THE RADIOCARBON DATES

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Over the past twenty years several models for the chronology and pacing of the development of Hawaiian culture have been put forth (Cordy 1981; Dye and Komori 1992a; Hommon 1976, 1986; Hunt and Holsen 1991; Kirch 1985, 1990; Spriggs 1988; Spriggs and Anderson 1993) based either on radiocarbon-dated features, usually habitation features, or on the radiocarbon dates themselves. These models differ in their details. Kirch (1985), for instance, places colonization of leeward valleys (such as North Hälawa Valley) during the Expansion period from A.D. 1100 to 1650. Hommon (1986) takes a smaller period (Phase II) from A.D. 1400 to 1600 for the initial large-scale expansion into inland zones but notes that some smaller-scale use of inland areas would have occurred earlier. Spriggs (1988) divides Kirch's Expansion period into early (A.D. 1100–1400) and late (A.D. 1400–1600) phases. During the early phase, new settlements were established "in previously uninhabited drier leeward areas although in favorable locations such as around natural coastal fishponds or sheltered inlets" (Spriggs 1988:60). The later phase witnessed the "the development of large-scale permanent agricultural field complexes in the inland areas of the leeward sides of the islands" (Spriggs 1988:61). The radiocarbon dates from North Hälawa Valley provide a new opportunity to examine these models at the level of a single, relatively wet, but still leeward valley.

SAMPLE COLLECTION AND ANALYSIS

The 93 samples selected for radiocarbon dating were drawn from a larger set of samples tagged by field personnel as potential radiocarbon samples. Samples collected in the field were immediately wrapped in foil, placed in a paper bag, and labeled with provenience information. When samples were selected for radiocarbon analysis, they were cleaned, dried, and sorted by lab personnel. The samples were given Hawai'i Radiocarbon (HRC) numbers, weighed, wrapped in foil, placed in plastic bags, and sent out for analysis. An effort was made to obtain samples of at least 20 g of material. Generally, if the cleaned sample was much larger than 20 g, a portion was retained for archival storage. These samples, with their provenience information, are currently wrapped in foil and stored in glass jars at Bishop Museum.

The mean sample weight was 19.9 g, ranging from 2.3 to 37.7 g. In all instances the samples submitted for dating consisted of carbonized vegetation. No shell or bone samples were dated. Most samples were identified by lab personnel as wood, though some were identified as burned *kukui* (*Aleurites moluccana*) seed coats. In a few instances, identifications of *kï* (*Cordyline fruticosa*) were made by a paleoethnobotanist, but the vast majority of identifications were not verified. It is clear from the $\delta^{13}C$ results provided by the laboratory (see below) that in many cases the sample falls outside the range of values typically associated with most wood taxa and may represent some other type of plant remain. It is a fairly simple matter, for instance, to mistake burned *kï* root for wood charcoal when making preliminary identifications. In cases where part of the sample has been archived, additional material is still available to check for non-wood materials or for additional dates.

All radiocarbon samples were sent to Beta Analytic Inc. for analysis over a period from August 1988 to April 1992. Most samples were subjected to standard counting, though in a few instances Beta Analytic was obliged to use extended counting due to small sample size. The results were obtained on the portion of suitable carbon remaining after any necessary chemical and mechanical pretreatments of the material. Pretreatments were applied, where necessary, to isolate ^{14}C, which may best represent the time event of interest. The analysis was done by synthesizing sample carbon to benzene (92% C), measuring for ^{14}C content in a scintillation spectrometer, and then calculating the radiocarbon age. When extended counting was required, the ^{14}C content was measured for a greatly extended period of time. The standard Libby value of 5,568 years was used as the half-life value of radiocarbon.

Beta Analytic provided stable carbon isotope ($\delta^{13}C$) measurements for all samples. These values range from -29.7 to -9.8. Most of the $\delta^{13}C$ values are clustered between -29 and -26 (Figure 4.1) and likely represent wood species (Burleigh et al. 1984; Stuiver and Polach 1977). There are, however, other modes in the distribution. One of these, between -22 and -19, likely represents wood, but two others, a single spike between -17 and -16 and another in the -12 to -11 range, may represent non-wood species. Several species could account for these values, including succulents (such as pineapple and cactus) and grasses, but these species are not likely to be mistaken for wood even when burned. Before more can be said about these data, better information is needed about the range of $\delta^{13}C$ values for Pacific plant species. Overall, the distribution and range of North Hälawa Valley $\delta^{13}C$ values is not unlike that published by Dye and Komori (1992a:119) for a larger sample of 347 dates taken from across the Hawaiian Islands.

Though the dates were submitted for analysis across a four-year period, all results reported here have been calibrated with a single calibration program and tree ring data set—in this instance the CALIB program Version 3.0.3c (Stuiver and Reimer 1993) with the Stuiver and Pearson (1993) bidecadal tree ring data set to 9440 Cal B.C. A full reporting of the calibration results for each date can be found in the respective site reports (Volume 2).

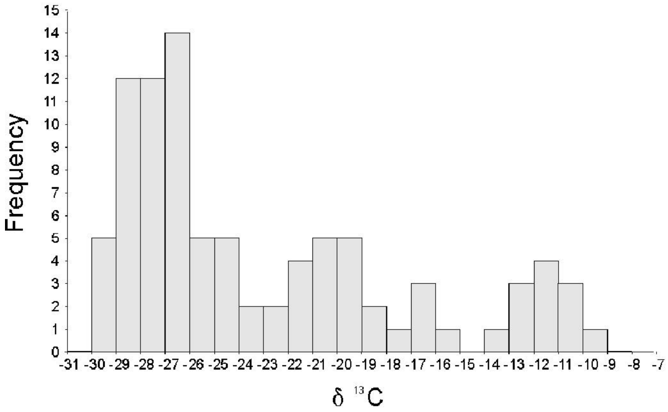

Figure 4.1. **Distribution of $\delta^{13}C$ values for 93 dates.**

DISTRIBUTION AND QUALITY ISSUES

A total of 93 radiocarbon dates were obtained from 44 of the 70 sites investigated during inventory survey (Table 4.1). Of these, 18 sites have a single date and 26 others have at least two dates. Site 2010 has the most, with nine dates. The sites selected for radiocarbon dating range the length of the valley. Sites 2005 and 2094 sit near the mouth of the valley a little over 4 km from Pearl Harbor, whereas Site 2091 is the farthest site up the valley, nearly 10 km from Pearl Harbor. The samples also represent the range of site types recorded in the valley, including pre- and post-Contact sites, rockshelters, agricultural and habitation sites, and sites with specialized activities.

In addition to being distributed among sites in North Hälawa Valley, the dates are distributed across different feature types. In the site reports (Volume 2), each feature is classified according to a basic form and a functional interpretation. The distribution of radiocarbon-dated features according to form and function is shown in Tables 4.2. and 4.3. By far the most common form of radiocarbon-dated feature is pits and depressions. In total, 45 of these features were dated. Next, 30 terraces, both earthen and rock-faced, have ^{14}C dates. Given that most of the features are pits and depressions, it is no surprise that fire-related functional interpretations, such as *imu*, are by far the most common in the distribution by function. Twenty-four inventory survey *imu* have ^{14}C dates. Twenty-one more dated features are classified as either firepits or fire-related features. The next most common feature function, with 19 dates, is habitation. In these instances, an assessment was made as to whether the habitation was permanent or temporary, though in a few cases the habitation feature could not be definitively classified as either.

Table 4.1. Distribution of Radiocarbon Samples

Site	Radiocarbon Dates (N)
2005	1
2008	4
2009	2
2010	9
2011	5
2012	1
2013	2
2014	1
2015	1
2016	4
2017	4
2018	2
2019	2
2020	1
2021	2
2134	1
2136	2
2137	3
2138	1
2139	1
2089	2
2090	2

Site	Radiocarbon Dates (N)
2091	5
2093	2
2094	2
2095	2
2096	3
2098	2
2099	2
2100	1
2102	2
2104	1
2141	1
2222	1
2225	5
2226	2
2229	1
2232	1
2233	1
2234	1
2236	2
2252	2
2253	1
2256	1

Table 4.2. Radiocarbon Determinations by Feature Form

Feature Form	Frequency
Charcoal lens	3
Depression	8
Enclosure	3
Mixed	2
Mound	1
No feature	7
Pavement	1
Pit	37
Platform	1
Terrace	30

Table 4.3. Radiocarbon Determinations by Feature Function

Feature Function	Frequency
Activity area	7
Agriculture	9
Fire feature	5
Fire-related activity	6
Firepit	10
Habitation	19
Imu	24
Mixed	2
No feature	7
Postmold	2
Soil retention	1
Undetermined	1

Besides being distributed across sites and features, the radiocarbon samples are also distributed through a variety of stratigraphic contexts. Their stratigraphic distribution must be considered when drawing certain types of conclusions about the distribution of dates. A systematic program to find the earliest occupation in North Hälawa Valley, for instance, will necessarily bias the data set toward early context samples and make it more difficult to draw interpretations from changes in the data during later periods. On the other hand, a sample drawn randomly from excavated samples will probably miss some of the earliest dates but give a more balanced view of the valley as a whole. In fact, the dates from North Hälawa Valley fit the latter case (Table 4.4). The stratigraphic distribution of dated samples matches fairly well the stratigraphic distribution of all archaeological materials recovered from the valley. By far the greatest number of both radiocarbon samples and material bags is from Layer II contexts. The largest difference between the two data sets is in the number of samples dated from feature fill. The significance of this difference is, however, ambiguous, since the layer from which these features fills originate is unknown. In all likelihood, they follow the same basic distribution as the layers, with most of the feature fill originating in Layer II contexts. In all, given the similarity of the two stratigraphic distributions, any patterns seen in the radiocarbon data should correlate well with patterns seen in other lines of evidence presented in this report.

Another concern regarding these dates is their association with the archaeological features and behaviors they purport to date (Dean 1978; Graves and Cachola-Abad 1996). One sign of this issue is apparent in Table 4.4. The total number of stratigraphic contexts for radiocarbon determinations (101) exceeds the actual number of radiocarbon determinations (93). This is the result of samples being combined to obtain sufficient material to be dated, which may directly affect the behavioral association of the date. Thus, before examining the chronological and spatial distribution of these dates, one must evaluate samples' association with the archaeological features. For the present analysis we apply confidence levels to each sample, following Taylor (1987:114–115), with the addition of three more levels (Table 4.5).

Table 4.4. Radiocarbon Determinations and Bags of all Excavated Material Types by Layer

	Radiocarbon Determinations		Bags of Materials	
Layer	N	Percent	N	Percent
Feature fill	24	23.8	644	8.2
I	14	13.9	1,426	18.1
II	44	43.6	4,328	55.0
III	14	13.9	1,276	16.2
IV	5	4.9	175	2.2
V	0	0	18	0.0

Level 1 refers to dates obtained directly from the object for which a date is sought. No such dates were obtained from North Hälawa Valley.

Level 2 refers to dates taken from organics in a direct functional relationship with the object or event for which a date is sought. By far the majority of the inventory survey dates are in this category. By feature type, these are pits and depressions. By feature function, these are mostly *imu* and other fire features, though a few are from postmolds that could be indicative of habitation features.

Level 3 refers to dates taken from the same stratigraphic deposit as the feature for which the date is sought. These are almost entirely terraces, where wood charcoal was collected from the same layer as the base of terrace construction. For this to be the case, the excavation unit had to come into contact with the terrace face.

Level 4 refers to dates taken from a stratigraphic layer that is assumed to correlate with another layer that contains the feature for which the date is sought. In other words, Level 4 is one step removed from Level 3 in that it is based on accurate stratigraphic correlations from one excavation unit containing a feature to another containing dated material. Many North Hälawa Valley features were dated in this way (see Volume 2), but for this summary of dates this confidence level is not used.

Table 4.5. Confidence Intervals

Confidence Level*	Description	Frequency
Level 1	Radiocarbon analysis on object for which date is sought	0
Level 2	Radiocarbon analysis on organics in direct functional relationship with feature for which date is sought	46
Level 3	Radiocarbon analysis on organics in enclosing deposits of assumed similar age to feature for which date is sought	11
Level 4	Radiocarbon analysis of organics from deposits correlated with deposits containing feature for which date is sought	0
Level 5	Radiocarbon analysis of organics from deposits thought to be correlated with feature for which date is sought.	23
Level 6	Radiocarbon analysis not associated with a feature	6
Level 7	Radiocarbon analysis not intended to be associated with a feature	7

*Adapted from Taylor (1987:115).

Whereas Taylor stops at four levels, three additional levels were added for this analysis:

Level 5 refers to dates taken from deposits that are inferred or suggested to be correlated with the feature to be dated. The most common example of this type is when the surface of a terrace or the interior of an enclosure is excavated but the excavation does not intersect the feature in such a way that its construction can be assigned to a particular layer. Thus, although Layer II from behind a terrace may have a date associated with it, there is no direct evidence to indicate whether the terrace was constructed before, contemporaneous with, or after the deposition of Layer II.

Level 6 refers to a date taken from materials that do not relate to the feature for which the date is sought. This confidence level can occur when samples from different layers or units are mixed, when samples are collected from the same depth as a fire feature but outside its limits, or when samples are collected from layers which after further analysis are determined to predate the construction of a particular feature.

Level 7, "not applicable," is assigned to dates taken from excavation units not associated with a feature. Under guarded conditions, Level 7 dates may, nevertheless, date some unknown use of the site. In this analysis, for example, a scattering of charcoal in a unit from a rockshelter may not constitute an association with a discrete feature, but a date taken from this charcoal may provide some indication of when the rockshelter was used. This connection would be particularly tenuous were it not for the assumption that natural fires are quite rare in the Hawaiian Islands (Hunt and Holsen 1991:157–158; but see also Spriggs and Anderson 1993).

CHRONOLOGICAL PATTERNING

The two earliest dates in North Hälawa Valley come from Sites 2015 and 2233, with conventional ages of 690 ± 90 and 690 ± 80 years B.P., respectively, which after calibration likely date to the mid-thirteenth or fourteenth century. These two dates are from agricultural terraces in the middle and upper valley subzones, respectively. The next earliest fourteen dates are distributed fairly evenly across 250 radiocarbon years and come from 12 more sites (Figure 4.2). Starting about 400 radiocarbon years B.P., the mid-fifteenth century, the number of dates from the valley increases sharply, with the largest number of conventional dates falling in the period 100–200 years B.P. The sharp decrease thereafter undoubtedly reflects a bias against dating samples from obvious historic contexts. The period 100–200 B.P. is one of the most difficult for radiocarbon dating due to recent fluctuations in the amount of atmospheric carbon. Unfortunately, this period also coincides with the initial period of European contact in Hawaiʻi. As a result, it is difficult, if not impossible, to use radiocarbon dates to distinguish late pre-Contact events from early post-Contact. So, although it is possible to study the earliest occupation of the valley and settlement growth, it is difficult to study the important changes that occurred at the end of the eighteenth century.

When the conventional dates from all sites are plotted against the sites' distance from Pearl Harbor (Figure 4.3), additional patterns emerge. First, the earliest dates come from all parts of the valley, but for the first 200–300 years there is a separation between occupied parts of roughly one kilometer. Second, beginning around 400 radiocarbon years ago, the separation between occupations disappears such

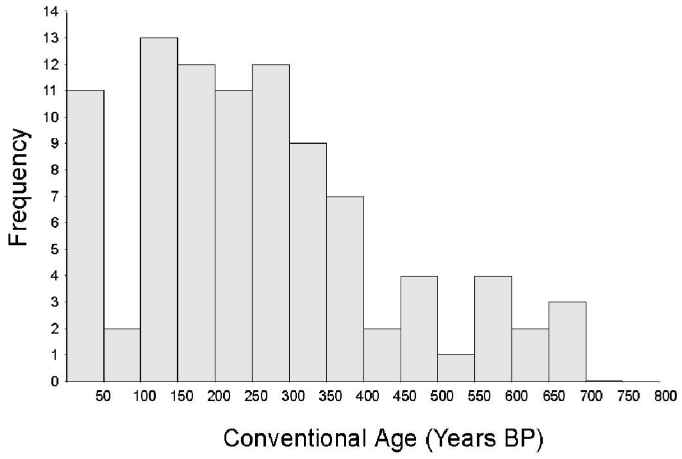

Figure 4.2. **The distribution of conventional ages.**

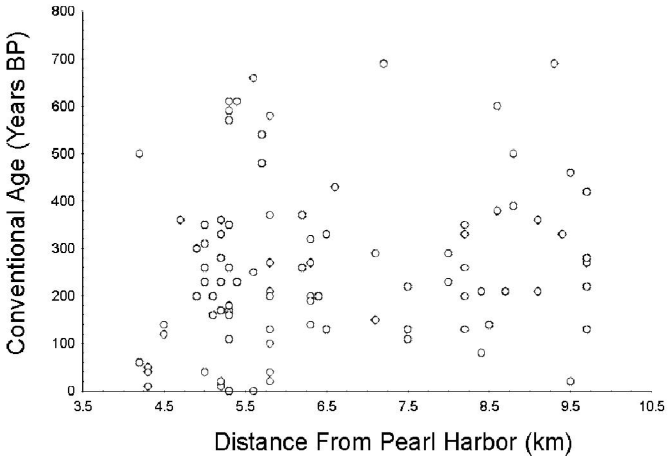

Figure 4.3. **Conventional age vs. distance from the mouth of Hälawa Stream.**

that the entire length of the valley is being used. This change appears to be fairly rapid, coinciding with the sharp increase in dates discussed previously. Third, there is some indication that the upper valley subzone was abandoned earlier than the lower valley subzone. This would fit with the model of continued use of the lower valley for sugarcane production during the post-Contact period. For the reasons stated above, however, interpretations of these later dates must be done with care.

The radiocarbon data also suggest that different parts of the valley were being used in different ways, as evidenced by the materials that were burned. In Figure 4.4 the $\delta^{13}C$ values (which may vary according to the taxa of carbonized plant) are plotted against the sites' distance from Pearl Harbor. There is a clear distinction in the graph between sites above and below the 6.5 km mark. Dates from sites below this point are characterized by a wide range of $\delta^{13}C$ values, whereas dates from sites above this point have a more restricted $\delta^{13}C$ distribution. This latter distribution, which averages -27.1, corresponds quite well

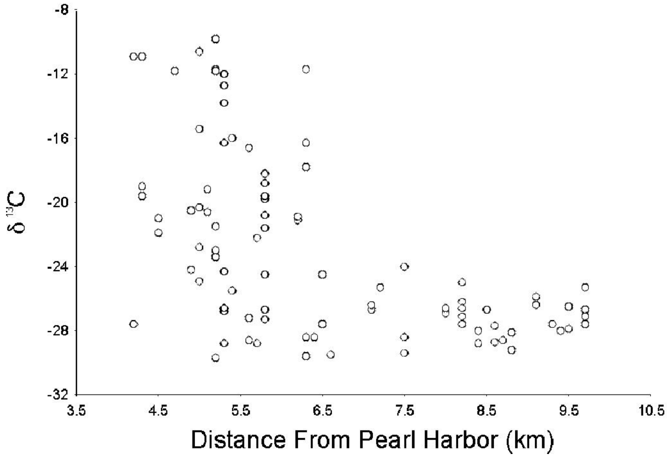

Figure 4.4. $\delta^{13}C$ value vs. distance from the mouth of Hälawa Stream.

with most wood taxa (Burleigh et al. 1984; Stuiver and Polach 1977), but the other may include some non-wood taxa or a larger variety of wood taxa. As discussed above, exactly which taxa might account for this wider distribution is currently unknown, but it can be said that a wider range of taxa were exploited in the lower valley.

One explanation of this pattern is that taxa with greater $\delta^{13}C$ values do not occur above 6.5 km up North Hälawa Valley. Perhaps this is associated with a shift to soils more often characterized as rough mountainous and rock land in the upper portions of the valley. Another possibility, not exclusive of the others, is that the lower and upper subzones were used in different ways. Perhaps occupation was more intensive or of longer duration in the lower subzone, resulting in a more diversified use of the resource base. There is also some indication that this pattern changes through time (Figure 4.5). Aside from three outliers, a change in the range of $\delta^{13}C$ values occurs around 400 years B.P. As discussed above, this is about the same time the number of dates in valley and the density of occupation both increase.

Figure 4.5. $\delta^{13}C$ value vs. conventional age.

These data suggest two phases in the prehistoric settlement of the valley. In the first phase, the entire extent of the valley was occupied but with a fairly low and constant density. In the second phase, site density increased, with more area of the valley being occupied. If the type of activities that generate charcoal deposits remained fairly constant, then the sharp increase in dates during this period may reflect a concomitant rise in population. Superimposed on these patterns, the $\delta^{13}C$ values also suggest that the upper and lower portions of the valley were being used differently.

Another way to approach these chronological patterns is on a feature-by-feature basis. Spear (1992), for instance, plotted dates for agricultural and habitation features separately. He found that both types of feature appear together from the earliest settlement of the valley in the mid- to late thirteenth century. When Spear contrasted *imu*, caves and rockshelters, and small pits to habitation terraces, he found that the former are represented earlier than the latter. With these data, Spear built a model of rapid development of extensive agricultural systems but with generally small sites and short-term habitations from A.D. 1200 to 1400. For the period after A.D. 1400 he proposed a shift in the settlement system, with the development of permanent habitation sites in the lower end of the valley.

Spear's (1992) analysis of the radiocarbon data for North Hälawa Valley was based on a sample of 74 dates. This chapter builds on his analysis with a new sample of dates but differs in several ways. First, many of Spear's dates could not be included in this analysis because they came from data recovery or monitoring phases of work and as such are not reported on here. Second, we obtained additional dates from the inventory survey phase after Spear's publication. Third, even when the dates are the same between samples, the interpretation of some features has changed. For instance, terraces that might have been interpreted as temporary habitation may now be interpreted as agricultural terraces, or vice versa. In total, 58 of Spear's 74 dates are used in this new analysis.

Spear's analysis (see also Williams 1992, Allen 1992, and other articles in this issue of the *New Zealand Journal of Archaeology*) is based on a technique described by Dye and Komori (1992b) for summarizing a series of radiocarbon dates. This technique involves first calibrating each date and then summing the resulting probability distributions to produce a graphic which Dye and Komori call an "annual frequency diagram." This diagram describes the probability that one or all of the dates fall in a given year. The more dates that overlap within a certain period, the higher the probability. Futhermore, the overall shape of the resulting graph can be interpreted. For instance, a sharp increase in probabilities followed by a steady high plateau could reflect a rather sudden appearance and continuation of a particular archaeological phenonenon, whereas a slow steady increase in probabilities might reflect a more gradual introduction of that phenonenon. Caution must be taken, however, in interpreting each fluctuation in the graph, since fluctuations in the calibration curve can be translated to the annual frequency diagram. Thus, Dye and Komori (1992b:40–42) suggest focusing on only the general trends or first-order changes in shape.

For our reexamination of Spear's analysis, we follow Dye and Komori's (1992b) method with one exception. For all modern dates in their sample, rather than use standard calibration probability distributions they calculated normal distributions. Interpreting modern dates is difficult, but normalizing their distribution introduces additional problems, particularly when they are combined with dates treated in the standard manner. For this reason, we accept the results of the calibration procedure regard-less of whether the date is modern or not. However, we remove dates with conventional ages of 0 years B.P. from the analysis. Also, when examining patterns in dates associated with features, we consider only confidence Levels 1 through 5 acceptable for analysis. When looking for patterns in the overall settlement of the valley, however, we consider all dates regardless of their association with features.

Eight dates are available from agricultural features. Only one of these dates, however, can be confidently (Level 3) associated with the terrace feature. The remaining seven are thought to be associated with terraces (Level 5). The resulting annual frequency distribution (Figure 4.6) is nearly identical to Spear's (1992:81). There are four agricultural features with conventional ages between 600 and 690 years B.P., resulting in a sharp spike in the annual frequency distribution between Cal A.D. 1300 and 1400. Two additional dates between 330 and 360 years B.P. create another mode between Cal A.D. 1500 and 1650, and two modern dates account for the remainder of the frequency distribution. As with Spear's (1992) original look at these patterns, the sample size is small. It is therefore not prudent to make too much of these data, except to say that agriculture is one of the earliest dated activities in the valley. One of these early dates comes from Site 2233 in the back of the valley. Its association with the terrace is not certain, but it would seem to indicate that agricultural production in the valley was under way by this time.

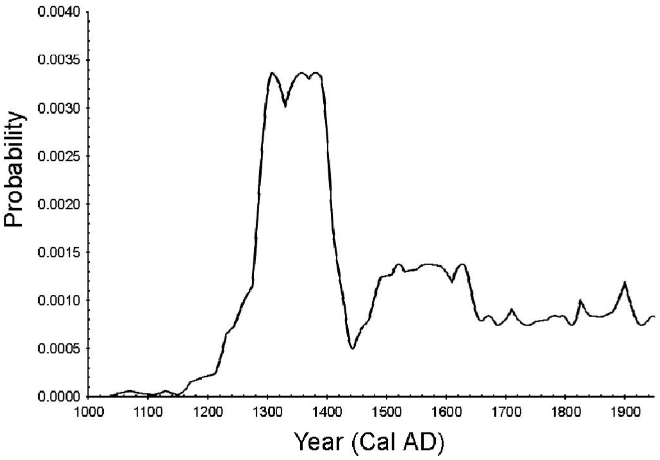

Figure 4.6. **Annual frequency diagram for agricultural features.**

To examine the relationship of agriculture to permanent and temporary habitation, rather than plot features by functional type as Spear did we assess the degree of permanence for each feature. Some *imu*, for instance, are associated with temporary occupations, whereas others are clearly associated with permanent occupations. In all, of the 93 dates available from the valley, 30 can be associated with permanent occupation and 42 could be associated with temporary occupation. When plotted, these data reveal a more complex picture (Figure 4.7). The earliest dates for permanent and temporary occupation are roughly the same, with both beginning around Cal A.D. 1300. There are, however, only two dates from a single site represented in the first peak of the permanent curve, and they are followed by a gap of more than 200 radiocarbon years. The temporary curve, on the other hand, rises steadily without a gap through to the post-Contact period. The earliest permanent occupation dates come from Site 2225, a medium-size permanent habitation and agricultural site in the lower subzone of the valley. The next earliest evidence of permanent occupation comes from Sites 2009, 2096, 2013, and 2011, in the lower and middle subzones of the valley. All of these sites are medium to large permanent habitation and agricultural complexes in the lower half of the valley. If not for Site 2225, the data would fit fairly well with Spear's model of temporary habitation and agriculture starting roughly two centuries prior to permanent habitation, though the data presented here suggest that this shift was probably closer to A.D. 1500 than to A.D. 1400. The two dates from Site 2225, however, cannot be ignored, and they suggest that fairly limited permanent habitation may have preceded the wide-scale development of permanent habitations by at least 150 years.

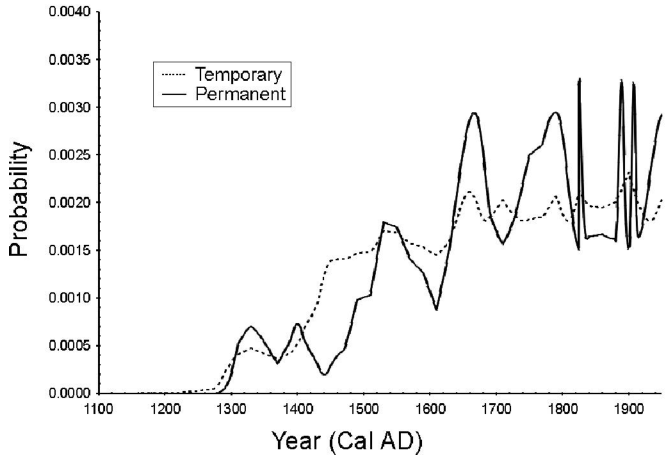

Figure 4.7. Annual frequency diagram for features associated with permanent and temporary occupations.

DISCUSSION

The earliest dates in North Hälawa Valley come from agricultural terraces. Temporary and permanent habitations appear sooner after. Temporary habitation would appear to predate permanent if not for Site 2225. There also seems to be a fairly consistent pattern of a low density of dates prior to Cal A.D. 1400–1440, followed soon after by a period of increasing density. Several factors could be causing this change in density (Dye and Komori 1992a), but if we assume that factors such as collection and preservation bias are constant then the increasing density of dates could reflect either a change in the type of activities or an increase in the frequency of activities that result in charred botanical remains. If activities per capita remained constant, then this increase in radiocarbon dates could mean an increase in population during this period (Dye and Komori 1992a; Dye 1994).

In their examination of 598 radiocarbon dates from the Hawaiian Islands, Dye and Komori found evidence for three periods based on changes in their cumulative frequency diagram. They interpreted these changes as reflecting changes in the Islands' population. During the first period, from colonization until about Cal A.D. 1150, population levels were low and fluctuating. For the period from Cal A.D. 1150 to 1441, they argue that populations increased rapidly. Thereafter, until European contact, populations levels were fairly constant with short periods of rapid decline and recovery. In comparison, North Hälawa Valley appears to show an initial settlement sometime during the fourteenth century (Figure 4.8). Growth during this time appears dramatic only in contrast to the absence of dates before this period. For about a century, population levels remain fairly low and constant. Then, about the time islandwide averages show steady population numbers, the North Hälawa Valley data show a period of steady increase that never quite achieves a plateau in the pre-Contact period. There is, however, a sharp drop in the cumulative frequency diagram at roughly Cal A.D. 1600, followed by a sharp increase. The significance of this fluctuation is unclear. It very nearly correlates to a sharp decrease in Dye and Komori's data, but theirs appears to be about 50–100 years later.

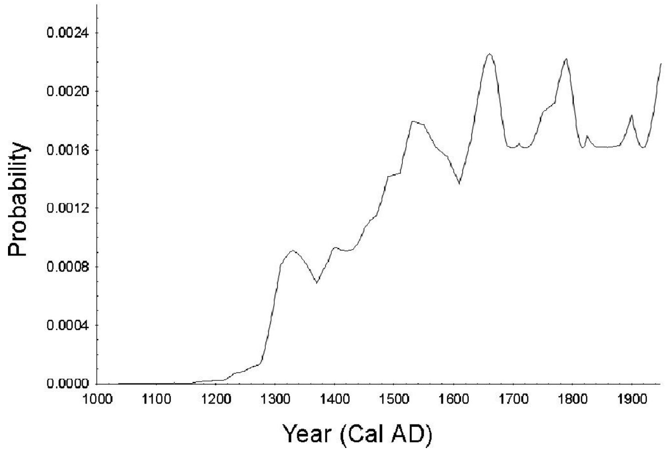

Figure 4.8. Cumulative frequency diagram for all dates.

Alternatively, the drop could be an artifact of the cumulative frequency methodology and problems with the correlation curves. One way to test this possibility is to generate cumulative frequency diagrams from controlled data and to examine their shape for any deviations from the expected pattern. Figure 4.9 presents a hypothetical radiocarbon data set created by generating a radiocarbon event corresponding to an actual calendar event every five years from A.D. 1300 to 1795. Theoretically, this would correspond to a constant population size maintaining a single set of activities that produces charred botanical remains over a 495-year period. The cumulative frequency diagram rises sharply at Cal A.D. 1300, as one would expect, and maintains a fairly steady plateau until the second half of the seventeenth century, when it falls a century before it should do so. This premature drop and the following fluctuations, however, are easily attributed to problems in the calibration curve as one approaches the modern period. A portion of the probility that would normally keep the curve at the plateau until Cal A.D. 1795 has been redistributed into the final two centuries. The North Hälawa Valley dates, however, seem to be outside the time range at which they should be affected by these problems.

Finally, it seems possible that this is just a random, statistical fluctuation that would disappear if the number of dates from the valley were increased.

Based on the North Hälawa Valley data, in particular the histogram of conventional ages and the cumulative frequency diagram of all dates from the valley, there appears to be a set of early dates that distinguish themselves from the remaining dates. During this 250–300-year period, occupation of

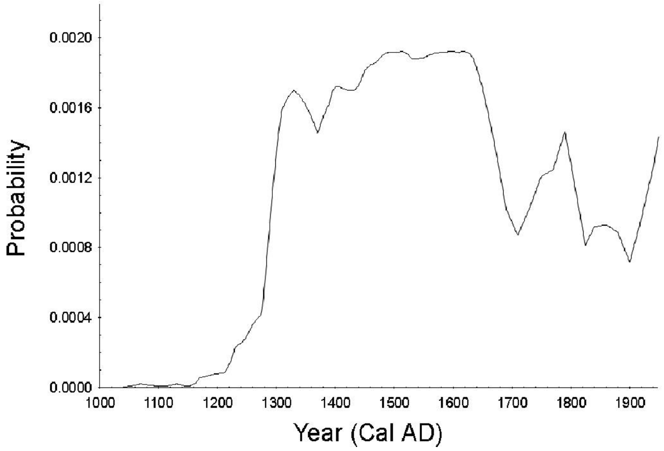

Figure 4.9. Cumulative frequency diagram for a hypothetical data set constructed with dates at 5-year intervals from 1300 to 1795.

the valley is fairly constant and of low intensity. When exactly this period ends is somewhat arbitrary, but starting around 400 years B.P. (Cal A.D. 1475) the number of dates from the valley begins a period of steady increase which continues through to the modern period. The dates can be assigned to sites, rather than to individual features, and divided into these periods (Table 4.6). The result is that 15 of 44 sites can be considered early and 27 later but still most likely pre-Contact. Twenty-three sites have dates that place their occupation in either the late pre-Contact or the post-Contact. Eighteen sites fall into only one of these three categories, with three sites falling into all three periods and the remaining 23 sites having occupation in at least two periods.

The earliest dates for North Hälawa Valley fit fairly well with what is known from other leeward valleys on O‘ahu. During the period A.D. 1100–1300, settlement expanded into Mäkaha Valley, the interior portions of Anahulu Valley, and neighboring South Hälawa Valley (Kirch 1985:304).

Only three radiocarbon dates are available for South Hälawa Valley. They all come from Site B1-30 (50-80-10-695), a large walled complex containing a permanent habitation, and range from 430 ± 130 to 580 ± 125 years B.P. (Crozier 1974). These dates fit well with the earliest dated permanent habitation in North Hälawa Valley (590 ± 50 and 570 ± 60 years B.P.) at Site 2225. Though less is known of South Hälawa Valley, these dates suggest that the two neighboring valleys were used in similar ways at roughly the same time.

Mäkaha Valley, with some 28 radiocarbon dates, presents a more detailed pattern which is also similar to that of North Hälawa Valley. Substantial settlement of this valley begins around A.D. 1100, which agrees well with the Expansion period model (Kirch 1985) but is at least a couple centuries early than in North Hälawa Valley. Beginning at A.D. 1100, Green (1980) sees two successive periods of settlement. In the first of these, A.D. 1100–1400, extensive dryland agricultural systems were established in the lower and middle portions of the valley, with associated temporary habitation. During this time population levels grew slowly. Next, starting in the fifteenth century and continuing through the eighteenth, the subsistence system changed with the development of individual irrigated wet *kalo* systems in the previously unused upper valley (Green 1980). Population levels reached a point at which they expanded into the upper portion of the valley, and in the late Expansion period a large *heiau*,

Table 4.6. Site Occupation by Period

Site	Conv. Age > 400 B.P.	Conv. Age 400–201 B.P.	Conv. Age modern
2005	x		
2008		x	x
2009		x	x
2010	x	x	x
2011		x	x
2012			x
2013		x	x
2014	x		
2015	x		
2016		x	x
2017		x	x
2018		x	x
2019	x	x	
2020		x	
2021	x		
2089		x	
2090	x		x
2091	x	x	x
2093			x
2094			x
2095		x	x
2096		x	
2098			x
2099	x	x	
2100		x	
2102		x	x
2104			x
2134		x	
2136		x	x
2137	x	x	x
2138	x		
2139		x	
2141			x
2222			x
2225	x		x
2226	x	x	
2229	x		
2232		x	
2233	x		
2234		x	
2236		x	x
2252		x	
2253		x	
2256			x

indicative of social changes occurring at this time, was constructed in the middle of the valley. Though the data presented here do not speak directly to a change in subsistence patterns or social changes, an argument can be made for at least a shift in the intensity of subsistence behavior soon after A.D. 1400 in North Hälawa Valley. The small sample of dates from agricultural terraces does not show it, but every other class of data argues for increasing activity and probably increased populations in the valley after A.D. 1400.

In Anahulu Valley, with the single exception of an *imu* found on the valley floor, the only Expansion period dates come from a series of rockshelters. Though there are many more rockshelters known from North Hälawa Valley, those from Anahulu are generally larger and have deeper sequences. Kirch (1992) reports nine radiocarbon samples from four shelters. One of these samples is considered modern by Kirch and removed from analysis. In North Hälawa Valley, 12 dates are available from seven rockshelters. Five of these dates have conventional ages of 60 years B.P. or less and are excluded to make the data sets more comparable. The two data sets are overall quite similar (Figure 6.10). The earliest Anahulu date (600 ± 100 years B.P.), from an ash lens at the base of the deposits, calibrates to the fourteenth century. The earliest North Hälawa date (500 ± 140 years B.P.), though later, has a large standard deviation and thus partially overlaps the earliest Anahulu date. As a result, the earliest occupations of the two valleys are hardly distinguishable. Thereafter, the only real difference is that more North Hälawa dates cluster in the sixteenth and seventeenth centuries.

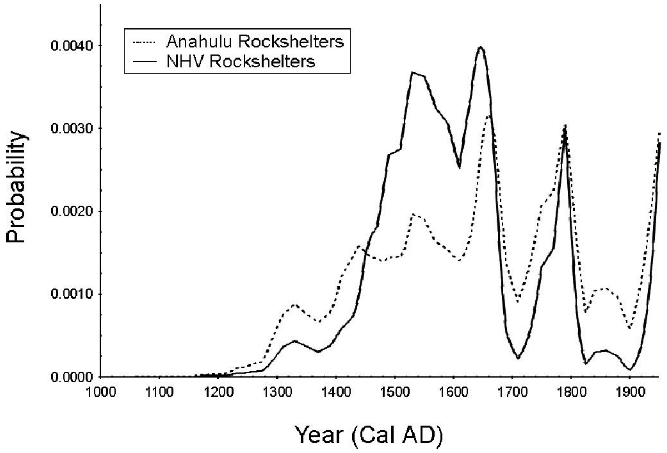

Figure 4.10. **Cumulative frequency diagram for Anahulu and North Hälawa rockshelters.**

CONCLUSION

North Hälawa Valley offers an excellent opportunity to examine changes through time in a single valley system. The number of radiocarbon determinations, 93 from the inventory survey phase of work alone, provides a large enough sample to examine the chronology of the valley not only from the site level but also from the level of specific feature types. The results of this analysis indicate that North Hälawa Valley fits well within current models for settlement expansion and growth in the Hawaiian Islands. North Hälawa Valley was settled in the latter half of Kirch's (1985; Spriggs 1988) Expansion period or Hommon's (1986) Phase II. This period is characterized by a movement into the drier leeward areas of the Islands and by the establishment of large-scale dryland agriculture. Occupation continued in North Hälawa Valley through to the late pre-Contact period. Due to the inherent limitations of the radiocarbon technique as one approaches the modern period, it is not possible to say what kinds of changes might have occurred just prior to and immediately after European contact. For this, other types of chronological analysis will have to take over. From the post-Contact artifact (see Chapter 6) and document analyses (Klieger 1995), however, it is known that North Hälawa Valley was also occupied during the post-Contact period.

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