. Problems such as these are recognized by studying "the data" (Binford 2001a). Questions which such problems prompt may be studied dimensionally with various types of analytical or property space, the advantage of which is that it may be experimentally designed (Binford 2001b: 80,111-112).

This endeavor derives quite directly from the materials presented from my nine-year comparative study and analysis of hunter-gatherer ethnography (Binford 2001b). What is different, however, is that my focus here is upon the issue of methods that are available for use when seeking to expand our learning capabilities as a part of conducting pattern recognition studies. I make no claim, however, that what is focused upon empirically is exhaustive. This paper is about strategies for learning with some examples thereof.

I will attempt to consider this viewpoint from the perspective of a simple example. If two creatures, a mouse and an elephant, both lived in roughly the same environment, geographically speaking, and the environment changed over the course of six months in a very dramatic manner, would the consequences for the mouse and the elephant be the same as regards behavior in general as well as reproductive success or even survival? I think that most would agree it is very unlikely for there to be identical responses to an identical set of "causal" conditioning environmental changes on the part of the mouse and the elephant! This is a situation where identical environmental changes are likely to impact different entities very differently. This example illustrates the justification for being concerned with systemic initial conditions. At the same time, this example falls under the broader methodological assumption of "other things being equal". Of course, this assumption is not met if we ignore the systemic characteristics of the initial conditions standing "behind" the units being investigated, such as mice versus elephants!

In science we study classes of phenomena. How such classes are "bounded" is a major issue since the definition of the class is both something we seek to improve, and at the same time we seek to use it as the minimal basis for specifying "those other things that are considered equal' when conducting our studies of variability among the members of the "class" chosen for research. This is a pragmatic strategy and is not dependent upon recognizing "natural kinds" (Quine 1991) prior to research into the

causal conditioners standing behind variability documented among the cases falling within the chosen class of phenomena for study.

In my comparative study of hunter-gatherers (Binford 2001b) the latter class was operationally defined as including ethnographically or historically documented peoples who dominantly obtained their foods from non-domesticated species. During the course of that research I recognized sub-classes that differed among themselves in the role of domesticated species within the organization of their cultural systems. Stated another way, other things were not equal. Good examples of the latter were the Plains Indians of North America and the Patagonian mounted hunters of Argentina and Chile. Both used domesticated animals (horses) for transportation but not significantly as food. In the case of the North American Plains Indians they did use the wild Bison of the Plains as food but the use of the horse made possible much more extensive coverage of land (increased mobility), larger group sizes, and the presence of social forms more commonly associated with very high population densities among other hunters and gatherers. Plains Indian population densities were very low! Plains Indians were clearly cases where "other things were not equal". Recognition of this resulted in learning about them and the initial exploration of niche creation thru extensification as opposed to very different niche development being driven by processes of intensification (Binford 2001b: 346-347).

Researching the character of initial conditions and what are those "other things that must be equal" for any generalizing proposition to be "germane" is basic to scientific method. *If we stand this point on its head, it should be clear that researching the character of initial conditions among the cases being generalized about, and seeking knowledge of those variables that are "not equal" is a fundamental way of gaining relevant new knowledge about the classes of phenomena being explored by scientists.*

In this study I will take the opportunity to examine cases that appear exceptional relative to the overall patterning characteristic within a class or sub-class of cases. Clues to, or knowledge indicative of, those other things that must be considered equal when seeking to generalize and/or explain, could well rest with cases that appear exceptional relative to the consistently patterned cases. I will, therefore, turn to this issue prior to a further consideration of the possibility that cases ethnographically classified as, for instance, aquatic resource dependent cases, may have at an earlier time been hunters of terrestrial animals or collectors of terrestrial plants! Put another way, historically speaking the ancestors of the people studied ethnographically may have previously been properly assigned to a different class depending upon their dominant sources of food exploited in the past.

When I speak of the macro-class of "hunter-gatherers", I have excluded the North American Plains Indians and the Patagonian mounted raiders and hunters. The justification being simply that other things are not equal with respect to mobility and the contexts of niche construction demonstrable between those who are excluded relative to those that are included in the class of cases being targeted for research. Excluding the above mentioned cases does not mean that I will not seek to expand our understanding of extensification thru future research. The more immediate problem is simply that more attention needs to be given to how we generate useful classes of phenomena for use in any scientific study.

Extensification has long been an overlooked process that provided the basis for niche diversification and accompanying regional differentiation as well as increased ranges of variability in the forms and complexity thereof found among cultural systems. In this paper, however, given that science studies classes of phenomena, I will not necessarily exclude cases suspected of extensification per se, since we need increased knowledge of the processes promoting it. Exclusion of suspected cases would not necessarily further such learning goals. Such goals include the recognition of causal contexts that might differentiate systems into domains of intensification versus extensification thereby differentiating among systems independently developing organizational

differences thru time. The search for relevant differentially conditioning variables certainly suggests that there is more to learn regarding extensification. Extensification is expected to stand behind some groups with domesticated reindeer. Sled dogs, and in some situations boats, may also have facilitated more extensive land use patterns. We need to know more about these things.

Pattern recognition techniques: exploring a class of hunter-gatherer cases

The subset of hunter-gatherer cases displayed in Figure #1, and others that follow, are primarily examples from peoples who respond to increasing population density by expanding their diet breadth, at the same time they were intensifying their land use by increasing their yields per unit area. The latter is best indicated by reductions in the total number of kilometers traversed annually while moving from one residential location to another. In addition, the germane cases of hunter-gatherers were dominantly dependent, for their subsistence, upon foods obtained from terrestrial animals. The other constraint on the cases chosen for display and study in Figure #1 is that none of the cases displayed were "Packed". That is, all the displayed cases had population densities less than 9.098 persons per 100 squar kilometers. This limitation on population density of the cases examined in Figure 1 is indicated by the strong dashed vertical reference line paralleling the right side of the graph border. The original plotted distribution of terrestrial hunters showed two cases to the right of the packing threshold of figure 1

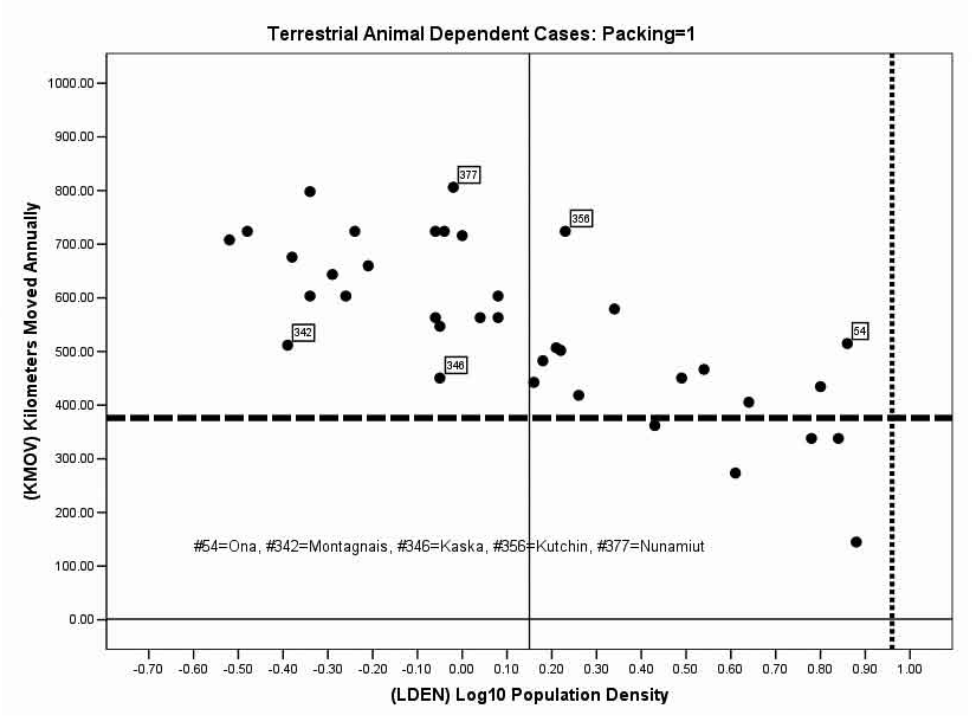

Fig. 1 - Kilometers Moved Annually vs. Log10 Population Density (people per 100 sq km) for Unpacked Terrestrial Animal Dependent Hunter-Gatherers [vertical dashed line marks the packing threshold of 9.089 persons/ 100 sq km; horizontal dashed line marks a reference value of 375 km moved annually]

(not shown here because the values were corrected in the master data file over 7 years ago).

These were the Achumawi (recognized as an exception in Binford 2001a: Fig.10.06: 382) where it was found to have been incorrectly classified as to subsistence base. The Achumawi are in fact an aquatic resource dependant group (Olmsted and Stewart 1978: 225-235). The second "exceptional" case was the Honey Lake Paiute with a population density value within the range of measurement error for population density thus their "exceptional" status was not convincing. Nevertheless, these two cases that were corrected a number of years ago are enough to permit the recognition of "other things that must be equal", namely, (a) the accuracy of the observational data and, (b) cases that fall within the expectable statistical ranges of error for a given data set are not necessarily to be considered exceptional.

There are currently no known cases of terrestrial animal hunters distributed beyond the "packing" population density threshold, at 9.098 persons/ 100 sq kilometers. Traditional terrestrial animal dependent peoples are assumed to be primarily foot travelers during their subsistence round. This is not to say, however, that cases of "recently" intensified former terrestrial animal food dependant peoples do not exist, they most certainly do ethnically and/or socially. If they remained "hunter-gatherers" their former condition was not recognizable because at the time of ethnographic observation their diet had, under intensification pressure, already shifted. That is they were either terrestrial plant or aquatic resource dependant peoples. Exploring ways for identifying initial conditions standing behind such changed states among cases is one research goal of this essay.

An ancillary research strategy is to use "outlier" cases as potential guides to the recognition of previously unrecognized variables that may condition systemic differentiation among classes or sub-classes of hunter-gatherer peoples as documented. Put another way, I am trying to apply research tactics for identifying some of the "other things that must be considered equal" but about which we are at present largely ignorant! One strategy is to study "outlier" cases as recognized by their position relative to the major clustered distribution of cases as plotted in two dimensional property-space. This is a tactic that should result in the recognition of "other things" that are not equal. What these "things" are is important to know when building theory regarding "unambiguous classes". This is also true when framing more specific forms of argument regarding the variables that could well contribute to dynamic processes of differential systems change within a "class" of studied cases.

Studying outlier cases as a way to discover "Other things that may or may not be equal"

A quick examination of figure 1 will show that there are five cases identified by their group number in the case array. These are judged to be the "outliers" when considered relative to the patterned distribution described by the majority of cases. The identified cases are #346, the Kaska; #342, the Montagnais; #54, the Ona; #356, the Kutchin; and #377, the Nunamiut. Among all outlier cases listed above, the ethnographic information available for comparative study was generalized from, two or more, different collapsed time periods. There was information documented by the ethnographer at the time of the observers visit, and "memory culture" information recalled by informants having reference to more traditional times prior to changes stimulated by contact with western expansionist cultures. Generally, there were reduced numbers of people (e.g. a response to introduced disease, new habits with alcohol, etc.) at the time of the ethnographer's studies after "contact" and not uncommonly less mobility as well. On the other hand, accurate memory culture estimates for mobility prior to contact may be inflated

for the period of actual ethnographic observation when there was a tendency to concentrate around locations of contact with outsiders. Put another way, other things were not necessarily equal in that the ethnographic information presented for a particular social unit could have reference to different systems states, extant at different time periods. I did not reject such information at the time of tabulating case material since it was unknown how such possibly temporally diverse information would impact generalizations attempted from the data in general. Since such information was frequently "smoothed" together by ethnographers trying to normatively describe their cases. It was not always clear what the generalization by the authors unambiguously referenced.

I think it should be clear from the above examples how important actually meeting the conditions, "other things being equal" might be. This is particularly true if one was attempting to "test" propositions derived from prior arguments about causes of variability among cases falling within the general class of phenomena being studied comparatively. On the other hand, if one is trying to identify what the "other things" might be that should be constant in order to guard the integrity of a class being studied, a more informed definition for the boundary conditions of the class of cases under study might be in order. I followed the latter strategy in my earlier cross cultural comparison of cases loosely called "hunter-gatherers". Much of the partitioning of the gross class of cases initially considered as possible hunter-gatherers (Binford 2001b: 120-121) was conducted to aid in actually refining the definition for the class hunter-gatherers less ambigu-

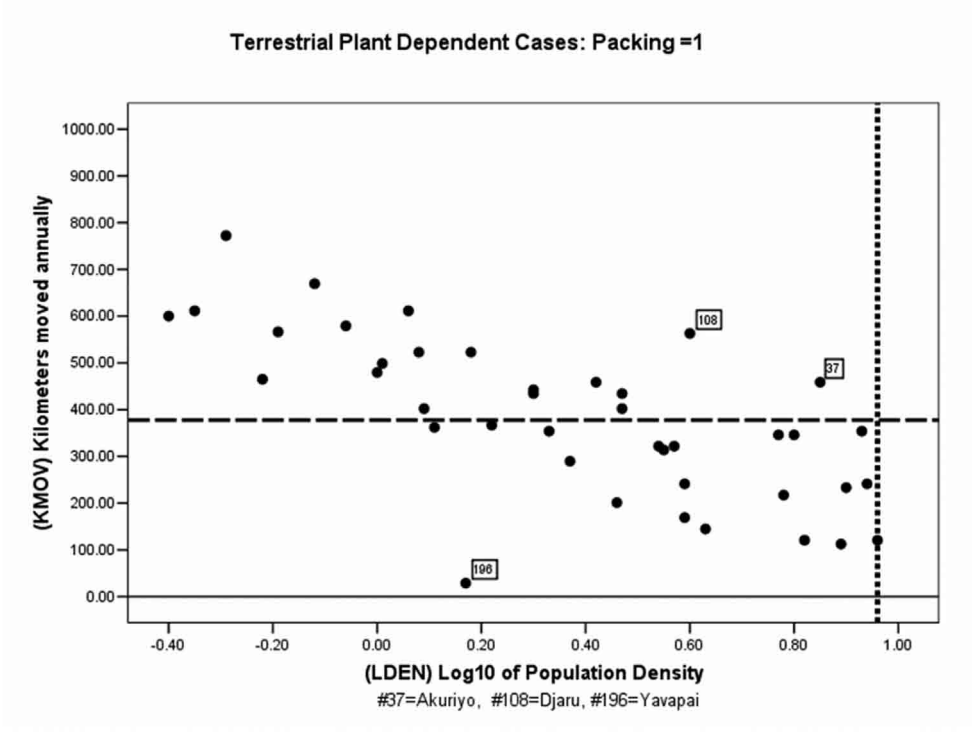

Fig. 2 - Kilometers Moved Annually vs. Log10 Population Density (people per 100 sq km) for Unpacked Terrestrial Plant Dependent Hunter-Gatherers [vertical dashed line marks the packing threshold of 9.089 persons/ 100 sq km; horizontal dashed line marks a reference value of 375 km moved annually].

ously, particularly with regard to other things that had to be equal differentially across sub-classes of "hunter-gatherers" (Binford 2001b: 297-314).

The cases making up the sub-class of hunter-gatherers displayed in Figure 2 are all cases where the highest percentage of food was obtained from terrestrial plants instead of terrestrial animals as was the situation shown in Figure 1. The outliers are distributed less ambiguously than was the case with Figure 1 and they, in many ways, are more informative.

(a) #37, the Akuriyo are a group of hunter gatherers living in a tropical rainforest where water is ubiquitous and food is similarly widely available. The consequence of adequate food and water widely accessible is that mobility primarily functions to access the limited locations where raw materials for making tools and other gear were localized. These people simply fed along the way as they moved between three widely separated locations at which were obtained needed localized raw materials, not food. Camps were minimal investment sites organized, in most cases, at different locations each night as they fed their way across the landscape. Given that food needs did not drive mobility the strong relationship between population density and scale of land use is not expected to be tight. This case illustrates the value of "outliers" as sources of information with regard to the issue of "other things being equal". "Other things" were not equal, in that for the class "hunter gatherers", mobility was assumed to be the tactical basis for their food procurement. Decreasing mobility conditioned by increased population per unit area must result in intensification "other things being equal". The Akuriyo case tells us quite directly that in environments where water and food procurement venues were distributed "ubiquitously" mobility may be driven by the distribution of other "essential materials" such as axes to cut down trees from which foods were extracted. Arrow reeds used in obtaining animal foods from the rainforest canopy, and products from which to make the hammocks in which they slept were three other raw materials essential to their pattern of life. Unfortunately, in the case of the Akuriyo we do not know if they were actually product specialists serving to supply finished products and/or raw materials needed for item production to other groups of people in the region. In short, the Akuriyo may be mutualists instead of hunter-gatherers! In this example, we have learned of a possibility that appears reasonable, but our lack of detailed information renders the case ambiguous and therefore inconclusive as to their "status within the class of "hunter- gatherers".

The Akuriyo are an extreme case, however, they serve an important function since other peoples may well be conditioned in their mobility patterns by both food and non-food product distributions. Such a situation could result in more or less residential mobility if distributions of accessible food patches were the sole conditioning factor. What is hunted and gathered is not always only food. Other things may not always be equal when considered relative to mobility among cases of "hunter-gatherers".

There are two additional outliers shown on Figure 2 which deviate dramatically from the generally patterned relationship noted between mobility and population density, these are #196, the Yavapai, and #108, the Djaru.

(b) #196, the Yavapai. The latter were sedentary, and at a very low population density when ethnographically described. It is relevant that the Yavapai were also resettled and encouraged to be horticulturalists on a relatively large, but very unproductive "reservation", at the time of description. I think we may discount this "exception" in that the data refer to different periods of their history and therefore does not meet, unambiguously, the criteria for class inclusion as "hunter-gatherers".

(c) #108, the Djaru have relatively high population density, nevertheless, their mobility appears inflated. As was the situation with the Yavapai, I reexamined the ethnography and conclude as follows: The Djaru, a group from the Western Kimberley Mountains of Australia, are

very well described as regards memory culture and as they lived during post European settlement in their own country (Kaberry 1939). Examination of research notes shows that reconstructive estimates of the pre-contact territory as used traditionally by the Djaru were used in my earlier study, on the other hand, the population density estimates for the Djaru were based on post-contact census counts of mission centered occupations in a much smaller area. It must be concluded that this case appears "exceptional" because the recorded data does not unambiguously refer to the same historical state of the Djaru system.

The last of the basic sub-sets of hunter-gatherer cases to be examined for outlier clues regarding "other things" that may not be equal are all those that are primarily dependant upon aquatic biomes as their major habitat source for foods.

Table 1 - Ethnographic cases recognized as not meeting the assumption of "other things being equal" [numbers indicate the Group Number identifier from Binford 2001]

(1) Error in coded subsistence	
Achumawi #187, Honey Lake Paiute #212.	
(2) Information merged from two or more time periods	
Kaska #349	Nunamiut #377
Montagnais #342	Yavapai #196
Ona #54.	Djaru #105
Kutchin #356	*Holikachuk* #364
(3) Mutualists?	
Akuriyo #37 **Ubiquitous food and wate**r.	
Carrier #249 (**Traders**).	
(4)- Pastoralists.	
Ket #24	
(5)- Extraordinary resource reliability	
Netselik #387	
(6) Exceptional seasonal transhumance	
East Tasmanians #36	
Kitchibuan #327	

In order to save space, I have prepared Table 1 which summarizes the findings of the previous two discursive sections as well as the additional information from the aquatic resource dependent peoples mentioned above. The latter cases are indicated by italics in Table 1.

The noted exceptions reviewed above include "other things that were not equal, and/or pro-perties not recorded as independent variables that might well condition meaningfully variable sub-sets of "hunter-gatherers" cases yet to be organized. Alternatively we may conclude that some cases are not "hunter-gatherers" given the "class" boundaries as developed.

Comparing sub-sets of hunter-gatherer cases- another approach for evaluating the importance of initial conditions

Another way of learning about other things that may not be equal is to conduct comparative studies among well defined sub-sets of cases partitioned unambiguously from among the macro-class of cases of interest. In this situation, the sub-sets will be derived from among the general class of Hunter-Gatherer cases (Johnson 2004a: 23-24). Figures 3, 4, 5, 6 & 7 are rescaled and clustered presentations analogous to Figures 1, 2,. The same sub-sets based on dominant sources of food are represented, however, all the "Outliers" that informed us that "other things that were not equal" have been removed from the subsistence subclass arrays. Also all cases that were "Mounted Plains Hunters", mutualists, and domesticated plant supplemented cases, have been removed from conside-ration. This makes it possible to compare the subsistence subsets purged of cases where it is has been demonstrated that "other things were not equal". The result is that cases in each subset are now clustered together so we may more conveniently see the orientation and slope of the linear distributions.

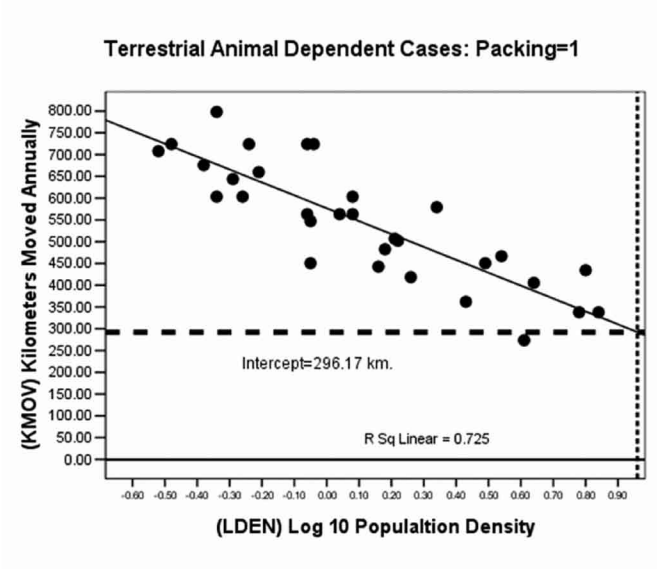

Fig. 3 - Kilometers Moved Annually vs. Log10 Population Density (people per 100 sq km) for Unpacked Terrestrial Animal Dependent Hunter-Gatherers [vertical dashed line marks the packing threshold of 9.089 persons/ 100 sq km; horizontal dashed line marks a value of 296.17 km as the mean distance moved per year at the packing threshold]

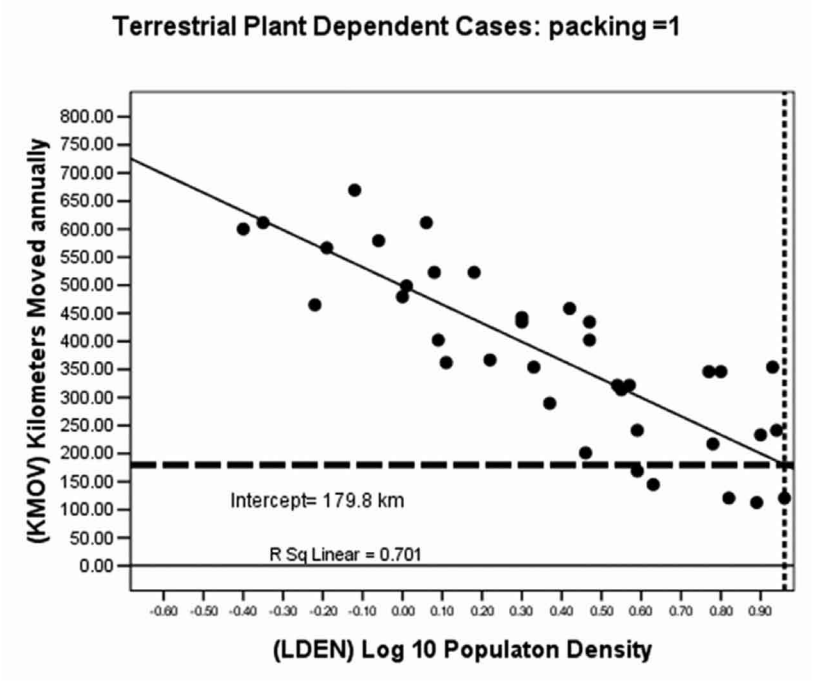

Fig. 4 - Kilometers Moved Annually vs. Log10 Population Density (people per 100 sq km) for Unpacked Terrestrial Plant Dependent Hunter-Gatherers [vertical dashed line marks the packing threshold of 9.089 persons/ 100 sq km; horizontal dashed line marks a value of 179.8 km as the mean distance moved per year at the packing threshold]

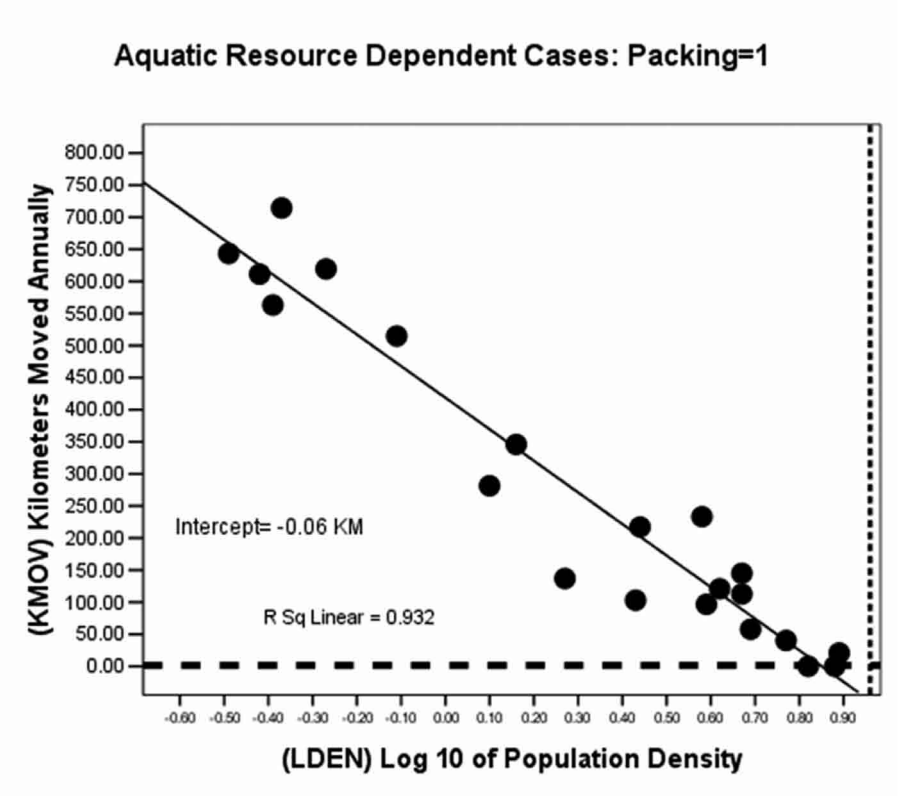

Fig. 5 - Kilometers Moved Annually vs. Log10 Population Density (people per 100 sq km) for Unpacked Aquatic Resource Dependent Hunter-Gatherers [vertical dashed line marks the packing threshold of 9.089 persons/ 100 sq km; horizontal dashed line marks a value of -.06 km as the mean distance moved per year at the packing threshold]

We may also observe more clearly the shifts in patterning which are characteristic of the cases when population density exceeds the value at the packing threshold, (9.098) persons per 100 square kilometers. Figure 3 displays the non-packed cases of terrestrial animal hunters. It should be recognized that there are no known cases where hunted terrestrial animals provided the dominant source for food after population density exceeds 9.098 persons per 100 sq. kilometers.

This is in dramatic contrast to peoples who are dominantly dependent upon terrestrial plants. Within the latter sub-class, 35.5% of all given differentiated cases exhibit population densities lower than the packing threshold while 64.5% have population densities that exceed those at the packing threshold (Figure 6 versus Figure 7). Twenty percent of the Aquatic resource dependent peoples are non-packed while the percentage having densities in excess of the packing threshold dramatically jump to 80.0 percent (Figure 9 versus 10).

I think that the above contrast in percentages should alert us to the fact that, the intensification process, as indicated by population density, does not proceed equally among the three subsistence based subsets of cases.

Further comparative examination among figures 3, 4, and 5, shows that the values at packing where the fitted regression lines for the relationship between kilometers moved residentially per year and the log 10 value for population density, actually intercept the packing threshold

at very different values, when shown relative to a vertical dashed line just inside the right margin of all the above mentioned graphs.

Generalization 1 - Terrestrial hunters (Fig. 3) pass the packing threshold at a residential mobility value of 296.17 kilometers per year. Terrestrial plant dependent groups (Fig. 4) moved only 179.8 kilometers per year among residences, and aquatic resource dependent peoples (Fig. 5) were essentially sedentary at the packing threshold as indicated by –0.60 kilometer value for residential distance moved annually at packing.

The above generalizations are our last comment looking backwards toward the hunter-gatherers living in a non-packed demographic state.

The differential ordinal patterning in mobility demonstrated at "packing" by the three subsistence based subclasses is not very surprising. I think most can appreciate that hunting animals of moderate to large body size (assuming similar or proportional territorial patterns) would required larger ranges than among those where foods were predominantly obtained from terrestrial plants. The packing threshold was modeled using terrestrial plant dependent peoples as the empirical basis for the model. Given this fact, we may expect that there would be differences in the scales of mobility manifest among hunter-gatherers dominantly dependent upon resources other than terrestrial plants. In short, different subsistence bases would be positioned ecologically such that other things were not equal relative to the packing threshold as known only among terrestrial plant dependant peoples. This situation minimally demands subsistence based subsets within the macro class of "Hunter-gatherers" in any realistic comparative study. Clearly within the latter "macro" class, "other things' are demonstrably "not equal".

Perhaps the best way to examine the importance of the phrase "other things being equal" for a realistic look at organizational patterning, and not simply the differential accuracy of ethnographic reporting or our differential ignorance regarding its impact, is to explore a class of cases which is suspected of being internally heterogeneous in provocative ways. I propose to do this thru the comparative study of packed cases, that is where the population density exceeds 9.098 persons per 100 square kilometers, and the dominant sources for foods are permitted to vary such that peoples dominantly dependent upon (a) Terrestrial plants and (b) Aquatic resources are treated as distinct sub-classes of hunter-gatherer peoples both existing without the option of using domesticated plants and/or animals as food sources.

Surrogate indicators regarding prior systems states that served as differential "Initial Conditions" for systems as documented subsequently

The above approaches undertaken in the previous section sound fascinating, but it must be realized that "other things are not necessarily equal" if we even succeed in taking into account all the types of "unequal" properties discussed in the previous section!

Cases that were unpacked societies, hunting primarily terrestrial animals are no longer identifiable as such from ethnographically obtained knowledge! Can we find a way of anticipating which of the cases within the ethnographically observed subsets of terrestrial plant and aquatic resource dependent peoples would have been terrestrial animal dependent when living as non-packed populations? Equally, we may expect that there have been other shifts in the dominant sources for foods among the cases as they crossed into the packed demographic state, and/or continued to increase in population density as their mobility was simultaneously reduced.

The differential patterning for residential mobility as described relative to the packing threshold suggests that changing dominant food sources may be strongly conditioned by variable mobility patterns among packed cases.

What if during earlier times when density values were considerably less and groups could move among different environmental settings without commonly encountering competitors, that is they were less intensified than after the packing threshold, they could well have had different mixes of resources and hence different food sources dominating their patterns of food consumption!

Is it possible to find a way of anticipating or modeling which of the cases among the ethnographically observed subsets of terrestrial plant and aquatic resource dependent peoples were terrestrial animal dependent when living as non-packed ethnic units? This problem sounds challenging enough, nevertheless we must also realize that systems states were not static while living under packed conditions. Equally, we may expect that there have been shifts in the mix of food sources in their diets, as well as changes in their forms of socio-cultural system as they responded to a packed state that were also dynamic as regards continuing increases in population density. In addition, we might suspect there to have been further changes as people's mobility was restructured and simultaneously further reduced with increasing population density. What is summarized above might be called the issue of "forward looking" change during the packed state.

If we focus upon the packed cases and examine the terrestrial model's projections (Binford 2001b: 186-188) as to the subsistence base for the same cases anticipated at a hypothetical period when they were technologically unaided and eating exclusively upon terrestrial resources, but living under the same environmental conditions extant at the time of ethnographic documentation, we may well succeed in gaining some insight into the importance of initial conditions. This is essential for gaining and understanding of systems change thru time. What is uncertain is simply whether the latter subsistence estimates provide a reliable estimate of the groups causally important "initial conditions" (Binford 2001b: 186-188)?

I think that without a doubt the terrestrial models projections do provide at least a clue to earlier conditions. The degree that the projected early conditions are isomorphic with what we would specifically like to know is, technically speaking, unknown. Nevertheless, such projections are judged to be relevant given a knowledge of how the terrestrial model was obtained (Binford 2001b: 187-192). In addition, the projections are understood as regards how they were produced and in that sense "other thing are equal". What differ are the environmental settings for the cases being studied. This cannot help but to provide some appreciation as to how important initial conditions may be, and in this situation, some approximations as to the different specific conditions probably standing behind the cases actually being studied.

Clearly, reduced terrestrial mobility is achieved most effectively when using aquatic resources. This conclusion is further supported by the number of aquatic dependant cases who move residentially less than 150 kilometers per year (Figure 5). These "low mobility" cases are clustered prior to the packing threshold. This contrasts with the patterns seen among primarily terrestrial animal (Fig. 3) or terrestrial plant (Fig. 4) consumers. Among the latter sets of cases, the 150 km. threshold is approached, but not passed, at the packing threshold of 9.098 persons per 100 square kilometers[2].

[2] It is considered likely that this difference is related to the fact that aquatic dependent peoples tend to exhibit linear settlement patterning. This patterning is not uncommonly an ordered size hierarchy along coasts and rivers. Such a pattern is totally at odds with the "shape of the land use pattern" developed largely from empirical generalizations based on terrestrial plant dependent peoples that were used in the reasoning by Binford.

Generalization 2: There are no cases of terrestrial animal dependent peoples known to occur when population density exceeds the packing threshold of 9.098-10.0 persons per 100 square kilometers[3].

It is unclear what happens to cases that were dominantly dependent upon terrestrial animals (See Fig. 1) after population exceeds the packing threshold. There are simply no animal dependent cases identifiable on the high population side of the packing threshold.

It should be understood that as ethnic groups or "peoples" the hunters did not go extinct, instead they "become something else" after the packing threshold, either dominantly dependent upon terrestrial plants or, more likely in areas above 40 degrees north or south latitude (ET=12.75), dominantly dependent upon aquatic resources (Binford 2001b: 267) other things being equal.

Generalization 3: Among peoples dominantly exploiting terrestrial plants there will be a phase after the packing threshold is exceeded when moderate residential mobility remains common.

We, therefore, may expect to see some "noisy" variability shortly after the packing threshold. Some cases of former terrestrial animal dependent peoples, upon subsequent ethnographic study, would be classified as terrestrial plant, or aquatic resource dependent groups when observed by ethnographers. In their intensified ethnographic states they may be expected to exhibit moderate or higher percentage values for dependence upon other sources of foods thus accounting for their "reclassification" as non-terrestrial animal dependent cases. It would appear that, in the main–

(Proposition 1) At least some Hunter-gatherers do not go directly from being mobile to being sedentary. Such a transition is characterized by new combinations of food source dependencies, combinations that result in greater subsistence diversity correlated with a gradual reduction in residential mobility as population density continues to increase.

Consistent with the difference noted above is the fact that among packed or "less-mobile" aquatic dependent peoples (Fig. 6), they may exhibit an annual residential mobility pattern of up to about 150 kilometers, across a substantial range of increasing population densities. Such a situation continues until a log10 value for population density of 1.45 or 28 persons per 100 square kilometers is achieved (Fig. 6). Thereafter there is a gradual reduction in mobility across a wide range of population densities.

This cannot be demonstrated directly for former terrestrial animal dependent groups since such a high proportion of the total diet coming from terrestrial animals is unknown among peoples with population densities that are greater than the packing threshold. Nevertheless, as pointed-out earlier, one expects that increased diversification in diet breadth would cause the former hunters, existing in a post intensification state, to be classified primarily as aquatic resource dependent and secondarily as terrestrial plant exploiters (Binford 2001b: 194-197) other things being equal. Such reclassification has the effect of deceivingly inflating the diversity of forms existing among the less mobile peoples as shown in Figures 6 and 7. The latter peoples should, as suggested above, be shifting away from terrestrial animals, thus insuring related increases in foods derived from terrestrial

[3] Technically this is incorrect. There were two such cases, the Achumawi, and the Honey Lake Paiute. The former was found to have been incorrectly classified (Binford 2001a, Fig 10.06, p. 382). The Achumawi were aquatic resource dependent (See Olmsted and Stewart 1978, 22). The latter case is within the range of measurement error for population density, thus their "exceptional" status is not convincing.

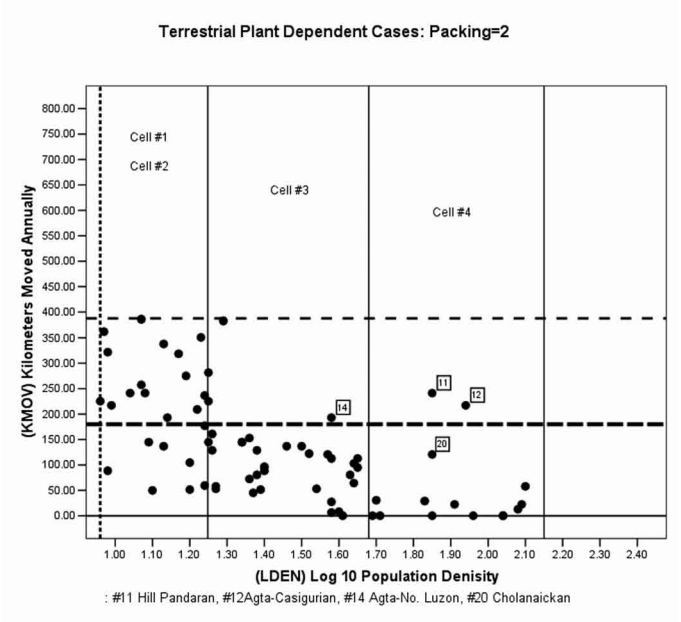

Fig. 6 - Kilometers Moved Annually vs. Log10 Population Density (people per 100 sq km) for Packed Terrestrial Plant Dependent Hunter-Gatherers [vertical dashed line marks the packing threshold of 9.089 persons/ 100 sq km; horizontal dashed lines mark (top) a reference value of 375 km moved annually and (bottom) a value of 179.8 km as the mean distance moved per year at the packing threshold]

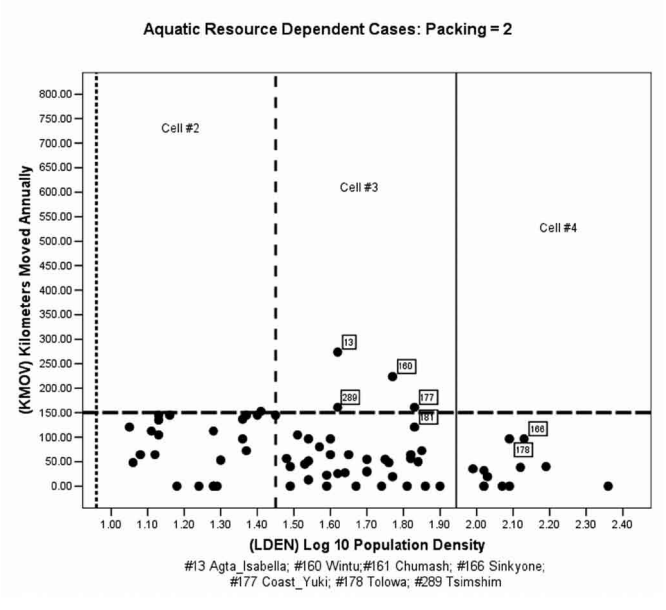

Fig. 7 - Kilometers Moved Annually vs. Log10 Population Density (people per 100 sq km) for Packed Aquatic Resource Dependent Hunter-Gatherers [vertical dashed line (left) marks the packing threshold of 9.089 persons/ 100 sq km; horizontal dashed lines mark (top) a reference value of 150 km moved annually]

plant and/or aquatic sources. Given that the latter are the only two possible categories available for "reclassification", among the options used in this study, we may expect that intensified cases of former terrestrial hunters will not be directly identified among the "reduced mobility" post packing tabulations. Instead such intensified cases would, at the time of ethnographic description, be described as terrestrial plant and/or aquatic resource dependent peoples insofar as they are recognizable as hunter and gatherers. This means that the most direct way of recognizing changed post-packing states for systems originally dominantly dependent upon terrestrial animals is from the archaeological record. This recognition could imply that the common criteria for identifying "ethnic" continuity within archaeological sequences found in specified regions might not be a reliable indicator of cultural-historical continuity. Instead we could see some rather dramatic changes in spatial distribution, organization of labor, types of tools used, and forms of settlement pattern, not to mention dramatic changes in dietary indicators. Such changes may be only a few of the contrasts that could characterize a well controlled chronological sequence derived from a dramatic subsistence change experienced by a single ethnic group!

I hope that my earlier illustration of the "exceptional cases" has convinced the reader to re-cognize that there are likely to be a large number of factors that must be considered when defining classes for study and when systematically attempting to refer cases to classes devised for comparative research. I do not mean that the class of cases actually used in comparative study must be "pure" with respect to defining characteristics before research begins. I stress that one of the earliest uses of the class of cases assembled should be to search for consistent patterning within the class when arrayed with respect to variables recorded for the class and any variables available for use as a frame of reference, or suggestions derived from other "Bodies of Reference Knowledge" (Wands-nider 2004).

I cannot overstress the issue of gaining knowledge regarding specific initial conditions, as well as those "other things that must be equal" for generalizations regarding patterning among classes of phenomena to be considered seriously. Any suite of cases is likely to be bounded in a scalar manner and that scale is always one of the "other things that must be equal" for generalizations to be seated in an identifiable empirical zone. Many times a change of research scale is required before such "prior knowledge" may be recognized as useful (Johnson 2004: 279-288).

The inferences offered regarding the change of trajectory among formally dominant hunters of terrestrial mammals that begins and is accomplished at the packing threshold certainly challenges at least some of the traditional archaeological assumptions regarding the ability to identify lasting ethnicity thru archaeological time by referencing ethnic continuity resulting from gradual substitutive change. The differential reductions in mobility observed among the diet based subclasses of hunter gatherers testifies to very different rates of culture change relative to different population density levels. For instance, it may be reasonably generalized that:

Generalization 4: Among peoples dominantly exploiting terrestrial plants there will be a phase after the packing threshold is exceeded when moderate residential mobility remains common. (See figure 7 Cell 1 and 2).

Similarly, shifts from hunting terrestrial animals to dominantly exploiting aquatic resources will proceed along different trajectories in different environmental setting and almost certainly at very different rates across distinct ecological settings. Ethnic identity may fade from view as the patterns of differentiation within a changing system increases in complexity.

Comparison between sub-sets of the hunter-gatherer cases as clues to recognizing causal conditioners

If we examine the actual scale of mobility (Figures 1 and 2), and recall that aquatic dependent peoples move very little (Figure 7) we note an interesting and provocative contrast which suggests:

Generalization 5 - Terrestrial animal dependent peoples move over greater distances absolutely, such that they move residentially between 800 and 500 kilometers annually at very low densities (between-.6 and -.0 log 10 density values). Thereafter they drop in a linear manner to between 500 and 150 kilometers at a log 10 value for population density of between +.9 and +1.0 values, or the packing threshold. In addition, there are more cases clustered where the log 10 values for population density are less than 0 .15 persons per 100 square kilometers than in other density ranges.

This pattern while grossly similar to that derived from peoples who are dominantly dependent upon terrestrial plants does deviate in several ways, perhaps indicative of slightly different initial causal conditioners.

The second set of "exceptions" to be discussed has reference to the terrestrial plant dependant people's (Figure 2) behavioral responses to the packing threshold. It was previously argued that intensification or increasing the food yield per/unit area, was only possible for hunter-gatherers shown in fig. 2 if they: (a) shifted to increased dependence upon aquatic resources, if available, and/or (b) intensified the exploitation of the traditional area commonly indicative of increased diet breadth, and/or (c) experienced an accompanying reduction in the area traditionally used to obtain their food, and/or an accommodating increased investment in storage bringing with it associated increased processing costs. The latter also holds possible subsequent implications for the appearance of horticultural adaptations although the causal process is unidentified at present.

Since no cases of dominantly terrestrial animal consumers survive the packing threshold, the only other subset of hunter-gatherers available for study in a post-packing situation are the Aquatic resource dependent peoples (Fig. 7). Therefore, I refocus upon the dominantly aquatic resource dependent peoples (Figs. 5 and 7). Those who are not mobile, that is where population density is greater than "Packing," or 9.098 persons per 100 square kilometers, we see a radical difference relative to the terrestrial animal and plant dependent peoples, both of whom remain mobile at around 150 kilometers annually down to the 0.9-1.0 Log 10 value of the packing threshold. There is a difference in the slope of the linear relationship between kilometers residentially moved annually and the log 10 value for population density. For instance, the clustering of cases around the 150 kilometer line for residential mobility is between .30 and .70 log 10 value for population density among aquatic resource dependent cases while among terrestrial plant dependent peoples it occurs plus or minus the packing threshold of 1.0 on the log ten axis of population density. Put another way, the aquatic resource dependent peoples regardless of the unknown "original conditions" of their subsistence are sedentary, or very nearly so, prior to and at the packing threshold!

This difference could relate to the transport potential of watercraft and differences between terrestrial adaptations versus aquatic ones, namely in what is transported by "collectors" (Binford 1980) regardless of the conditioners thereof. In addition, there may be a chain of conditioned responses expressed in spatial associations for processing byproducts when boat transport is an option to foot-travel (See Ames 2002). Such suspected differences could impact the differential localization of labor rather than the mobility of labor when engaged in processing tasks such as bulk –weight reduction to facilitate land transport of procured resources into residential locations of terrestrial collectors.

In addition, to the above considera-tions the actual utility of coastal and riparian locations for long term residential settlement varies greatly across many regions. The ability to find locations where whale could be beached, where tides did not render the "beach" useless for many hours per/day, where swamps are minimal etc., all insures that waterside settlements may be located such that there is considerable variability in actual versus ideal settlement locations considered relative to the actual locations of resource procurement.

The reader may recall Proposition 1 that suggested, (a) the transition from a mobile to sedentary way of life is likely to have been extended over a considerable period of time. During this transition there were most likely shifting food source dependencies, with increased subsistence diversity coincident with a gradual reduction of residential mobility. At the same time population density would continue to increase!

We have no direct indication as to how long such an unstable transition might last, however, one may reasonable expect: (a) it would be variable with the character of the environment within which the hunter gatherer groups were embedded, and (b) at least in the case of aquatic dependent peoples, the sophistication of their technology when it is considered relative (See Binford 2001a, pp. 385-395) to varying environments.

Looking for Initial Conditions with Models and controlled experiments

As a further exploration, I will tabulate the distribution of figure's 6 and 7 relative to the dominant sources of food as anticipated by the terrestrial model (Binford 2001b: 187-196) for the same environmental locations that the ethnographically documented peoples shown in figure's 6 and 7 actually lived.

It should be recalled that the terrestrial model was developed as a relevant guide to the sustainability of environments or habitats for humans minimally aided by technology. In short, they ate what they could "reach" without projectiles, or ways of obtaining food from trees except climbing them. They ate animals that they could dig out of their burrows, run down, or extract from their nests, capture from their resting places etc., In short, it is a minimal estimate for the number of people that could be supported by only a minimalist technology. Most food would be small if non-plant, or scavenged if from larger animals, thus their diet would be strongly biased toward plant products, other things being equal.

The first set of such comparative results are displayed in table 3 were the case frequencies are distributed across the columns for the four "Cells" defined in figure 7 as displayed previously. One should keep in mind that Cell 1 actually sits "on top" of Cell #2 in figure 7 This means that mobility is greater among cases in Cell 1 where the range is approximately 180 kilometers to 390 kilometers residentially moved annually. Both Cells 1 and 2 share the same range of post packing population densities (packing, to a log 10 value of 1.20 for population density). Nevertheless, Cell 2 only exhibits an annual residential mobility range from zero to 180 kilometers. On the other hand, Cells #3 and #4 exhibit a pattern of gradually reducing mobility across a wide range of increasing population densities.

The most obvious pattern is that among the 66 cases that were ethnographically described as being dominantly dependent upon terrestrial plant resources with the population density in excess of the packing threshold, forty two or 63.6% of all such cases are projected by the terrestrial model to be dominantly dependent upon terrestrial plants even given the assumed minimalists terms regarding technological aids available to the people. Perhaps the best way to think of the terrestrial model is as a projection as to the numbers of persons supported from the available wild plant and animal resources characteristic of the habitats within which the ethnic groups were living at the time of documentation. It should be recalled that the terrestrial model was developed to anticipate the subsistence base under minimal

Table 2 - Terrestrial Model Initial Condition Comparisons of Hunter-Gatherer Organizational Variables by Packed Subsistence Base for (A) Aquatic Resource Dependent ("Aquatic Block") and (B) Terrestrial Plant Dependent ("Plant Block") Hunter-Gatherers.

Table # 2 Terrestrial Model Comparisons

A. "Aquatic Block" Cases (N=65, (Hunting=42, Plant foods=23 Cases))

Comparison of Terrestrial Model Initial Conditions: hunting vs gathering

Leaders, Trade & Community		Mortuary Practices		Kinship Practices		Warfare & Its Resolution		Marriage Practices	
Different	**Same**	**Different**	**Same**	**Different**	**Same**	**Different**	**Same**	**Different**	**Same**
Class		**Bodyt**	Dispc	**Elab4**	Adjun4	**Enemy**	Gpgpcon	**Marinv**	Divorce
Commun		**Caudeath**	Ritufocus	**Gqpater**	Augment2	**Grqpres**		**Marprop**	Fres1
Comstfun		**Death**	Ritscale	**Kinbia2**	Kinbia1	**Intcon**		**Marcer**	Fres2
Excorg		**Discomp2**		**Kinder**	Kincon	**Intres**		**Marsel**	Mardiv
Forcol		**Disloc**		**Kinmar**	Kinexo	**Prisoners**		**Minlaw**	Res1
Grptrd		**Divmor**		**Kinscale**		**War1**			
Headman		**Dom1**		**Kinstru**		**WarLead**			
Indtrfo		**Dom2**		**Kinterm2**					
IndTrd		**Dritual**		**Polyg**					
Initf		**Gcont**							
Initm		**Gdist**							
Leader		**Gfur**							
Mobp2		**Usebody**							
Money		**Gcont**							
Occupsp									
Orgfair									
Owners									
Perogat									
Polpos									
Polyscale									
Shaman									
Slave									
N=22	N.=0	N=14	N=03	N=09	N=05	N=07	N=01	N=05	N=05
100%	0.0%	**82.4%**	17.65%	**64.2%**	35.7%	**87.5%**	12.5%	**50%**	50%

B. "Plant Block" Cases (N=44, (Hunting=12, Plant foods=32 Cases))

Comparison of Terrestrial Model Initial Conditions: hunting vs gathering *Note: Cell #1 cases not included*

Leaders, Trade & Community		Mortuary Practices		Kinship Practices		Warfare & Its Resolution		Marriage Practices	
Different	**Same**	**Different**	**Same**	**Different**	**Same**	**Different**	**Same**	**Different**	**Same**
Commun	Class	**Dritual**	Bodyt	**Kinbia1**	Adjun4	**Gpgpres**	Gpgpcon	**Fres2**	Divorce
Leader	Comstfun	**Dispc**	Caudeath	**Kinbia2**	Augment2		Intcon	**Marsel**	Fres1
Money	Excorg	**Ritfocus**	Death	**Kinder**	Elab4		Intres		Marcer
Perogat	Forcol	**Ritscale**	Discomp2	**Kinterm2**	Gqpater		Prisoners		Mardiv
Polpos	Gpgptrd	**Usebody**	Disloc		Kincon		War1		Marinv
Slave	Headman		Divmor		Kinexo		WarLead		Marprop
	Indtrfo		Dom1		Kinmar				Res1
	Indtrd		Dom2		Kinscale				
	Initm		Dritual		Kinstru				
	Initf		Gcont						
	Mobp2		Gdist						
	Occupsp		Gfur						
	Orgfair								
	Owners								
	Polyscale								
	Shaman								
N=06	N=16	N=5	N=12	N=04	N=09	N=01	N=06	N=02	N=07
27.27%	**72.72%**	29.4%	**70.6%**	30.8%	**69.2%**	14.3%	**85.7%**	22.2%	**77.7%**

assumptions of cultural and technological development. Thus the cases of particular interest are the fourteen (Table 2, Row 4) that were described ethnographically as dominantly dependent upon terrestrial plants but projected by the terrestrial model to have been primarily dependent upon terrestrial animals, given the minimalist technological assumptions of the model. It is interesting that 13 of the 14 cases fall in the last two cells of the demographic array shown in Table 2. That is they have high population densities. This almost certainly indicates, since dependence upon terrestrial animals disappears at the packing threshold, that these cases have a long post-packing history of terrestrial plant dietary dominance. Such cases account for twenty one percent of the total suite of 66 unedited cases distributed across the "Cells" shown in figure #6. *Do these fourteen cases differ as a group from those that were terrestrial plant dependent peoples prior to packing and simply continued as such under packed conditions?* This important issue will be explored in several ways.

Controlled experiments and holding "other things constant"

Perhaps the first point to be made is that thirteen of the fourteen cases with terrestrial model (TM) subsistence projected as coming from terrestrial animals falls into Table 2, cells 3 and 4 where the highest mean population densities among packed plant dependent cases are recorded, around 28 persons per 100 square km. (See Fig's 6 and 7). This essential tripling of the density which marks "packing" indicates that an early transition from dominant dependence upon terrestrial animals was made and that much of the subsequent increase in density was fueled primarily by increased dietary roles for terrestrial plants.

The question asked above is fundamental. Namely "do these 14 cases differ organizationally as a group from those that are projected to have "always been terrestrial plant dependent peoples"? As a second attempt at providing germane information I have separated all the cases that fell into the "Cells" numbered one through four on Figures 6 and 7 from the total available sample of hunter-gatherer cases. It should be recalled that these are all cases that are "packed" that is with population densities in excess of 9.098 persons per 100 square kilometers. All of these packed cases were further separated as to the dominant source for food at the time of ethnographic description, namely Terrestrial plants versus Aquatic resources. The latter separation corresponds to the "Plant Block" and "Aquatic Block" as shown on Figures 6 and 7 These macro sub-sets of cases were called into SPSS and each further divided into smaller sub-sets depending upon the differentiation by "TM subsistence" being used here as possible clues to initial conditions or as "their subsistence base in the past".

In practical terms this means that the cases that remained after the Mounted plains hunters, the Mutualists cases, and those supplemented by horticulture at the time of recording were rejected for use in this study, along with those that were not packed as the time of ethnographic documentation, resulting in 109 cases available for comparative study.

The "collapsed" Terrestrial Model's projections are for dominant subsistence upon (1) terrestrial animals or (2) terrestrial plants under the conditions of the model. Each of the two (TM subsistence) subsets, were cross tabulated with the two post packing sub-classes of cases as they were documented ethnographically, either terrestrial plant or aquatic resource dependent cases. Each of the ethnographically documented subsistence subsets was independently searched with respect to the terrestrial models subsistence projections using a variety of statistical tests, designed to indicate the probability of there being regular patterned relationships distributed among the cross tabulated cases for a range of ethnographic variable sets such as Kinship variables, Marriage practices, Leadership and Community properties etc. Each such subject class has a variety of orga-

nizational or conventional variants which have been cross tabulated by frequency within each variable as it is arranged as a member of a class of variables such as "Mortuary Practices" or "Warfare and its resolution". The statistical tests were executed with respect to cross tabulations between the different properties grouped under the headings of "Kinship variables", "Marriage practices" etc. and the dominant source for food and/or the occupational potential of the geographical locations of the ethnographically described hunter-gatherer cases as projected by the Terrestrial model. The results implicate directly the question posed earlier, namely "do cases that were ethnographically described as practicing a different subsistence strategy from that "projected by the terrestrial model" differ systematically as regards the basic cultural customs practiced when evaluated statistically? The basis for the latter tests were organized relative to variables, when at the same time, the cases are also differentially organized relative to the subsistence projections made by the terrestrial model.

Since all of the cases occurring in the "Plant block" were also projected by the terrestrial model as either (1) "having been" dependent upon terrestrial plants or living in uninhabitable settings as modeled for technologically unsophisticated people. These two possibilities were collapsed with the result referred to as " TM-Plant dependant" since terrestrial plants are expected to support more people per 100 square kilometers, other things being equal. Secondly (2), or "having been" dominantly dependent upon terrestrial animals or mixed terrestrial animal and plant sources in roughly equal proportions. These possibilities were also collapsed and are referred to as "TM-Animal dependant" cases.

The cross- tabulations of ethnic customs and/or systems properties, mentioned above, were executed with respect to the two collapsed alternatives of the terrestrial model tabulated as possible clues to "initial conditions" in the past.

The execution of the above procedures produced interesting patterns that were reported in Table 2. It must be kept in mind that the cases selected for study as outlined above, were all packed and either dominantly dependent upon terrestrial plants (the Plant Block=Table 2B) or aquatic resources (the Aquatic Block=Table 2A) at the time of ethnographic description.

Table 2B is based on the forty four cases that were packed and dominantly dependent upon terrestrial plants at the time of ethnographic description (Figure 6). Of these cases, thirty two are projected by the collapsed Terrestrial Model to "have been" dominantly dependent upon terrestrial plants. The remaining 12 cases were projected by the Terrestrial Model, in its collapsed form, to have been dominantly dependent upon terrestrial animals.

These thirty two cases would be those clustered in cells 3 & 4 of Table 1 about which we asked earlier "Do these fourteen cases differ as a group from those that are projected to have always been terrestrial plant dependent peoples?" First the fourteen cases mentioned above included one case, from Cell 1, indicating a change in subsistence essentially at the packing threshold. I am not interested in that case. What interests me, are the cases that may have undergone considerable culture change in a post packing situation. Are those cases with (TM subsistence) projections for terrestrial plant dependence different from those that have (TM subsistence) projections for terrestrial animals as likely contrastive "initial conditions?

Table 2B was partially compiled from a total of 44 cases that constituted the Plant Block (Figure 6). Thirty two cases of the above mentioned 44 had (TM subsistence) projections favoring terrestrial plant foods while twelve cases had (TM subsistence) projections for terrestrial animals (Table 2 Plant Block Cases). The latter twelve are the cases, without missing values, for any of the cultural properties listed under the "Plant Block" section of Table 2. used here from the set of 13 cases identified earlier from Table 1 as interesting because they were clustered in the last two cells of the Plant block. That is they had changed most dramatically in population density when com-

pared to the value of the packing threshold. This placement in the distribution could or "might" also imply a longer "time elapsed" since the packing threshold was passed. This inference depends upon the general expectation that "other things being equal" the greater the population density, the longer the population has been growing.

Continuing our focus on the "Plant Block" cases of Table 2B, it should be noted that columns marked "**Same**" do, without exception, identify the columns with the longest lists of variables. This means that statistical tests uniformly returned statistical results of "no significant difference." These cases are listed in Table 2B as "**Same**" and the (TM subsistence) projections for subsistence used here are viewed as possible clues to initial conditions extant in the past.

It is dramatic that only eighteen cultural attributes (26.47%) out of the 68 compared, were found to differ, as judged by appropriate statistical tests, when tabulated relative to (TM subsistence) projections of either dominantly "being in the past" dependent upon terrestrial plants versus animals.

I may answer the question poised earlier very directly,

Generalization 6: There is not much difference between the cultural systems falling into the post-packing "Plant block" in spite of having different subsistence "starting points" as projected by the Terrestrial Model. Judging from the variables listed as different in Table 2B. I suggest that the demographic size of the society and the scale of ritual participation known from within the region are the major dimensions of differentiation. The only obvious additional dimension is the scale of organizational differentiation within societies when viewed at a regional perspective. Indicators of the latter dimension would be judged by institutionalized leadership roles, status differentiation as with slavery, or the presence or absence of "money" as well as the status prerogatives accruing to leaders.

Variations in mortuary practices are focused upon alternative treatments of the corpse (e.g. burial, cremations, exposure etc.) the scale of participation in the ritual and the differential "role" of the corpse in resolving issues of witchcraft as a possible cause for death. Kinship conventions judged to be different are gender conventions when tracing kin, and alternative cousin terminology. The only variable suite dealing with warfare has to do with conventions for resolving group to group conflict. The only conventions dealing with marriage that differ are the customs regarding how spouses are chosen and who actually makes the marriage decision. The kin where the couple camps while they are reproductively active is the only additional convention evaluated as "different".

It appears safe to generalize that packed terrestrial adaptations falling within the plant block are very similar to one another as evaluated by the suite of variables chosen for statistical comparison (Table 2B). At the time of ethnographic observation all forty four plant block cases with no missing variables were dominantly exploiting terrestrial plants. The mean population density value for these same cases ranged from 12.89 persons per 100 square kilometers in "Cell 1 (Figure 7) which is closest to the packing threshold up to 80.81 persons per 100 square kilometers in Cell 4, (Figure 7) most distant from the packing threshold. Certainly, if population density was the main driving force, the above mentioned contrasts between Cell 1 and 4 should be sufficient to yield some major contrasts.

Complex societies certainly exist among hunter gatherers, however, thus far there has been little progress made toward isolating why! In addition, little progress has been made in understanding why some hunter-gatherers, such as those that are dominantly dependent upon terrestrial plants for their foods, appear to be generally undifferentiated and relatively non-complex? Can any hunter-gatherer group just become equally complex relative to others if, as judged relative to one another, some variables are held constant? Do some niche constructions predispose changing systems toward different organizational forms and/or different scales of internal social segmentation? The "yes" answer

is consistent with the patterned implications derived from the cultural characteristics yielding statistically significant indicators of difference versus those that did not as they were differentially distributed between the Plant versus Aquatic Block comparisons shown in Table 2.

One could hardly conceive of results from statistical evaluations that would be more contrastive than what was discovered when packed cases of the "Aquatic Block" were studied in the exact same manner as yielded the results reported for the terrestrial plant dependant cases discussed above. For instance, one hundred percent of the twenty two cultural attributes tabulated under the "**Leaders, Trade, & Community**" heading were judged as being "different" among cultural attributes tabulated between the sub-sets of cases sharing different (TM subsistence) projections of hunting, versus gathering. These differences were advanced as perhaps referable to modeled contrasts in "initial conditions" among ethnographically recorded Aquatic Block Cases.

The above facts are striking, nevertheless, it must be realized that there were a total of six different culture element categories that were statistically evaluated using the same protocols as employed with the twenty two traits listed under the *Leaders, Trade & and Community* column of the "Aquatic Block" cases. Instead of 100% of the attributes listed under the *Leaders, Trade, & Community* category of the "Aquatic Block" cases being different only 27.27% were found to be different among "Plant Block" cases in the analogous column. What is conditioning such an amazing difference between the Aquatic Block responses and those from Plant Block cases?

If we shift the comparison again and examine the sum of the frequencies for "different" verses "same" statistical evaluations distributed among "Plant block" versus "Aquatic block" cases, the contrast is very large. Eighty point four percent (80.4%) of 71 comparisons were judged different among "Aquatic Block" cases when compared to Terrestrial Model projections for terrestrial plant focused adaptations. In the latter case, only twenty six point five percent (26.5%) of the 68 "Plant Block" comparisons were judged to be different when identical comparisons relative to the Terrestrial Models projections were made!

Table 3 - Frequency tabulations of Systems State [SYSTATE3] expectations for Plant Block cases among "Cell Number" sets as shown in Figure 6

[SYSTATE3] Systems State Seq. No. 1-7	Terrestrial Plant Block				
	Cell #1	Cell #2	Cell #3	Cell #4	Total
Generic-H & G's (Row #1) Seq. No. 4	**9.0** **60.0%**	1.0 12.5%	6.0 *21.4%*	2.0 13.3%	18.0 *27.3%*
Mutualists (Row #2) Seq. No. 3	3.0 *20.0%*	**4.0** **50.0%**	5.0 17.9%	3.0 *20.0%*	15.0 22.7%
Wealth scaled units (Row #3) Seq. No. 6	3.0 *20.0%*	**2.0** **25.0%**	2.0 7.1%	0.0 0.0%	7.0 10.6%
Internally Ranked (Row #4) Seq. No.7	0.0 0.0%	0.0 0.0%	**12.0** **42.9%**	**7.0** **46.7%**	**19.0** **28.8%**
Horticulture added (Row #5) Seq. No. 2	0.0 0.0%	1.0 *12.5%*	3.0 10.7%	**3.0** **20.%**	7.0 10.6%
Column Total	15.0 100.0%	8.0 100.0%	28.0 100.0%	15.0 100.0%	**66.0** **100.0%**

Note: The high mobility cases of Cell #1 (See Fig #3b) are included here but were not Included in the "Plant Block " Cases of Table #2.

In fact, the overwhelming difference between the indications of dramatic culture change among the cases, in the post-packing situation, were among those cases dominantly dependent upon aquatic resources while those exhibiting significantly less change were focused exploiters of terrestrial plants. This contrast demands research and hence presents itself as a valuable learning opportunity. Put another way, what are the other things that are not equal between the two sets of cases as regards "post-packing" culture change while all the cases, nevertheless, remained hunter-gatherers!

It may be recalled that the cases tabulated in Cell 1- Table 3 shared the same range of potential population densities, but differed in the kilometers residentially moved annually. It is clear that the population densities for Cells 1 and 2 of figure 6 differ one from another only about one tenth of a person per 100 square kilometers. The meaningful comparisons should be made between cells 2 thru 4 where the maximum mean density for Plant

Block cases is approximately 71 persons per 100 square kilometers. Importantly, among Aquatic Block cases the mean value for cell 4 is approximately 109 persons per 100 square kilometers.

Generalization 7: *Post-packing hunter-gatherers exploiting aquatic resources achieve 25% higher population density levels on average than do terrestrial plant dependent peoples living in a post-packing state.*

There are several ways of looking at this situation. (1) Since all hunter-gatherers described ethnographically lasted into the colonial era and beyond, the patterns demonstrated in Table 2 document an overwhelming bias toward more complex forms of social organization occurring among aquatic resource dependant peoples. These same cases, as noted above, also had higher population densities (Table 4).

While this is interesting, we want to uncover, if possible, the dynamics operative among interacting cultural variables as well as the character of suspected shifting ecological relationships within the dynamics with which socio-cultural systems interact and are "pushed" toward changing trajectories in their customary cultural practices.

Table 4 - Frequency tabulations of Systems State [SYSTATE3] expectations for Aquatic Block cases among "Cell Number" sets as shown in Figure 7

[SYSTATE3] Systems State Seq. No. 1-7	Aquatic Block			
	Cell #2	Cell #3	Cell #4	Total
Plus Horticulture (Row #1) Seq. No. 2	**1.0** **4.5%**	1.0 *3.3%*	0.0 0.0%	2.0 *2.9%*
Generic-H & G's (Row #2) Seq. No. 4	**1.0** **4.5%**	*1.0* *3.3%*	0.0 0.0%	2.0 2.9%
Generic + Leaders (Row #3) Seq. No. 5	5.0 *22.7%*	**12.0** **40.0%**	1.0 6.7%	18.0 26.9%
Internally Ranked (Row #4) Seq. No.7	7.0 *31.8%*	5.0 16.6%	**5.0** **42.9%**	*17.0* *28.8%*
Wealth Scaled Units (Row #5) Seq. No. 6	8.0 36.4%	11.0 *36.7%*	**9.0** **60.0%**	**28.0** **41.8%**
Column Total	22.0 100.0%	30.0 100.0%	15.0 100.0%	**67.0** **100.0%**

Based upon my previous knowledge of aquatic resource dependent hunter-gatherers the pattern demonstrated in Table 2A for the "Aquatic Block" cases, having shifted away from terrestrial animal or animal and plant mixed dependence is not unexpected. Shifts of this type represent a near total divergence from the "on foot" mode of transportation associated with "generic" hunter-gatherers mode of regular habitat exploitation. In addition, it was recognized long ago that shifts in the direction of increased use of aquatic resources were associated with major technological shifts (Binford 1968: 272-273).

It is largely the contrast between the cultural changes conditioned by the shift to aquatic resources above 40 degrees latitude with minimal to no culture change below 40 degrees latitude, among the "Plant Block" cases of Table 2B that accounts for the dramatic statistical contrasts in the "Same" versus "Different" columns of the "Plant Block" as opposed to the "Aquatic Block" cases in Table 2.

Generalization 8: It seems to be the case that shifting from a dominantly terrestrial animal dependant subsistence strategy to dominantly an aquatic resource dependant strategy, above 40 degrees latitude, in both the north Atlantic and North Pacific Basins favor major organizational change in almost all aspects of life for the cultural systems involved. On the other hand, changes occurring among hunter-gatherer peoples living at latitudes less than 40 degrees exhibit little overall systems change, except in possible scale related phenomena, as they continue to be dominantly dependent upon terrestrial plants.

Having made explicit Generalization 7 it is clear that we must shift to a more ecologically oriented approach regarding the patterning in Table 2 if we are to advance our knowledge much further. For instance, cases living at latitudes greater than 40 degrees south (The Pacific coast of Chile, Atlantic coast of Argentina, The Falkland Islands, New Zealand's South

island, the Chatham Islands, and Tasmania) are not homes to complex cultural systems in any way comparable to the aboriginal peoples of the Northwest Coast of North America nor Northern Japan, the Amur river area of the Asiatic mainland as well as the coastal regions up into the Kamchatka Peninsula region. Why?

I consulted the *FAO yearbook of Fishery statistics-Capture production published by the Food and Agriculture Organization of the United Nations Vol. 92/2 -2001* (Statistician 2003) for information regarding anadromous fish capture in latitudes south of the area between the southern tip of the Baja Peninsula, Mexico and the northern Mexican town of Ensenada. The latter area is generally given as the most southern record for Pacific anadromous fish. The results are that no anadromous fish are reported to have been captured from the coasts or rivers of Meso-America, South America, or Africa in neither the Pacific nor the Atlantic ocean basin regions. In short, the land areas in southern latitudes above forty degrees south are miniscule relative the amount of land with major rivers found at comparable north latitudes. In addition the equatorial waters at latitudes below 30 degrees are reported to support no anadromous fish apparently serving as a barrier to movement of northern latitude anadromous fish into the waters of the southern hemisphere. The presence of anadromous eels along the south Australian coast at a location just short of 40 degrees latitude is an exception that needs further investigation. Eels are also reported from the Chatham Island (Anderson 1982: 87) and one suspects their presence in other locations within the region being discussed here.

Seeking ecological linkages for the dramatic patterning of table 2

We have learned a great deal by exploring the research potential when the phrase "other things, being equal" is taken seriously. Thus far I have avoided the issue of holding constant environmental conditions, as well as related ecological articulations. Certainly we must acknowledge that adaptations bear strong relationships to the ecological context within which they are embedded. In turn, the latter general conditions point to the potential for a large array of variables, many of which have never been satisfactorily evaluated in their potential causal roles as regards documented systems state variability among ethnographic cases in general. Similarly, studies as to how such variables may be related to different patterns of sequential change, as documented archeologically at varying time periods, have not been strongly developed in our literature (Johnson 2004).

The basis for the dramatic patterning documented in Table 2 should be clarified by Figure 8 in that all cases above 40 degrees latitude are shown to be projected to "have been" in their past, with only two exceptions, dominantly dependent upon the hunting of terrestrial animals. On the other hand, all cases found at latitudes less that 40 degrees are shown to "have been" dominantly dependant upon terrestrial plants (41 cases) with the exception of ten ethnic groups who are projected by the Terrestrial Model to have been dominantly dependant upon the hunting of terrestrial animals in warm settings. I think we may therefore conclude that "other things" were not equal as regards initial conditions standing behind cases that varied substantially in complexity when observed ethnographically.

Additional information regarding the differentiation between the subsets occurring above versus below 40 degrees latitude is provided by Figure 9. Thus far we have only considered the "packed" cases. It is reasonable to wonder if there might be some clues to aspects of process differences among "non-packed" cases when compared to "packed" cases if environmental variables are controlled. Therefore, Figure 9 displays the distribution of both packed and unpacked hunter-gatherer cases (see columns) that were classified by "Systate 3" (Binford 2001b: 368-372.), as variable numbers of subsets numbered four through seven, thus restricting the cases to only those that were generic hunter-gatherers running thru those with internally ranked leadership and generalized segmental

complexity. In addition, the upper row displays ethnic units that lived in settings greater than 40 degrees latitude while the bottom row shows cases living where latitude was less than 40 degrees.

Figure 9 shows the distribution of non-packed hunter-gatherer cases distinguished from packed cases arrayed in identical property space, that is both above and below forty degrees Latitude as was shown in Figure 8. In addition the context of their geographic location relative to water sources is added to provide further information about their ecological settings. Clearly, there is a major contrast relative to the patterned distributions as seen in Figure #8. Importantly the vast majority of the non-packed cases known from regions where the latitude equals or exceeds 40 degrees, north and or south latitude, experience their major rainfall during the winter and spring months with remarkably few cases occurring after the end of summer. On the other hand, examination of Figure 9 shows that the majority of the “packed” peoples living at greater than 40 degrees latitude experience their rainfall primarily during later summer and fall. Thus much precipitation is experienced as snowfall. On the other hand non-packed peoples living in setting of 40 degrees or

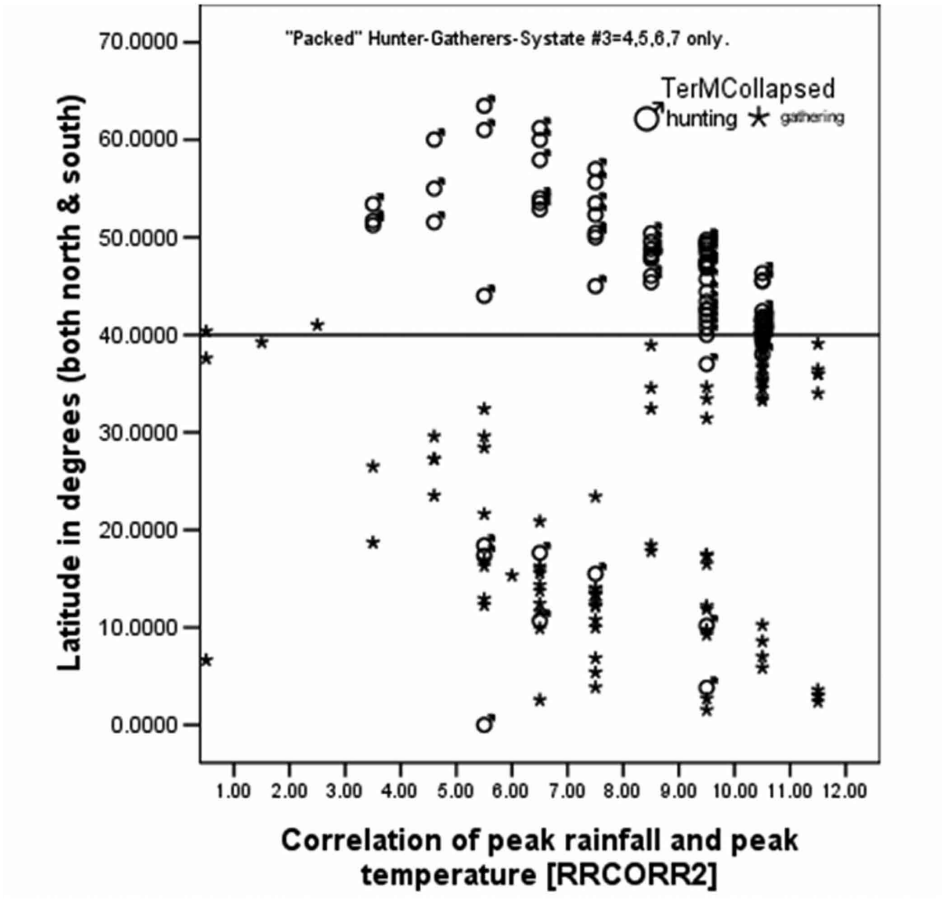

Fig. 8 - Latitude vs. Correlation in months of peak temperature and peak rainfall [RRCORR2 from standardized Java program calculations] showing biased distribution of Terrestrial Model initial conditions for hunting vs. plant dependence.

less latitude, not unexpectedly, are dominantly situated near "pans" and there is little clustering as to the months were high rainfall is coincident with high temperature in or near equatorial settings as is indicated by "RRCORR2". There is nevertheless, a generalized inverse relationship between the rank of streams and rivers with the numbered months of dominant rainfall. This pattern is possibly reversed among packed cases who also inhabit settings with latitudes less than or equal to 40 degrees.

The latter pattern is possibly related to the impacts on mobility as an immediate means for locating food as opposed to obtaining foods during the months when snowfall is not an impediment to subsistence related mobility coupled with storage.. The latter strategy is, nevertheless, coupled with heavy investments in the processing and storage of food for the coldest months at more permanent residential locations (Schalk 1977, 1981). I have discussed these relationships before (Binford 2001b: 256-263). However, given the context of the above mentioned data it is important to recognize that (Panowski 1985) has argued convincingly that general systems complexity is best indicated by the number of different species prepared for storage. It should be kept in mind that her research was importantly conducted among some of the very "packed" peoples tabulated in Figure 8 and 9. In turn, the species being considered by Panowski were largely different species of anadromous fish as well as salt water mammals such as seals, etc. Given these conditions it should come as no surprise that coastal hunter gatherers of the south Chilean coastal region south of Valdivia as well as the Argentine coasts

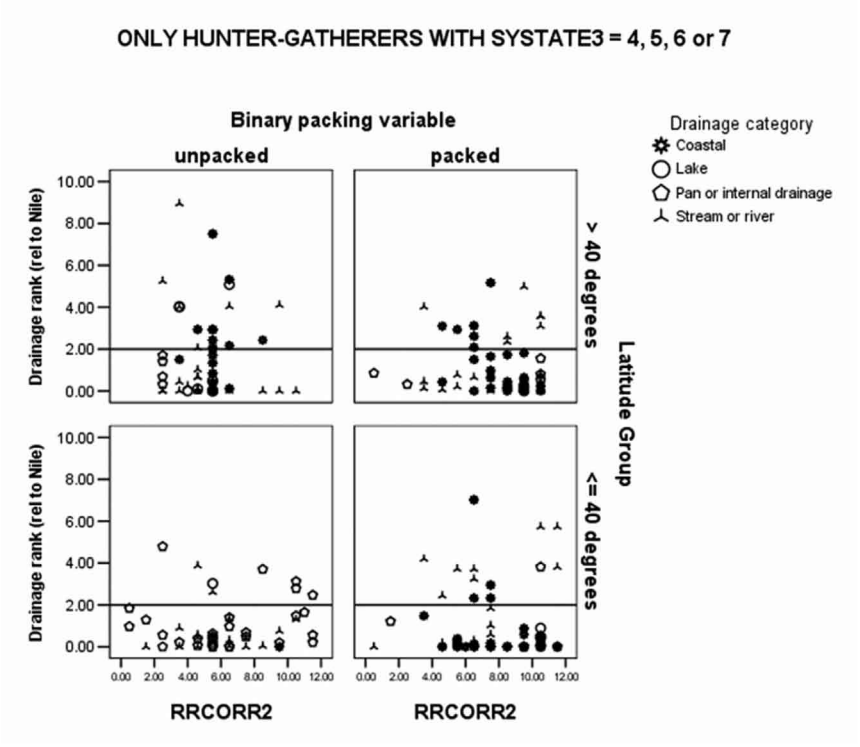

Fig. 9 - Latitude vs. Correlation in months of peak temperature and peak rainfall [RRCORR2 from standardized Java program calculations] subdivided by packing (population density less than or greater than 9.089 persons per 100 sq km) and latitude (above or below 40 degrees), and marked by setting with respect to water sources.

south of Bahia Blanca live where anadromous fish are not present, hence the storage potential that they offer peoples of the Northern Atlantic and Pacific coastal regions are simply not present in the southern hemisphere. Importantly, other things are not equal between the northern verses southern hemispheres are regards the exploitation potential afforded by anadromous fish that underpins the near coastal subsistence patterns of the northern hemisphere.

This point is further illustrated by the archaeology of the South Island of New Zealand where an immigrant horticultural based population from Polynesia settled the previously uninhabited islands of New Zealand. The emigrants to the south island all of which is located south of the 40 degree south latitude line abandoned their horticultural background and reverted to primarily hunting terrestrial animals. Later many species were driven to extinction subsequent to which, the people again began to explore anew the practice of horticulture. This important case demonstrates that in a latitudinal setting greater than 40 degrees hunting terrestrial animals was preferred to practicing horticulture; on the other hand, hunting terrestrial animals over a relatively small land surface resulted in over exploitation. As we have learned, an anadromous fish based aquatic alternative with its built in storage potential was not available thus, with time, a partial return to horticulture was practiced together with a more intensive exploitation of native plant species linked to increased diversification in the food base.

The issue of there being a very distinctive "Sub Antarctic" adaptive zone with Cultural systems centered in four major settings, Patagonia, Tasmania, the South Island of New Zealand south of the Waitaki River, and the Chatham islands. These locations have been described (Sutton 1982) as sharing a large number of distinctive properties none of which justified the cases as being classified as having "Complex" socio-cultural systems. A common feature across the locations considered was that there was an annual rotational exploitation of different species generally obtained at slightly different locations with generally direct consumption of each in turn. Storage played little role in the subsistence strategy and a diverse species food base grounded the subsistence strategy. This is totally different from storage based adaptations of the Sub-arctic Area where anadromous fish were basic targets for high labor investment resulting in substantial quantities of stored food. Even sea mammals were exploited differently. In the Sub-Antarctic seals were generally taken at rookeries in spring, while in the Arctic they were most commonly taken at breathing holds while the people lived on the sea ice in winter. This high arctic strategy obviated the need for large meat stores for winter. It also served as an alternative "backup' strategy for groups who experienced failed strategies during the warmer months to obtain sufficient animals or fish to supply the stored food for consumption over winter (Binford 2001b: 358). No such technique is reported from the Sub-Antarctic. Clearly, other things are not equal as viewed from an ecological, geographic, and topographic perspective between the environments of the Sub-Arctic versus that of the Sub-Antarctic. These places are very different and it is not surprising that the hunter-gatherers of the two areas are also very different. Relatively complex socio-cultural systems with internally ranked leadership are totally lacking among the southern hemisphere Sub-Antarctic cases of hunter-gatherers. On the other hand, complex cases are so common among the Sub-Arctic cases that in the past they have regularly been called "anomalous" by writers discussing "hunter gatherers" in general!

Retrospective

If we reflect back to the introduction of this essay we find ourselves in the intellectual posture described in the very first paragraph, namely that it should be clear that most of the propositions offered in section IV. are subjec-

tive, they were derived, "in a technical sense- by their author". What is true about this essay is essentially also true of many essays, for instance one by Jared Diamond (1997) who built an accommodative argument regarding the "causal" effects of physical geography on the historical episodes with outcomes of dominance and oppression by "superior" colonialists populations. The physical settings of their history made them "superior" or alternatively "inferior", not their brains nor biology. The latter point is obviously made in service of liberal piety while attended by an additional goal of making history "scientific" (Diamond 1997: 37).

It is the latter point that provides a clue to why I view the shortcoming of this essay as bearing some similarity to the flawed arguments of Jared Diamond. It is simply that I have not rendered the data nor the variables recognized into dimensions. The variability as dimensionally summarized is judged to have relevance to causal patterning. A dimension is recognized by having its own unique instrument for measurement. The dimension of extension may be measured most commonly by meters, or feet, or even by light years depending upon the scale of extension being measured.

Weight is measured with a scales. Temperature is measured with a thermometer. In short, variables must be dimensionalized so there are clear standards for describing variability within or among classes of phenomena. It is in science that such measured variability is analyzed relative to other measured properties that are used in developing theory and in turn providing explanations for diverse dynamic empirical patterns.

None of the categories of phenomena that were recognized as "not equal", within the bounds of this paper, have been dimensionally described nor yet used to organize sub-classes of phenomena for analysis in any serious manner. It is true that I have used cases that were previously dimensionalized and could be employed in analysis as was reported in Table 2. In turn patterns resulting from such analysis were used in organizing sub-classes for comparative study in order to evaluate the possibility of differing "initial conditions" being a major conditioner for subsequent change trajectories as investigated among packed cases dominantly subsisting, at the time of ethnographic description, upon Terrestrial Plants versus Aquatic resource focused subsistence strategies. We certainly learned from using such strategies. Nevertheless, what was learned about "other things that were not equal" has not yet been dimensioned for use as either frames of reference or data, similarly what was learned has not yet been integrated into a theory building argument. In short, what was learned has not yet been integrated into new problems for which ans-wers might be forthcoming (See Binford 2001a) given sufficient attention to how data are dimensiona-lized as well as how patterned analytical results are summarized.

One must think of this paper as an exploration of learning strategies, useful when seeking germane knowledge for guiding the definition for classes of phenomena to use in comparative studies and when exploring empirical observations for clues to possible conditioners for differential dynamic outcomes when causal processes are at work.

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