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The South Point Radiocarbon Dates Thiry Years Later

Tom Dye[1]

ABSTRACT

A technique for estimating the duration of cultural periods or site layers with aggregate ^{14}C dates is described and illustrated with an analysis of ^{14}C dates from the H1 and H8 sites at South Point, Hawai'i Island. In contrast to previous analyses, which found little in the way of meaningful pattern in the H1 dates, the analysis of aggregate ^{14}C dates yields results that are internally consistent and mesh well with a cross-dating of the site based on one-piece fishhook heads. These results suggest that, on present evidence, the H1 site was established in the early fifteenth century and that the primary period of occupation there was relatively brief.

Keywords: RADIOCARBON, SOUTH POINT, HAWAI'I, CROSS-DATING, FISHHOOKS, CHRONOLOGY.

Archaeologists in Hawai'i have been radiocarbon dating for 40 years now, with well over 1,000 age determinations available. Like their colleagues in other parts of the world, archaeologists in Hawai'i have made little use of methods for analysing aggregate ^{14}C dates (Ottaway 1986). One way that aggregate ^{14}C dates might usefully be analysed is illustrated here, using as an example the South Point dating programme carried out by Emory, Bonk, and Sinoto. In particular, the analysis of aggregate ^{14}C dates shows that the H1 ^{14}C date suite that Emory and Sinoto described as "beset with difficulties" (1969: 3), that led Green to remark that "anomalous results are to be expected" (1971: 175) and that Kirch claims "has posed more problems than probably any other site in Polynesia" (1985: 82) is in fact consistent with a cross-dating of the site based on the head types of one-piece fishhooks.

The central problem of the South Point analysis is to establish the duration of stratigraphic layers at sites H1 and H8 by estimating the ages of layer boundaries. At least two proposed techniques estimate the duration of site layers, or more generally cultural periods, with aggregate ^{14}C dates. Ottaway proposed the use of the dispersion diagram, which provides a simple and direct summary of a suite of dates, but does not take direct account of the sample standard deviation (1973). A technique that does take direct account of the sample standard deviation is Green's (1971: 174) modification of Emory and Sinoto's (1969) diagram of the H8 date ranges. Here the date ranges are ordered stratigraphically and the slope of two parallel lines and the distance between them are adjusted until they bracket or intersect a sufficient proportion of the date ranges. The example provided by Green fails to bracket or intersect only two dates on a single sample from near the bottom of the stratigraphic column. As it stands, the method is open to two criticisms: 1) the choice of how many date ranges can fall outside the parallel lines is subjective; and 2) as the number of dates increases and the number of age estimates that vary significantly from their true ages also increases, either the distance between the parallel lines will need to increase,

[1]Tom Dye, State of Hawaii, Department of Land and Natural Resources, Historic Preservation Division, 33 South King Street, 6th Floor. Honolulu, Hawaii 96813.

which degrades the precision of the method, or the number of date ranges that fall outside the parallel lines will increase. A desirable feature of any statistical measure is that it provides better estimates of a population parameter as sample size increases, a feature that this method lacks.

Annual frequency distributions (Dye and Komori, this volume) can be used to estimate the duration of layers at the South Point sites, or more generally to estimate the duration of cultural periods. This is illustrated in Figure 1 with a hypothetical example. Three site layers, labelled III, II, and I, whose durations are 400, 300, and 200 years respectively, were hypothesised. With a random number generator, the calendar ages of 15 hypothetical charcoal samples from each layer were chosen. A conventional ^{14}C age was calculated for each hypothetical sample and each was assigned a random sample standard deviation from the range 50–150. This represents a somewhat ideal case, where dating errors are sufficiently small that all samples date to their proper layers, although there is no guarantee of an even distribution of dates across the age range of the layer. Annual frequency distributions were constructed for each layer and normalised to a peak sample density of one to compensate for variations in layer duration. This step also compensates for variations in sample size between layers or cultural periods, although this was not necessary with the hypothetical example, where the sample size was the same for each layer. The resulting diagrams were then plotted on the same set of axes.

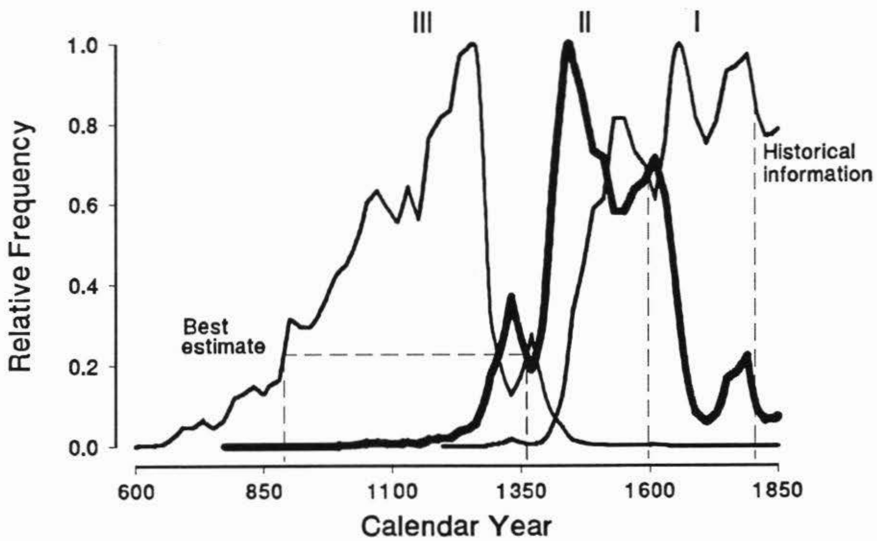

Figure 1: Estimating the duration of cultural periods or stratigraphic layers with annual frequency distributions. The solid lines are annual frequency distributions for three hypothetical samples of 15 ^{14}C dates. The dashed lines indicate the estimated ages of the hypothetical layer boundaries and were derived with an algorithm described in the text. The duration of each layer is estimated by the width of the interval between dashed lines. See the text for an explanation of the procedures used to generate the hypothetical data for this example.

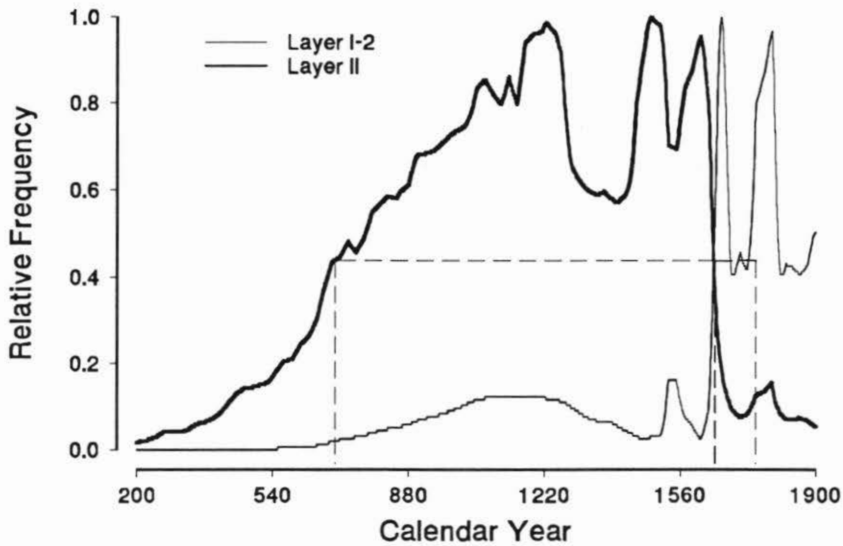

Figure 2: Estimating the duration of Layers II and I-2 at the H8 site with annual frequency distributions. The two radiocarbon dates from Layer I-1 are too few to contribute to this analysis. The upper boundary of Layer I-2 is based on Emory and Sinoto's (1969) estimated date of A.D. 1850 for the abandonment of the site, and the assumption that layers I-2 and I-1 were of equal duration.

The duration of layer II in the example, or more generally all but the bottom and top layers or the earliest and latest cultural periods, can be estimated from the diagram by measuring the interval between its intersections with the adjacent curves. Multiple intersections with an adjacent curve are resolved here by choosing the median intersection, although some other statistic or a smoothing technique to minimise wiggles in the curves might justifiably be used. With these hypothetical data, the duration of layer II in the example is underestimated by 63 years. The age of the base of layer III, or more generally the bottom layer of a stratigraphic profile or the earliest cultural period, can be estimated by drawing a horizontal line from the median intersection with the adjacent curve past the year(s) of peak sample density to its intersection(s) with the opposite side of the curve. The justification for this procedure is that the relative sample density at which the horizontal line is drawn represents the best estimate of the 'noise level' at the younger end of the diagram and, lacking additional information, this must also be the best estimate of the 'noise level' at the older end of the curve. The duration of layer III in the example is overestimated by 66 years. A similar logic would work for the top layer or the latest cultural period, but historic period artefacts at South Point provide additional data, and the upper boundary for the duration of the top layer can be specified fairly precisely. Assuming that the abandonment of the site can be fixed precisely, the duration of layer I in the example is overestimated by four years. This method: 1) is objective; 2) takes into account sample standard deviation; and, 3) in principle should yield increasingly accurate and precise results as sample size increases.

A wide variety of materials was dated at South Point, including wood charcoal, cowrie shell, sea urchin spine, fish bone, and fish scales. At the time the dates were processed, the ^{14}C dating community did not fully realise the importance of measuring stable carbon isotope ratios, and all of the ^{14}C ages were reported with an assumed $\delta^{13}C$ of -25 per mille. This assumption is justified, for the most part, for the wood charcoal samples, but it is not for the other sample materials. A reasonable estimate of $\delta^{13}C$ for cowrie shell would be 0 per mille (Taylor 1987: 122) and the ^{14}C ages of these samples have been recalculated accordingly. The other materials are dated infrequently, so there is insufficient evidence with which to estimate $\delta^{13}C$ for them. These samples have been excluded from the analysis until

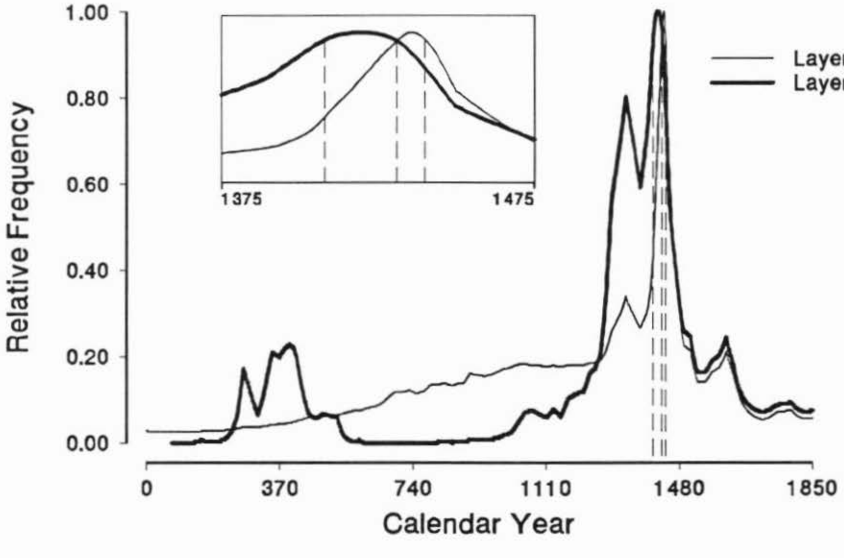

Figure 3: Estimating the duration of Layers III and II at the H1 site with annual frequency distributions. There are too few dates from Layer I to contribute to this analysis, so Layer II has been treated as if it were the topmost layer in the stratigraphic column.

sufficient information is available to arrive at a reasonable estimate. It is important to note that these samples have not been rejected because their ^{14}C ages differ from expected values. Appendix 1 lists the ^{14}C age determinations used in this analysis.

The wood charcoal samples were calibrated using the bidecadal calibration curve (Stuiver and Pearson 1986) and the cowrie shell samples with the marine model, using a Delta r value of 115 ± 50 years (Stuiver *et al.* 1986).

The results for H8 (Fig. 2) clearly reflect the conclusion of previous analyses that the duration of Layer II was substantially longer than those of succeeding layers. This analysis estimates that the H8 shelter was first occupied late in the seventh century A.D. and that the pavement between layers II and I-2 was laid down about A.D. 1650. Accepting Emory and

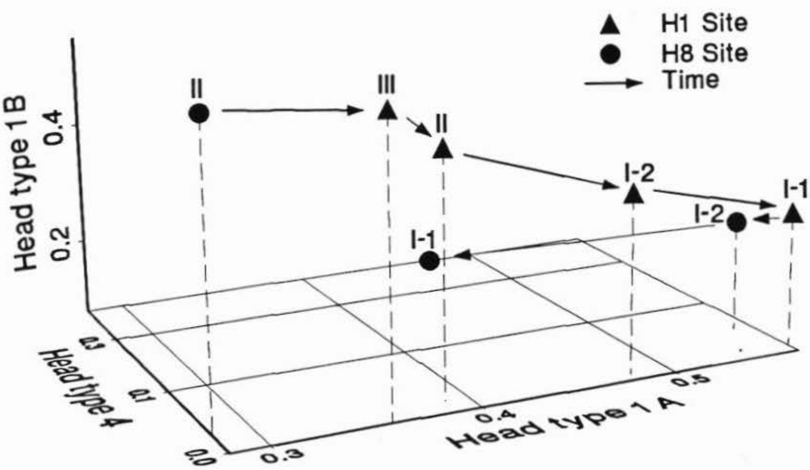

Figure 4: Chronology of the HI and H8 sites based on changes in the proportions of three one-piece fishhook head types. The data are plotted in three dimensions. The dashed drop lines are anchored on the place defined by the X and Y axes. The progression of time is indicated by the errors; it begins at the upper left foreground of the figure, heads down and to the right, and finally turns to the middle rear of the figure. The data are from Sinoto (1962). Similar results are yielded by the data of Goto (1986), whose fishhook classification differs slightly from Sinoto's.

Sinoto's (1969) estimate of 1850 for the abandonment of the site means that layers I-1 and I-2 together span a total of only 200 years. These results differ from earlier interpretations by dating the layer II/I-2 boundary to the middle of the seventeenth century; Emory and Sinoto (1969) argued for a date between the mid-thirteenth and mid-fourteenth centuries, Green (1971) for a date in the mid-fourteenth century or later, and Kirch (1985) for a date in the early thirteenth century.

The results for H1 (Fig. 3) estimate a date of A.D. 1432 for the layer III/II boundary, and suggest that the durations of layers III and II were very short: 25 years for layer III and only 10 years for layer II. While these duration estimates seem too short, they offer general support for the conclusions of Emory and Sinoto (1969) and Green (1971) that these layers were laid down over a relatively brief interval, and contradict analyses that argue for the validity of early layer III dates and a long period of occupation at the site (Emory *et al.* 1959; Kirch 1985). The early fifteenth century estimate of the age of the layer III and II deposits fits within Green's (1971) estimate of the age of these layers, but is younger than the estimates of Emory, Bonk and Sinoto (1959), Emory and Sinoto (1969), and Kirch (1985).

The conclusions drawn from this analysis of the aggregate South Point ^{14}C dates brings to at least four the number of competing hypotheses on the age and duration of the H1 site. Which should be the favoured hypothesis, at least until new evidence becomes available?

The internal evidence of cross-dating the H1 and H8 sites with the head types of one-piece fishhooks is consistent with the interpretation presented here. Figure 4 shows the frequency of one-piece fishhook head types 1A, 1B, and 4 in each layer of sites H1 and H8. Layer II at H8 is the oldest, followed by the four layers at H1, and finally Layers I-2 and I-1 at H8. Cross-dating places the bottom two layers at each site in the same order as the analysis of aggregate ^{14}C dates presented here, as well as the analyses of Emory and Sinoto (1969) and Green (1971), but in a different order than the analyses of Emory, Bonk, and Sinoto (1959) and Kirch (1985), which place layer III at H1 first in the sequence. The closeness of layers III and II at H1 (Fig. 4) supports the idea that the duration of these layers was short. Using the median dates for layers II and I-2 at H8, as estimated by the analysis of aggregate 14C dates, and interpolating dates for layers III and II at H1 based on Euclidean distance and an assumption of a constant rate of change in the interval, yields results that are very close to those yielded by the analysis of aggregate ^{14}C dates for the H1 site.

Cross-dating suggests that the durations of layers III and II at H1 were on the order of 40 years apiece, where the analysis of aggregate ^{14}C dates suggested 25 and 10 years. Cross-dating places the layer III/II boundary at A.D. 1380, some 50 years earlier than the analysis of aggregate ^{14}C dates. Given the mean sample standard deviation of 170 years for the South Point ^{14}C dates, these differences appear trivial.

Estimating the duration of cultural periods at South Point with ^{14}C density diagrams yields results that mesh well with the independent evidence of fishhook change, and that appear to have overcome the 'difficulties', 'anomalies', and 'problems' of the H1 dates. On this analysis, the H1 site was first occupied in the early 15th century and not, as the early Gröningen date seems to indicate, from the period of initial settlement of the archipelago. If this is so, what is to be made of the 'early' artefact types found at the site? One hypothesis is that these artefacts derived from a fugitive early layer at the base of the site that was not recognised during excavation. A test of this hypothesis will require analysis of the field notes and photographs at Bishop Museum, since a site report of the excavations at H1 was never produced. Another hypothesis is that the pace of artefact change was not gradual and constant, but episodic, a pattern that can be inferred from the evidence of the one-piece fishhook heads. The mid-seventeenth century estimate for the transition from notched to knobbed fishhook head types is later than the A.D. 1250 to 1350 date preferred by Emory and Sinoto and supports Green's suggestion that the transition was later than their estimate. If this estimate is correct, then changes in fishhook heads during the early part of the South Point sequence were slow, and involved a shift in emphasis from heads with two opposing notches to heads with a single notch. In contrast, the seventeenth and eighteenth centuries comprise a period of rapid change with the sudden growth in popularity of the knobbed head. If this analysis is used to generate hypotheses on rates of change for other artefact forms, then the presence of artefacts of supposedly early type found at H1 need not indicate any great antiquity for the site, but might instead represent chance finds of types that were produced in small quantities throughout most of the prehistoric period. Perhaps the best test of this hypothesis would be direct AMS dating of H1 artefacts, followed by an analysis of the aggregate ^{14}C dates with annual frequency distributions.

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APPENDIX 1

^{14}C AGE DETERMINATIONS FROM THE H1 AND H8 SITES

Site	Layer	Sample No.	Lab No.	Age[2]	Material
H1	II	HRC-0008	GAK-256	575±135	Charcoal
H1	II	HRC-0009	GRN-2062	460±40	Charcoal
H1	II	HRC-0012	GAK-257	680±360	Charcoal
H1	II	HRC-0013	GAK-258	2250±250	Charcoal
H1	II	HRC-0015	GAK-535	470±90	Charcoal
H1	II	HRC-0134	WSU-484	1025±180	Charcoal
H1	II	HRC-0135	WSU-883	900±230	Charcoal
H1	II	HRC-0135	WSU-761	1350±350	Charcoal
H1	II BOTTOM	HRC-0132	WSU-483	495±300	Charcoal
H1	II TOP	HEX-0088	WSU-557	1870±230	Cowrie shell
H1	II TOP	HRC-0131	WSU-482	370±340	Charcoal
H1	III	HRC-0001	GAK-259	710±170	Charcoal
H1	III	HRC-0002	M-863A	580±150	Charcoal
H1	III	HRC-0004	GAK-291	480±110	Charcoal
H1	III	HRC-0005	M-479	200±200	Charcoal
H1	III	HRC-0007	GAK-153	610±80	Charcoal
H1	III	HRC-0010	GRN-2225	1660±60	Charcoal
H1	III	HRC-0011	GRN-2297	490±60	Charcoal
H8	I-2	HEX-0085	WSU-549	1380±220	Cowrie shell
H8	I-2	HRC-0045	P-1119	200±42	Charcoal
H8	I-2	HRC-0072	P-1118A	227±46	Charcoal
H8	I-2	HRC-0072	P-1118	73±45	Charcoal
H8	II	HEX-0079	WSU-548	1230±180	Cowrie shell
H8	II	HEX-0082	WSU-558	1900±160	Cowrie shell
H8	II	HEX-0092	WSU-551	1460±150	Cowrie shell
H8	II	HEX-0095	WSU-544	1610±160	Cowrie shell
H8	II	HEX-0098	WSU-513	1450±310	Cowrie shell
H8	II	HEX-0101	WSU-514	1110±300	Cowrie shell
H8	II	HRC-0018	M-666	1000±200	Charcoal
H8	II	HRC-0019	M-863B	730±200	Charcoal
H8	II	HRC-0019	M-1245	600±200	Charcoal
H8	II	HRC-0019	GRN-2901	350±60	Charcoal

[2]It has not been possible to verify whether any of these dates are Conventional Radiocarbon Ages or not. In addition, the $\delta^{13}C$ was not measured for any of these dates. In this paper the shell dates have been recalculated using an assumed value of $\delta^{13}C = 0.0‰$. This involved an initial assumption that the formula for converting count data to radiocarbon years originally used $\delta^{13}C = -25.00‰$. Letters from Chatters (WSU) to Emory refer to isotopic fractionation in colloquial terms as a possible reason for some unexpected results from shell samples. We wrote to WSU about this with no informative response. From the Chatters' letters we believe that WSU treated shell like charcoal, assuming $\delta^{13}C = -25.00‰$ in both cases.

H8	II	HRC-0020	GRN-2149	350±40	Charcoal
H8	II	HRC-0070	GRN-4652	820±65	Charcoal
H8	II	HRC-0126	WSU-478	410±200	Charcoal
H8	II	HRC-0126	GAK-1969	390±90	Charcoal
H8	II	HRC-0128	WSU-479	685±300	Charcoal
H8	II	HRC-0137	WSU-486	965±310	Charcoal
H8	II	HRC-0138	WSU-487	1195±210	Charcoal
H8	II	HRC-0139	WSU-488	1100±140	Charcoal
H8	II	HRC-0140	WSU-489	1185±320	Charcoal