

X <THE MOSSBACKS SETTLEMENT PATTERN>

<Introduction>

The analysis of the Mossbacks settlement patterns is much briefer than that found in the preceding chapter. This is the result not only of the smaller sample and simpler nature of the Cedar Mesa Basketmaker III but also because the development of the analytical procedures does not need to be repeated here.

The basic expectations for the Mossbacks patterns is developed by contrasting the number and nature of the sites with the preceding Grand Gulch phase. These expectations are first examined using the same quadrat variables as before, and then re-examined using the niche hypervolume analysis. The use of on site variables are used to further explore aspects of site functions. The nature of social organization, and population sizes during the Mossbacks phases concludes the analysis.

<Expectations>

The Mossbacks Basketmaker II pattern is in some ways a contrast, and in other ways a continuation of the earlier Grand Gulch, Basketmaker II pattern. One of the most obvious differences lies in the variety of sites. In the Basketmaker II period, 52 out of 130 odd sites were habitations; in the Mossbacks Phase, we find that we have

classed 31 out of 48 components as habitations. Further, the distinctions between artifact profiles that were possible for the Grand Gulch Phase were not possible for the Mossbacks Phase. In contrast to the five site types found in the Grand Gulch Phase, only two are found in the Basketmaker III period; habitation and limited activity sites which differed primarily only in surface features and site size.

The change from almost two-thirds of the sites being non-habitation sites in the Grand Gulch Phase, to two-thirds being habitation sites in the Mossbacks appears to be a significant switch. While it is true that we defined Mossbacks in a conservative fashion, a more generous definition would not have added the numbers sufficient to triple the limited activity class. In terms of artifacts, some of the largest sites during the Grand Gulch Phase were limited activity campsites. All single component Mossbacks sites with 30 or more lithic tools have surface features indicative of habitation, showing that during this period no recorded limited activity site was of substantial size. These differences between our sample of Grand Gulch and Mossbacks sites, essentially a reduction in number and kind of non-residential sites through time, must be considered a correct reflection of the prehistoric situation.

The reduction in kinds of sites and numbers of sites would lead one to expect a simpler and less varied settlement pattern. The increased emphasis on habitation sites would lead one to expect the pattern to be more concentrated in the arable land area than previously. If, as before, habitations are centered in areas of arable soil, we would expect all sites to be more strictly limited to this area, as we lack the equivalent of the Grand Gulch "Campsite" class which results from regular use of areas distant from habitation sites. We might also expect this reduction in use of different environments on general evolutionary grounds in shifting from a time not long removed from a broad scale hunting and gathering pattern with a variety of sites and a broad niche in Basketmaker II times to one further removed and relying on fewer resources. The addition of beans in the Mossbacks Phase would further this argument as this important crop would reduce the need for reliance on other protein rich wild foods. We will return to this topics later as we have presented them here to justify the narrowing of the niche expectation.

Our main expectation, then, is that the habitations would be located in areas of apparent arable soil and that limited activity sites would also be concentrated there (This is basically the same as our 1971 original Basketmaker III hypothesis (Lipe and Matson 1971a)). For

both site kinds, the concentrations would be at high elevations in deep soil areas. Some exceptions to this pattern might be expected with limited activity sites found in areas suitable for canyon bottom flood water farming and low elevation sand dune farming. The 23 quadrats with habitation sites would be expected to have relatively high elevations. If low elevation wild resources are less important at this time, we might expect a slightly higher elevation than for Grand Gulch habitation quadrats, as this low elevation "pull" would be reduced. If, as during the Grand Gulch Phase, Cedar Mesa included environments too high and cold for successful agriculture, we would predict a similar high elevation truncation. If not, we would see habitations continuing past 2010 m (6600 ft).

<Quadrat Analysis>

The elevations are shown plotted in Figure X-1. Here we find an extraordinarily constricted pattern with an interquartile range or midbreadth of less than 60m (200 ft). The distance from the first quarter to the highest habitation quadrat is only 100m (322 ft), enclosing three-fourths of the sites. Note, that unlike the Grand Gulch case, there is no truncation at the higher elevations, which habitation sites existing within 20 meters of the highest elevations in the survey area. There is little use in testing this distribution against all

survey quadrats, at it is obviously highly significant. There is no doubt the the Mossbacks Basketmaker II quadrats are concentrated at the highest elevations. We can test to see if they are concentrated in higher elevations than the Grand Gulch habitation quadrats. While the mean difference is only 1926m (6319 ft) compared to 1974m (6476 ft), the two samples are significantly different according to the Wilcoxon Test (this unit normal deviate 2.193, 0.015 probability deviate is 2.17).

Inspecting the outliers(Figure X-1) we find that the lowest habitation quadrat has the largest site (North Road 11-4). As we have stated several times before, the North Road elevations are equivalent to those considerably higher elsewhere(Figure X-2). Even if North Road 11 is treated as 60 or 70m higher, it would still be one of the lower habitation sites. The previously mentioned concentration of Basketmaker III sites to the east may partially explain this site, as the eastern concentration may act as a "pull" for the Mossbacks sites.

The next lowest quadrat is Hardscrabble 14, which has a very complicated, at least three-component site. If there is not an actual Basketmaker III habitation site here, this is the largest nonhabitation Mossbacks site. This site is in an area of Pinyon-juniper with small sand dunes surrounded by sagebrush and it may represent the water storage option. Bullet 5 is not far from Bullet 18

(Figure X-2) and is located in a similarly very deep soil situation. So Hardscrabble 14 and Bullet 5 represent not too dissimilar deep soil divide areas. For that matter, North Road 11 also fits, but at lower elevations than most of the habitation quadrats. Bullet 22 is a site located in a canyon (Figure X-2) which is one of the few with much soil in it. Canyons are climatically equivalent to higher elevation flat areas and higher elevation areas are immediately adjacent to it. Bullet 22 is one of the few places in the upper Bullet drainage where canyon bottom floodwater farming (in the absence of arroyos) appears to be feasible.

So all four of the lowest habitation quadrats have attributes which suggest good arable soil. Three of them are located in areas of the deepest soil away from the sagebrush-filled valleys. The final one, is located in a canyon with alluvium. The association of habitation sites with arable land is clear and the upper elevation truncation observed for the earlier period is absent (see also Figure IV-10), suggesting that either the climate was now warmer or more cold tolerant varieties of maize had become available.

Examining the elevation of all quadrats that had limited activity sites present, we find (Figure X-1) a distribution in some ways similar to the one of habitation

quadrats and in other ways, different. The upper half of the distribution appears to be very similar, but the lower half is much more dispersed. The upper half is in agreement with the expectation of concentration in areas of arable soil, but the lower half needs further inspection. Note that the second quarter of the limited activity quadrats has a range of 150m (500 ft) compared to 30m (100 ft) for the habitation quadrats, and that the low for the limited activity sites is 90m (300 ft) lower than for habitation quadrats.

Looking at the extremes, we find that the lowest quadrat, Hardscrabble 4, is one, along with the adjacent Hardscrabble 5 (Figure X-2), in the area most suitable for low elevation sand dune agriculture. This area also has abundant Indian rice grass which may be an alternative focus. So the most extreme exception fits one of the two most likely alternative farming strategies.

Next in elevation is North Road 5. North Road quadrats are equivalent to areas up to 100 meters higher in elevation elsewhere and this quadrat is located across the canyon from North Road 11, adjacent to one of the largest deep-soil sagebrush flats in the drainage. While low elevation it appears to be an area of definite agricultural potential. Nearly at the same elevation is North Road 10, 400 meters from North Road 11 and in a similar setting with similar good agriculture potential.

The quadrat defining the first quartile is also the one with the largest single Basketmaker III site, North Road 11, previously discussed above. The next quadrat has the only low elevation site without obvious agriculture potential, Bullet 17-2. This is a site on the cliff part way down into lower Bullet Canyon. There is no obvious easy access to the canyon bottom, where there is abundant alluvium nor are there adjacent deep soils on the rim top. Two Pueblo cliff-dwelling components do exist in this quadrat, however, indicating that this area did have some value for Anasazi agriculturalists. Further, not only do we have Bullet 22 as evidence of Basketmaker III use of the canyons, but we also found occasional Mossbacks sites during the canyon surveys of the three northern drainages (Chapter IV). So, in spite of no obvious modern access to the canyon, it is likely that this site is related to canyon bottom flood water farming.

If there is less emphasis on low elevation non-agricultural pursuits in the Mossbacks phase than in the earlier Grand Gulch phase, we would expect the earlier limited activity sites to have lower elevations. This same elevational difference would also exist if the limited activity sites of both phases were agricultural related, but there was a tendency of the agricultural pursuits to increase in elevation in time. This last hypothesis can be

fairly well rejected as a possible explanation, since many, if not most, of the Basketmaker II limited activity sites are not, contrary to the Mossbacks limited activity sites reviewed above, located in situations with much agricultural potential.

One way to test the first, and most reasonable, hypothesis is to compare the Limited Activity Sites (Groups 0-1) quadrats of the Grand Gulch phase with the Mossbacks limited activity quadrats. According to the Wilcoxon test, the Basketmaker III limited activity sites are higher, at least at the .10 level (this rank sum is 226.5, .10 probability rank sum is 230).

In the Grand Gulch Phase settlement pattern analysis, we used percent of dense pinyon-juniper coverage as a measure of amount of arable soil. If Mossbacks habitation sites are even more related to rainfall agriculture than Grand Gulch habitations, we ought to find higher percentages of dense pinyon-juniper. On the other hand, the highest elevation with deepest soils often have sagebrush parks and if these were used for farming, they might cancel out increased pinyon-juniper coverage, and might be the variable measuring the most arable soil.

Figure X-3 shows the values of the 23 quadrats plotted, with the median value being as high as one could expect, 80%. Fully three-fourths of the habitation quadrats have values greater than 60 percent coverage.

Inspection of the lowest outliers shows a replacement of pinyon-juniper with sagebrush. Hardscrabble 14 has more evidence of dune formation and is at a lower elevation, while Bullet 18 is located on a very deep soil divide with both pinyon-juniper and sagebrush present, as well as some small dunes, and is at a higher elevation. Upper Grand Gulch 6 has lots of thin soil, but is surrounded by deep soil pinyon-juniper and is close to large, high elevation, sagebrush flats. North Road 4, while also having bare rock present, is adjacent to the Brushy Flats area, the highest elevation, deep soil pinyon-juniper and sagebrush area of the combined Bullet and North Road drainage area. Bullet 22, the last member of the first quartile, is the previously mentioned canyon-with-soil quadrat. Dense pinyon-juniper is found adjacent to habitation sites with quadrats having lower amounts either being immediately adjacent to such areas, or replacing some pinyon-juniper coverage with sagebrush, or being located in canyons or having small dune areas (possibly Hardscrabble 14 and Bullet 18). The looked for replacement of pinyon-juniper by sagebrush in the highest and most deep soil areas is not evident, with North Road 4 and Upper Grand Gulch 6 being the only two possibilities.

Using the Wilcoxon test in an attempt to see if there is a greater concentration of dense pinyon-juniper coverage

on habitation quadrats during the Mossbacks phase than earlier, no significance difference is found. Comparing Figures IX-3 and X-3 shows that there is an increased percentage of deep soil pinyon-juniper during the later period, but the shift can be expected to occur through repeated sampling of the same population about one time in five (this normal deviate .947, probability .18 normal deviate .915). The fact that the elevation difference was highly significant while coverage is not suggests that higher elevations were more important than denser pinyon-juniper in this shift.

Sagebrush flats appear to be equally present in both the Mossbacks and Grand Gulch phases. Only 15 of the 32 habitation quadrats in the earlier period have 1 percent or more of their cover classed as sagebrush and only 14 of the 23 quadrats in the later period. Our impression of a closer sagebrush association with the Mossbacks phase does not appear to be born out.

Comparing habitation quadrats of the two Basketmaker periods does not show that the later inhabitants placed their dwelling sites in areas with significantly more pinyon-juniper or sagebrush. The actual point estimates of both, however, are higher for the later time period. If we think about the expected amounts of deep soil pinyon-juniper on Mossbacks limited activity quadrats compared to habitation quadrats, we find an expectation of

a higher central tendency and a broader dispersion. This is expected whether we view all or just some of them as agricultural field sites. If we view all of them as agricultural field stations, we would expect most of them to be in areas of densest deep-soil pinyon-juniper. This prediction follows from the Plog and Hill(1971) argument that limited activity sites will be located immediately adjacent to the critical resource while multiple activity sites, such as base camps, will be located with respect to a number of resources in a compromise situation. On the other hand, some field stations should be located in alternative farming areas, whether extreme water storage dune areas, floodwater plots or in canyons, and thus some should not have large percentages of pinyon-juniper cover present. If one argues that some of the limited activity sites are not field stations, then one is suggesting that the low percentage of deep-soil pinyon-juniper tail should be increased, since at least some limited activities are not located near deep-soil pinyon-juniper.

Inspection of Figure X-3 does show these tendencies with a concentration of sites above 80 percent and others strung out below 50 percent. The high concentration would agree with our expectations of field stations; let us examine the residuals in the first quarter.

The most extreme quadrat is Hardscrabble 4, as on the

elevation plot. As discussed before, this is probably either a sand dune agricultural area, an Indian rice grass processing site, or possibly a combination of both. This area is also at the head of a canyon with a spring and good access to lower Grand Gulch. The next quadrat is Bullet 17 and the site present here is the multicomponent cliff dwelling with a small Mossback component. This site is difficult to picture as an agricultural site (or any other kind, for that matter) unless the alluvial bottom of lower Bullet Canyon, far below, was farmed. Upper Grand Gulch 9 is a quadrat filled with primary lithic reduction sites and while UGG 9-1 is not as obviously a primary lithic reduction site as those of other periods in this quadrat, this is our best estimate as a function, as reported in Chapter VI. It does not overlook, nor is it close to, any obviously arable soil. The definer of the quartile, North Road 4, is the previous discussed site next to Brushy Flats. So, of the four outliers, two (Hardscrabble 4 and North Road 4) are probably agricultural, one (Bullet 17) is likely related to canyon bottom farming, and one (Upper Grand Gulch 9) is most likely nonagricultural.

From our discussion of the central tendency, we might expect the limited activity quadrats to have greater percentages of deep-soil pinyon-juniper than habitation quadrats. If we use the Wilcoxon Test to examine this, counting quadrats with both kinds of sites in both classes,

we do find this trend, but it is far from significant (this rank sum 272, .10 rank sum 248). If we examine just those with only limited activity sites (also plotted in Figure X-3), we find the reverse trend, but also not significant (this rank sum 97.5, .10 rank sum is 81). If we use the median test (Bradley 1968), which takes into account only whether the population falls on one side or the other of the grand median using all limited activity quadrats, we calculate a chi square of 3.273 with one degree of freedom, significant at the .10 probability level (.10 probability chi square is 2.706, .05 chi square is 3.841). Thus while there is not a tendency overall for the distribution of the limited activity quadrats to have a higher percentage of dense pinyon-juniper than habitation quadrats, a higher proportion is in the highest percentage coverage. So while a wider dispersion is evident, it depends on one's definition if there is considered to be a significant difference in central tendencies between habitation and limited activity sites.

Casual inspection of Figures X-3 and IX-3 shows a large difference between Mossbacks and Grand Gulch limited activity sites. Limited activity quadrats (n=15) appear to have significantly more deep soil pinyon-juniper than any of the three Grand Gulch limited activity classes. The closest relationship is with Grand Gulch limited activity

quadrats (Groups 0 and 1). If this difference is significant, the others will be more so. According to the Wilcoxon Test, the difference is significant at the .10 level (this rank sum 227.5, .10 rank sum, 230) which would mean the others are more significant. The close association with dense pinyon-juniper suggests a function of field stations related to rainfall farming for Mossbacks limited activity sites.

It is interesting to note that only five of the 15 limited activity quadrats have more than 1 percent covered by sagebrush, and none has more than 9 percent! Further, the seven limited activity quadrats without habitation sites have almost no sagebrush community coverage present. Only a single quadrat has any recorded and that is only 2 percent. These figures suggest that sagebrush flats were not farmed and that the minor association of sagebrush with habitation sites is due to the occurrence of such sagebrush areas in the higher elevations with deeper soils and not because Mossbacks people were locating adjacent to them for farming purposes. Perhaps the cold air drainage factor discussed earlier reduces the agricultural potential of sagebrush areas.

<Hypervolume>

The tests so far are indicative of Mossbacks sites being located in higher and deeper soils than in the Grand

Gulch period, with the habitation sites showing ^{fewer} ~~less~~ differences than the limited activity sites. As in the earlier period, the limited activity sites show more dispersion than the habitation sites but less broad than the earlier period. Turning to the hypervolume, let us see if these expectations are seen in the reconstructed niche.

Figure X-4 shows the first two dimensions with the habitation quadrats emphasized. On this plot, it is immediately apparent how the habitation sites avoid the rocky downward leg of the horseshoe. The three lowest quadrats, Upper Grand Gulch 6, North Road 4 and Bullet 22, have been discussed before, but it is worth repeating that Bullet 22 is in an alluvial canyon bottom setting and that the other two are immediately adjacent to two of the highest, deep-soil divides on the mesa.

The other aspect that is noticed is the trend to the deep-soil areas on the left. The Mossbacks phase goes as far ⁱⁿ this direction (Bullet 18 and Hardscrabble 14) as does the earlier period and proportionally has a larger part of the habitation quadrats in this area (9 of 23 compared to 10 of 32). This deep soil emphasis is what was expected, but which we were unable to demonstrate in the previous hypothesis testing. So the first two dimensions show a compressed hypervolume relative to the earlier period, with the rocky areas avoided and a greater emphasis on deep

soils.

Figure X-5 illustrates the next two dimensions. We would expect the habitation quadrats to be clustered in the center and this is what we find. Upper Grand Gulch 6 is the most extreme habitation quadrats and we have previously discussed its surroundings--high elevation deep soils. In summary, the niche space of the habitation sites is smaller and concentrated towards the deep soil areas, away from the rocky thin soils areas.

Turning to the limited activity sites (Figure X-6), we also find a concentration on the higher elevation deep soil areas, with only four of the 165 quadrats being located in other environments. These quadrats have all been discussed before, North Road 4, adjacent to the North Road-Bullet deep soil divide, Upper Grand Gulch 9, a lithic work shop site, Bullet 17, a small component at a cliff dwelling site, and Hardscrabble 4, sand dune agriculture/Indian rice grass area. This concentration in the deep soil pinyon-juniper area is a confirmation of the hypothesis testing and supports the idea that most of these limited activity sites were field stations.

While this is a broader pattern than that produced by the habitation quadrats, it is also a shift from the sagebrush areas toward the rockier areas. This change may be interpreted as further support of the idea that the sagebrush flats themselves were not farmed. The same

relative shift towards rockier environments was also observed for the limited activity sites in the earlier Grand Gulch Phase. In the limited activity plots of the earlier period (see Figures IX-6, IX-10 and IX-14) about half the limited activity quadrats were located away from the bend in the horseshoe. Here, less than one-third are, demonstrating the relative concentrated nature of the Mossback hypervolume.

Figure X-7 shows the third and fourth dimensions with the Mossbacks Limited Activity quadrats designated. While in the earlier phase (Figure IX-7, IX-11 and IX-15) many of the more environmentally extreme outlying quadrats had limited activity sites, not one has during the Mossbacks Phase. Hardscrabble 4, North Road 4, Upper Grand Gulch 9 and Bullet 17 repeat as the most extreme Limited Activity quadrats, but not one is far from the center of this figure. In contrast, the Grand Gulch Limited Activity sites, Group 0-1 had five quadrats more extreme than any here, and the Group 2 Campsites had six. The Mossbacks Limited Activity hypervolume is definitely much reduced from the Grand Gulch and this reduction is most apparent on these two dimensions which emphasize the extremes.

The total Mossbacks adaptation is much more specialized than the Grand Gulch one and this restricted niche is illustrated by the reconstructed hypervolume.

Mossbacks sites are concentrated in deep-soil pinyon-juniper areas, much more so than the earlier Grand Gulch Phase. This is true not only of the habitation sites, but also of the more broadly dispersed Limited Activity Sites, which are also more restricted than in the earlier phase. These patterns are all in accord with the notion that the Basketmaker II people were much more dependent on a single activity, rainfall farming, as predicted by Lipe and Matson (1971), than earlier Cedar Mesa inhabitants. Let us turn to site by site analysis to see if this idea is supported by on site variables.

<On Site Variables>

The preceding analysis is based on the proper identification of the two Mossbacks site classes as habitations and limited activity agricultural field stations. While we have presented good archaeological evidence for many members of the first, some members, particularly those of multicomponent sites, are less strongly identified, although the class as a whole has an environmental location that supports this functional identification. The limited activity class is clearly one of restricted activities because of the archaeological remains, but the identification as field stations is based primarily on the environmental locations. In this section

we use on site information to further explore the functions of these two site classes.

Following Haase (1983a), we expect a southern or southwestern exposure for habitation and a northern to northeastern exposure for agricultural field sites, as we argued for the Grand Gulch Phase. It will be recalled that the first notion appeared to be true for the Grand Gulch Phase habitation sites, but that we found a southeastern exposure in addition for the putative field stations.

Figure X-8 shows the results of tabulating the 30 habitation sites with definite exposures. Because of the multicomponent nature of many of these sites, these exposure measurements are probably less precise than those for the Grand Gulch habitation sites. In spite of this potential problem, a very similar pattern resulted (compare with Figures IX-20,-21). As before, the most common direction is due magnetic south. In the Mossbacks rose diagram, southwest is stronger than in the Grand Gulch Phase, but that makes the fit better with our expectations.

A secondary peak is found in the east, but we have no rationale for this exposure. As North Road slopes east, and has abundant Basketmaker III sites, we inspected the data to see if this was the source of this peak, but only two of the five sites with eastern exposures were from that drainage. This rose diagram, then, not only helps to

confirm the residential nature of the habitation sites, but also the general reliability of the exposure idea.

Figure X-9 is the corresponding diagram for the limited activity sites. Two sites which were clearly not field stations were not included in this tabulation (Bullet 17-1, Cliffside site, and Upper Grand Gulch 9-1, Lithic use site), leaving a total of 15. While the numbers involved are now relatively small, there does appear to be a real difference from the previous habitation site diagram. Although the habitation diagram had over half the habitations with exposures of south or southwest, only one fourth of the limited activity sites have these exposures. The limited activity sites, have a concentration of northern or northeastern exposures as contrasted to the southern or southwestern exposures found for the habitation sites. The north-northeastern emphasis expected for this class is what is found. A secondary emphasis is found to the magnetic south, which was also found on agricultural terraces on Wetherill Mesa (Erdman, Douglas and Marr 1969). In addition, a lesser emphasis on the southeastern exposure, which we found in the Grand Gulch Phase Limited Activity Sites may also exist at this time.

Thus while the numbers are small, the limited activity sites do show an increase in northern and northeastern exposures. When one realizes that nine of 15 sites used are in quadrats with habitation sites and thus should have

correlated exposures if certain landforms were not being selected, this change is rendered all the more significant.

Limited activity sites may well include other kinds of functions, summertime camps and so on, but a main function of field station fits well with our tests at this point.

If the limited activity sites are field stations, we would expect the immediate site vicinity to be usually one of arable soils. We have already demonstrated via elevation and percent of quadrat covered by dense pinyon-juniper that the general environment is of arable soils, we are now focussing on the immediate site setting.

Since the sites are at high enough elevations for sufficient rain, the other prerequisite for agriculture is soil of sufficient depth. We have two separate measures of soil depth for each site, the presence of big sage <*Artemisia tridentata*>, and the soil depth at which hydrochloric acid (HCl) reacts with the soil. The first is not a test for the occurrence of sagebrush flats, which do not appear to be tightly correlated with farming, but for the presence of individual sagebrush plants which occur within the pinyon-juniper community where the soils are deepest. Eleven of the 15 sites had big sage recorded, indicating the presence of deep soils right on the site. Since the chances of recording sagebrush are partly dependent on site size, and these are small sites, this

suggests that sagebrush is present, near, or on virtually all of these sites. It may be recalled that in one Grand Gulch Phase test on a selected subset of limited activity sites, nine out of 14 sites had sagebrush present.

According to this botanical measure, deep soil is present at most of the likely field stations in both phases with the difference being that most Mossbacks limited activity sites belong to this group.

The hydrochloric acid measurement is one that ideally measures the concentration of calcium carbonate in the soil which forms a caliche hardpan in many areas. This hardpan effectively acts as bedrock, limiting the movement of water. In high elevation divide areas, this measure appears to faithfully reflect soil depth, although the first reaction with HCl is far above the hardpan. In lower elevation areas, however, problems arise. In ⁿmay sand dune areas, the loose sand is highly reactive, even on the surface. In such a situation, the HCl test would indicate no soil depth, instead of the actual great soil depth. The median soil depth at which the soil reacts for all sites is about 10 cm. In contrast, the median depth for the 15 limited activity sites is 20 cm. This indicates, also, a greater than expected soil depth, although the measure does show a lot of variation.

If we look closer at the four sites that do not have sagebrush, we still find good environmental support for the

field station function. Upper Grand Gulch 4-4 does not have sagebrush, but the first reaction with HCl is at 30 cm and this site is located in what has to be one of the prime agricultural areas. While West Johns 16-4 shows only 10 cm of reactive free soil, saltbush (<*Atriplex canescens*>), another deep soil indicator, is present and the immediate area would also have to be rated as arable. North Road 4-3 has practically no soil present and no sagebrush either, but within the same quadrat is some of the highest elevation deep-soil pinyon-juniper to be found on Cedar Mesa. The final site without sagebrush present, Bullet 21-6, is the only one that does not appear to be on or adjacent to arable soil today. Sagebrush is not present and the soil reaction occurred at less than 30 cm. Today much of Bullet 21 consists of a series of deep soil ridges separated by parallel, deep arroyos. Because of the arroyos, a high water table cannot exist today. The sites found in this quadrat are located on the flat ridges between the arroyos. If these arroyos are post-occupation, this too, may have been arable land when occupied. What is certain, is that it is not so today.

The review of on site information supports the arguments about site functions based on other information. The habitation sites have all the characteristics of habitation sites, with a few exceptions; and the limited

activity sites appear to be field stations, located in areas of deep arable soil with sufficient moisture. Even the exposures of these two site classes meet the expectations. In addition to field stations, we found one cliffside site (Bullet 17-2) perhaps used for storage and possibly containing a small dwelling, as well as another (Upper Grand Gulch 9-1) of probable lithic reduction.

The overall settlement pattern appears to be one of intense focus and reliance on rainfall farming, with minor canyon bottom (Bullet 22 and 17) and sand dune (Hardscrabble 4 and possibly 14) farming extensions. While some of this "narrowness of niche" may be due to our conservative definition of the Mossbacks phase, no amount of juggling could transform this focussed adaptation to the broader based and much more widespread Grand Gulch adaptation.

<Mossbacks Villages>

The question of the existance of villages can be settled more decisively for the Mossbacks Phase than for the earlier Grand Gulch Phase. Table X-1 lists the habitation sites and inferred number of dwellings. While only one of the 52 Grand Gulch Phase habitation sites had clear evidence of more than one dwelling, at least two and probably three of the 31 Mossbacks habitation sites do. Table X-2 shows the distribution of habitation sites by

quadrats, as does Figure X-10. As with the earlier material, this distribution is indicative of a clustered pattern. Notice that while Bullet again has half the habitation sites, this time it is followed by Upper Grand Gulch. The concentration of the Mossbacks dwellings in the northern half of the mesa is another result of the Mossbacks shift to higher elevations.

Table X-3 lists the number of inferred dwellings per quadrat and this distribution is illustrated in Figure X-11. Notice that the variable under consideration is dwellings rather than habitation sites. With the Grand Gulch Phase material, we assumed only one dwelling per site which we can not do here. In Table X-3 and Figure X-11, we used the lower of possible values for number of dwellings in the cases of Bullet 6-2 and North Road 11-4. Again, as in the earlier period, more than half the dwellings (19 out of 34) are found in quadrats with other Mossbacks dwellings. The largest dwelling clusters are Bullet 3 and 6, with three to four dwellings, Upper Grand Gulch 2 and 4 with at least six dwellings, Upper Grand Gulch 6 with three dwellings and Bullet quadrats 12 and 19 with a total of three dwellings (Figure X-2). This kind of concentration is in agreement with the notion of dispersed villages. Not only are there sites with multiple dwellings, but there are four situations where three or

more dwellings are indentified in a small area. Since this is a more clustered distribution than found for the Grand Gulch Phase, the arguments made in that case should not only be valid but should have additional force. This general fit with the notion of villages is evaluated more formally below.

As with the Grand Gulch Phase material, we can test to see if the Mossbacks sites fit the distribution expected of clustered sites. The variance of the dwelling distribution is greater than the mean (Table X-4) suggesting again that the dwellings are clustered. We can test this as before against the Poisson and negative binomial distributions.

Table X-4 shows the agreement between the distribution of dwellings and that expected of the Poisson.

Dwellings are the unit of analysis because many Mossbacks habitation sites have multiple dwellings. Notice that the fit of the Poisson distribution is not good, again with low estimates for both ends of the distribution. Even with the simple chi-square over estimating the goodness-of-fit, this fit can be rejected at the 0.10 level.

The negative binomial (Table X-5) shows a much better fit. To use the chi-square test in this situation four cells were used and the last has an expected value of only 2.056. The exponent parameter k was estimated by the moment estimator. On inspecting the figure in Johnson and Kotz (1969:133), we find the efficiency of the moment

estimator is slightly under 90%, acceptable but not ideal. If we use another way of estimating k , method 2 of Bliss (1953) and Johnson and Kotz (1969:131), we calculate a smaller k (.86289) and an even better fit to the data (chi-square of .1949, probability of approximately .65). The Johnson and Kotz figure indicates that this method, using the frequency of zeros, has an efficiency of around 94-95% which should certainly be adequate for our purposes. Either way, there is no doubt about the goodness-of-fit of the dwelling distribution to a clustered distribution, supporting the previous judgement about the existence of villages at this point in time.

Since we are dealing with a shorter period of time, there is less chance these concentrations can occur through serial occupation. Basketmaker III villages exist elsewhere, making the situation on Cedar Mesa not unusual. While there are some indications that the spacing of the dwellings are closer than in the Grand Gulch Phase, in the main, the villages consisted of dispersed dwellings. The habitation site with the most dwellings, Upper Grand Gulch 4-3, might well have been recorded as three separate habitation sites if it were not for the very large (by Cedar Mesa standards) Pueblo site distributed across all three dwellings.

Since the quadrat sampling procedure would result in

quadrats that had isolated dwellings, even if all dwellings actually occurred in clusters, we can be certain we have overestimated the number of isolated dwellings. If we currently have about 60% (actually 58.3%) of our dwellings occurring in quadrats that have other dwellings, we can estimate that the true number of isolated dwellings is only half of these numbers. Probably only about 20% are truly isolated.

Because the number of dwellings on Mossbacks habitation sites vary, the size of habitation sites also vary more than in the more uniform Grand Gulch Phase. This trend continues, of course, to an even greater extent in later times. We excavated one very small one on Upper Grand Gulch 4-3, yet on Ute 95 nearby, a very large dwelling was found (Wilson 1974:34-49). The large dwellings, with their large trash middens, such as one at Upper Grand Gulch 4-3 and North Road 11-4, appear to be indicative of a longer duration of occupation than typical of Basketmaker II. On the other hand, some of the smaller "dwellings" are ephemeral and do not look like they were used for more than a few years at the most. In this way as well, there appears to be more variation in the Mossbacks villages than in earlier times. One would expect the variation in sizes of dwellings to be related to differences in the number of occupants. In general, through time one finds less variation in site types and

locations, but more variation in dwelling and habitation site size. We will return to these issues later.

<Population Estimates>

If we assume that all 31 sites we classified as habitation sites do have dwellings, we can relatively quickly derive population estimates. Using this assumption we have 34 to 36 dwellings because of some ambiguous features. If we use 35 dwellings as the most likely number we can calculate an estimated total number on Cedar Mesa of 1750 Mossbacks dwellings, assuming we have a 2% sampling rate. The true sampling rate is actually 1.45%, but in a number of cases the majority of a habitation site actually lies outside the quadrat boundaries, although extending inside as well. The use of 2% appears to be a conservative, but not too conservative, number.

The question of the proper number of people to assign to each dwelling is a bit more difficult. On the basis of surface remains, the gross dimensions of seven semi-circular houses are from four to five meters. This figure does not include presumed smaller antechambers. Another three are rectangular, 3x7, 4x6 and 8x6 meters. Some of our tests, and that of the Ute 95 excavations indicate the presence of even larger dwellings. Feature E of Upper Grand Gulch 4-3 illustrates the other size extreme

with a main chamber of three meters in diameter, and an antechamber of 2x1 meters. It is clear from these measurements that the mode is in the four to five meter in diameter range, with some seven of the 11 well defined dwellings found on the survey falling into this class. This size class results in 12 to 20 square meters of floor space, ignoring any antechambers. One of the three rectangular dwellings also has a floor area in this range, one is slightly larger, and the last, much larger. Finally Upper Grand Gulch 4-3 Feature E gives about seven square meters in floor space.

These figures indicate a size similar to that found in Grand Gulch houses. If we use Cook and Heizer's (1968) procedure--since their material is based on pithouses, it is probably the most appropriate among the available methods--we find the house four meters in diameter result in five or six people, and the five meter diameter, or seven people. With these and our previous estimate of five persons per house, it appears to be the best or, at least most conservative, to use an average of five individuals per dwelling.

The final decision before a graph can be plotted of population versus houselife is to make an estimate of the duration of the Basketmaker III occupation on Cedar Mesa. In our review of Mossbacks Phase dating, our dates combined with those from the Ute 95 excavations and elsewhere, show

a late starting date of post AD 650. If we use 100 years for the duration we can allow for some earlier Basketmaker II dates than we have yet obtained.

The resulting graph of instantaneous population is shown in Figure X-12. As before, given 1750 dwellings, if each was occupied for ten years that means only one-tenth of them would be occupied at any given time. (100 years total duration divided by 10 years average house life). This gives 175 dwellings being used at any given time, and five people per dwelling results in 875 people. This estimate is within the upper end of the probable range estimated for the Grand Gulch Phase. Again the major variable is that of expected dwelling uselife. One might reasonably expect slightly longer durations than in earlier times. If this is so, the 438 estimate based on a uselife of five years might be considered the minimum and uselives of the order of 10 to 15 years not all that unreasonable. Certainly, the amount of archaeological material associated with some habitation sites suggests at least this duration of occupation. Uselives of this order would correlate with a population of 1000 or more.

Again, as with the Grand Gulch Phase, this appears to be a substantial population. What are the possibilities that could lead to an overestimate? Since the Mossbacks concentration appears to be to the north of the Bullet and

North Road drainages, it does not appear that our sample of drainages happened to oversample the densest Mossbacks occupation. As we discussed above, our family size is a reasonable, but conservative figure. It is more likely to be larger than smaller. The only remaining possibility for major error is that there are significantly less habitation structures than we have estimated.

There are a total of 13 "habitation" sites without clear evidence of dwellings. If we state that none of these sites have dwellings, it would reduce the total number of Mossbacks dwellings from 35 to 21. In the earlier Grand Gulch Phase situation we had only 11 clear dwellings on 52 habitation sites. Thus in the Mossbacks situation, we do not have the same order of uncertainty about the number of dwellings. Some of the sites without clear surface evidence of pithouse structures must have had dwellings present, some, for instance, have abundant amount of jacal. We can probably be safe in predicting that half of the habitation sites without clear surface indications of dwellings present actually have pithouses present. Surely not all Mossbacks pithouses are going to be well defined on the surface, particularly since many of these sites are overlain by large Pueblo components. This procedure would give us a total 27 or 28, not enough different from the 35 used in face of the very large uncertainties about average houselife to make a significant

difference.

In this survey of population estimates for the Mossbacks Phase the main unknown variable is mean uselife of the dwellings. House uselives of five to ten or even 15 years appears to be reasonable and result in population estimates in the order of 400 to 1200 individuals, with 800 (uselife of nine years) being in the center of this range.

<Summary>

The Mossbacks settlement pattern, then, appeared to be the result ^{of} the concentration on rainfall agriculture in the upper elevation deep-soil pinyon-juniper areas. All but two habitation sites are found there, with one in canyon bottom (Bullet 22) and one in an equivocal situation (Hardscrabble 14). In contrast with the preceeding Grand Gulch Phase, there are fewer limited activity sites than habitations and all but three limited activity sites appear to be related pinyon-juniper field stations.

The evidence for a population of 400 to 1200 individuals, living in dispersed villages, concentrated in higher elevations than in the preceeding phase, is good. The size of villages might be estimated from the fact that our largest concentration is six dwellings and that a number of quadrats had three dwellings present giving a suggested population range of 15-30, perhaps as a suggested

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mid-breadth. Lower and dryer parts of the mesa were seldom used and occupation was essentially absent from the lower elevation canyons, all agreeing with a narrow, limited, and specialized niche.