# *Supplemental Material*

**Refined radiocarbon chronologies for Northern Iroquoian site sequences: Implications for coalescence, conflict, and the reception of European goods**

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**Radiocarbon Sample Pretreatment**

(i) University of Georgia (UGAMS). The UGAMS Dates measured at the Center for Applied Isotope Studies (CAIS) at the University of Georgia were processed using the following protocols and standard laboratory procedures (Cherkinsky et al. 2010).

*Botanical sample pretreatment:* The samples were manually cleaned and pre-treated using the acid/alkali/acid (AAA) method. Samples were placed in 1N HCl and heated to 80ºC for 1 hour to remove secondary carbonates and acid-soluble compounds; washed with 0.1 M NaOH to remove possible contamination by humic acids; and treated with dilute HCl a second time to remove atmospheric CO2. Following each acid or alkali treatment the samples were washed in deionized water, centrifuged, and decanted. Samples were dried at 60ºC. For AMS analysis, the cleaned samples were combusted at 900°C in evacuated/sealed quartz ampoules in the presence of CuO.

*Faunal sample pretreatment:* Bone samples were examined to evaluate the composition and preservation, and to select a well-preserved and contaminant-free portion of the sample. A subsample was mechanically cleaned using a scalpel and wire bristle brush to remove surface contamination. Collagen was recovered following a modified Longin extraction (Longin 1971) as follows. The subsample was gently reduced to smaller fragments of approximately 3–5 mm in size and demineralized in cold (4ºC) 1N HCl for 24 hours. The demineralized fragments were rinsed with ultrapure (MilliQ) water to neutral, treated with 0.1M NaOH to dissolve and remove humic acids, and rinsed in ultrapure water to neutral. The sample was treated with 1N HCl a second time to eliminate atmospheric CO2, rinsed in ultrapure water to pH 4 (slightly acidic), and heated at 80ºC for 8 hours. The resulting solution was filtered through glass fiber filters to isolate the total acid insoluble fraction (“collagen”) and freeze-dried. The sample was combusted at 575° C in an evacuated and sealed pyrex tube in the presence of CuO to produce CO2.

*14C by AMS*: The resulting carbon dioxide was cryogenically purified from the other reaction products and catalytically converted to graphite (85). Graphite 14C/13C ratios were measured using the CAIS 0.5 MeV accelerator mass spectrometer and normalized using the Oxalic Acid I standard (NBS SRM 4990). To correct for isotopic fractionation, the sample 13C/12C ratios were measured separately using isotope ratio mass spectrometry (IRMS) and expressed as δ13C with respect to PDB, with an error of less than 0.1‰. The quoted uncalibrated dates have been given in radiocarbon years BP (before 1950 CE), calculated using the Libby half-life of 5568 years. The error is quoted as one standard deviation and reflects both statistical and experimental errors. The quality of radiocarbon dates is assured through the monitoring of known-age standards, including Oxalic Acid I (NBS SRM 4990) and wood from the FIRI interlaboratory comparison (FIRI D,F), as well as anthracite background. A reported average pMC value of 104.65±0.26 from 65 measurements of full-sized OXI standards measured over a period of 6 months.

(ii) Groningen (GrM). The Groningen (GrM) data for the botanical samples in this project followed the ubiquitous acid-base-acid (ABA) framework and subsequent refinements (Dee et al. 2020). The first acid (HCl, 4% w/vol, 80oC) step is employed to eliminate any geological carbonates that may have penetrated into the materials. The samples are then rinsed to neutrality with ultra-pure water. The second step involves the application of an alkaline solution (NaOH, 1% w/vol, RT) which dissolves any supramolecular polyphenols (mainly humic acids) that may have been absorbed from the soil. After another rinse to neutrality, a second acid step is employed (HCl, 4% w/vol, 80oC) to ensure no atmospheric CO2 absorbed during the alkaline phase remains in the reaction vessel. The samples are then rinsed to neutrality once more. For the wood samples, an additional aqueous oxidation step is also applied (NaClO2,/H+, 2.5% w/vol, 80oC) to isolate the holocellulose fraction. This step is also followed by a final rinse to neutrality. The pretreated materials are then thoroughly dried. Approximately 3.5 mg aliquots of the charred seed and charcoal products, known as the reduced carbon fraction, and 5 mg of the holocellulose extracts, are then weighed into individual tin capsules for combustion in an Elemental Analyser (EA, IsotopeCube NCS, Elementar®). The EA is coupled to an Isotope Ratio Mass Spectrometer (IRMS, Isoprime® 100), which allows the δ13C value of the sample to be measured, and a fully automated cryogenic system that traps the CO2 liberated on combustion. When the run is complete, the individual reaction vessels are transferred to a graphitisation manifold, where a stoichiometric excess of H2 gas (1: 2.5) is added, and the CO2 gas is reduced to graphite over an Fe(s) catalyst. The graphite samples are then pressed into zinc cathodes, and their radiocarbon ratios measured by a MICADAS (IonPlus®) AMS (Wacker et al. 2010). The quality of radiocarbon dates at the CIO is assured through the monitoring of subsidiary data relative to acceptance criteria, International Atomic Energy Agency (IAEA) reference and known-age sample measurement, and regular repetition of pretreatments on the same sample. Subsidiary parameters include but are not limited to: sample pretreatment yields, %C on combustion, δ13C and δ15N values, and C:N ratios (bone collagen). Known-age standards of each of the main material types are taken through chemical pretreatment. The standards currently utilised include but are not limited to: the horse bone from the VIRI interlaboratory comparison; the Owen Buddleia modern charcoal standard (Oxford Radiocarbon Accelerator Unit); background wood from Kitzbuhel, Austria; and assorted dendrochronological tree-rings from the Dutch Cultural Heritage Agency.

Our dataset contains 34 instances where we have data on the same, split, sample from both UGAMS and GrM. We can thus compare the two laboratories directly, see Supplementary Figure 12. The data from the two laboratories are very consistent. Only one pairing fails a χ2 test for representing the same radiocarbon age within 95% probability (Ward and Wilson 1978) (the Coulter\_8a and 8b pairing). The weighted average difference between the two laboratories (UGAMS v. GrM) is small: -5.6±4.8 14C years (with UGAMS giving ages that are slightly more recent). This small difference across the two independently measured data sets implies that the data reported are robust.

Note, from OxCal version 4.4 the calibrated calendar ranges are given as 68.3% (versus previous 68.2%) and 95.4%. This reflects the fact the former range is ca. 68.26895 and the latter ca. 95.44997 and hence the correct rounded values are 68.3% and 95.4%.

**Site Duration Constraints**

Ethnohistoric, archaeological and modelling data indicate typical Iroquoian site durations for the period in question of 0–40 years (see text). The latter figure is seen very much as a maximum. Most sites post-dating A.D. 1400 were at the shorter end. Thus, it is appropriate to consider a constraint on the duration of a site. It should not be allowed—without good evidence to the contrary—to have a duration much beyond 40 years. Indeed, the 0–40 years statement, or other similar estimates, in reality implies most settlements were of around an average of nearer 20 or so years in duration, with some shorter and some longer and very few of more than 30–40+ years. One approach might be to use a Normal Distribution, e.g. 20±10 years, or perhaps better 25±10 years (since a range in the 0–5 or even 0–10 year range is unlikely barring accident or warfare, and a mean at 25 years is reasonable as an upper typical estimate, and the plausible duration ends at 95.4% probability at 45 years). The Normal Distribution does not have a hard upper limit, so exceptions are possible. Another better alternative again is to consider a LnN prior, for example LnN(ln(20),ln(2)). This function offers a plausible expectation (see Supplemental Figure 1A) (Manning et al. 2020) and has the benefit of expecting more site durations around the expected average shorter range but allowing for a longer tail to accommodate exceptions. The LnN function also has the advantage that it does not impose a hard upper limit; thus, if the data for a site does in fact indicate a longer duration, it can overwhelm the prior.

In contrast, a Uniform prior, e.g. stating the site must be within a 0–40 year range, has hard limits. There is no probability outside this stated range. This appears unrealistic for the situation in hand. Whatever the (inherently limited) ethnographic observations state, there may have been some sites that were exceptions. In practice, it can also become difficult to achieve successful model runs involving several site Phases when trying to enforce very rigid, tight constraints. The alternative to solve this issue is to use a larger Uniform range, e.g. 0–60 years or 0-80 years, etc. We used this approach in Manning et al. (2019; see also Manning and Hart 2019). The weakness of this strategy is that the expert knowledge available indicates a typical range under 30–40 years. Hence a Uniform prior of 0–60 or 0–80 (etc.) years is knowingly including 33.3% or 50% of a range that we do not expect to be represented. As noted above, making the Uniform constraint too tight sometimes causes difficulties achieving successful model runs. Thus use of either a Normal Distribution or especially of a LnN function appears a better and more satisfactory approach.

The selection of exact values for these priors is necessarily arbitrary. We do not have a large population of known data to act as the basis of a quantitative model. Just the guidance from archaeology and ethno-historic sources reviewed in the main text. An obvious question, therefore, is how important is the choice of specific prior in determining the modelled results? We have argued that use of a LnN function prior or a Normal Distribution prior is better in order to avoid a hard edge to the range—contrast a Uniform prior. Thus, it should be more forgiving of any variations in data under consideration and particularly to the possibility of a site that continues for longer than the ‘norm’ expected (i.e. over 30–40 years). In theoretical terms, this is relevant and appropriate. However, in practice for the short duration under consideration, the choice of prior between Uniform, Normal, and LnN in fact usually makes relatively little difference as discussed in Manning et al. (2020), where use of some different priors are compared. We consider another experiment here to investigate further the effect of the specific prior using the Humber Sequence (Supplemental Table 3). We compare results using: (i) no prior, (ii) a Uniform prior of 0–40 years, (iii) a Uniform Prior of 0–80 years, (iv) a Normal Distribution prior of 20±10 years, (v) a Normal Distribution prior of 25±10 years, (vi) a LnN(ln(20),ln(2)) prior, and (vii) a LnN(ln(25),ln(2)) prior: see Supplemental Table 11. We find an outcome similar to the cases assessed in Manning et al. (2020): relatively small differences between the different choices of prior that are all aimed at more or less a similar ‘shorter site’ constraint. In fact, looking at Supplemental Table 11, the only real difference is between the ‘no prior’ versus ‘prior’ models (and in general, this issue of difference depends on the other constraints within the model – see the Don Valley case discussed below). The prior models all reduce (narrow, tighten) the dating ranges. Among the prior models, there are small differences, but in practice, there is not that much difference. In the cases of the slightly looser priors, the date ranges can become slightly wider (and the Amodel and Aoverall values are accordingly a little higher as the model finds it easier to conform data with the constraints): e.g. comparing the U(0,40) v. U(0,80) results, or N(20,10) v. N(25,20) results or LnN(ln(20),ln(2)) v. LnN(ln(25),ln(2))results. But, even so, all the prior cases assessed in Supplemental Table 11 achieve the implied aim of constraining the site durations to more archaeologically and ethnographically representative periods of time. The LnN(ln(20),ln(2)) prior appears particularly appropriate as offering a human-process-like distribution (see Supplemental Figure 1). It ramps up quickly to a likely modal range covering the various ‘average’ durations stated for such sites from different sources, and then tails away more gradually allowing a range of some slightly longer to a few longer durations even beyond the standard expectation. Hence, this is the prior principally employed in this paper. However, as evident from Supplemental Table 11, we would not expect major differences if one of the other alternative short-site-duration priors was used instead.

In the models in this study we have employed the prior LnN(ln(20),ln(2)). In the case of the Hope site we use this prior for each part of the Hope site (Hope South, Hope North) and then apply a Normal Distribution prior of 20±10 years to the overall site. The logic here is that the Hope data indicate that the two parts of the Hope site are not necessarily exactly contemporary, and hence we might expect the overall site duration to be a little longer than the peak 5–20 years range of the LnN(ln(20),ln(2)) prior, while still less than about 40 years. A Normal Distribution moves the mode, median and mean of the distribution a little later, better representing the view that site likely had an overall duration e.g. 10–30 years (1SD) or 0–40 years (2SD). The Normal Distribution does not have a hard upper limit if the data in fact indicate a longer duration. We also considered alternatives for the overall Hope site limit: a Normal Distribution of 25±10 years (so shifting the expected mean duration a little longer) and a Uniform range of 0–50 years (since we expect the overall site duration to be less). We compare these models including site duration constraint priors with, finally, a model with no interval priors applied. See Supplemental Table 12. Again, as noted above, there is very little difference between the results using the three priors—which are essentially aiming at the same goal of constraining the overall site duration to a shorter duration commensurate with the archaeological and ethno-historic information. In this case, given a relatively well-constrained set of site Phases, there is also very little difference against a model with no site Phase constraints applied (to any of the site Phase elements in the model). It is mostly the overall model constraints that determine the possible site Phases. And, in such a situation a site duration prior expectation is actually sometimes useful to avoid a site becoming too short—see Supplemental Table 12 comparing the ranges with a prior versus the 68.3% hpd range with no prior site duration constraint. These issues are all evident if we consider the Hope site in isolation. Supplemental Figure 8A shows the start and end Boundaries and Date estimates and Interval estimates for the Hope site modelled in isolation and with no site Phase duration constraint prior included. This is compared to the Hope site modelled also in isolation, but with the site Phase duration constraints applied in the Supplementary Table 3 model in Supplementary Figure 8B. The calendar periods indicated are similar, but the difference is that the Supplemental Figure 8B modelled probability distributions yield shorter/narrower calendar age ranges. Supplemental Figure 9 shows and compares the Intervals calculated for Hope North and Hope South in each of the models from Supplemental Figure 8. The likely site durations exceed expectations from archaeology and ethno-historic reports in Supplemental Figure 9A, but conform well in Supplemental Figure 9B. Thus in isolation the site duration prior served to narrow the dating range slightly, but usefully. In contrast, in the context of the whole Don Valley model, with no site duration prior, there is a tendency to overly compress the Hope date range (see Supplemental Table 12). Thus an appropriate site duration prior, especially in the case of expected fairly short site phases as here, is useful in two ways.

The general observation is that use of a prior to constrain site Phase durations to both appropriate and also shorter periods consistent with archaeological and ethno-historic evidence is an important part of the models. But, the choice of specific prior is not so critical. A number of possible choices give relatively similar results (Manning et al. 2020, Supplemental Tables 11, 12). We have used the priors in this paper that appear particularly appropriate. Much more important are the assumed site sequences.

**Temporal Sequences from prior archaeological assessment/knowledge**

As noted in the main text, in the paper we have employed some generally accepted interpretations of archaeological site sequences as part of the prior information incorporated into our dating models (see Fig. 7 and sources cited and Supplementary Data Table 2). The models are thus not attempting to be independent and hence also assessments of the archaeological assumptions (contrast approaches taken in Manning et al. 2018; 2019; Manning and Hart 2019). We are instead using some available and generally accepted ‘expert knowledge’ as part of our models. We adopted this ‘subjectively-informed’ approach in this paper because we lack sufficient data and additional constraints (like wiggle-matches on wood/charcoal samples) to enable successful chronological resolution without them. The expert knowledge we use is not, we believe, under general debate nor ambiguous. It is fairly ‘macro’ in scale. We are not using assumptions of temporal order to separate between sites that in fact likely overlap (and where we do assume temporal order it is to indicate the nature of such a likely/assumed overlap—i.e. one site seems to start/end earlier/later than another). Rather, we are using a prior assumption of order only where the general assessment is that one site is more or less completely older/more recent than another or that a grouping (e.g. a Phase) of sites of one characteristic form (e.g. pre-coalescent) are earlier than those of another (coalescent). Thus for three examples: (i) in the Humber River model (Supplemental Fig. 2) we assume Black Creek is before Parsons in line with general assessment, and we place the apparent pre-contact sites as before the one apparent contact era site (Skandatut); (ii) in the Don Valley model (Supplemental Fig. 3) we assume that the pre-coalescent sites (as archaeologically defined and recognized) are before the coalescent sites (as archaeologically defined and recognized); and (iii) in the Trent Valley model (Supplemental Fig. 4) we assume that Kirche started after Jamieson started and ended by late Coulter, that Benson started after the start of Coulter and Kirche, that Coulter started before the end of Kirche (so overlapped), that Dawn starts after Jamieson and ends before Warminster, and that Sopher and Ball start after Benson. The latter is one of the more prior-assumptions-informed cases, but, these Ontario site relationships are also some of the most worked on and assessed, and the places of Ball and Warminster are tied down both by a tree-ring wiggle-match and concordant historical and multiple trade goods associations (Manning et al. 2019).

We acknowledge that use of this expert knowledge is important/key to the results we obtain. Without it, we would get very different results. This needless to say applies especially in the period of potential ambiguity across the plateau in the radiocarbon calibration curve 1480 to 1620. Hence, if it can be argued that the site orders and relative relationships we have used are incorrect, and should be substantively different, then our models will inherently be invalid and would need revision. They are not independent. We highlight this caveat.

To illustrate this point, we consider one case: the Seneca model (Supplemental Fig. 5). We re-ran this model removing all the expert knowledge that informed the grouping of Farrell and Footer as a Phase, the grouping of Richmond Hill and Belcher as a Phase, and the Sequence of Richmond Mills then Tram and then Cameron. The results from the re-run are shown for the whole model in Supplemental Fig. 10. As evident from a comparison of Supplemental Fig. 5A versus Fig. 10, the expert knowledge is crucial to the results in Supplemental Fig. 5A. We highlight this situation with a comparison of the Date estimates from Supplemental Fig. 5B (from Supplemental Fig. 5A) *with* expert knowledge included versus the Date estimates from Supplemental Fig. 10 *with the expert knowledge removed*: see Supplemental Figs. 11A versus 11B. In Supplemental Fig. 11A, with no expert knowledge, the sites with radiocarbon dates in the plateau region now exhibit either ambiguous Date estimates or much wider date regions (or effectively both). Thus, it is very evident that the dating clarity achieved in Supplemental Fig. 5 (resolving ambiguity and narrowing dating ranges) is critically determined by the inclusion of the expert knowledge/assumptions. We state this openly and hence the caveat that this knowledge and its incorporation as assumptions in the models is key to the findings reported in this paper.

We cannot at present do better otherwise. In the future, if we can find and incorporate relevant wood-charcoal samples with tree-ring sequences (of a few decades length at least) suitable at least for radiocarbon wiggle-matching (see discussion in Manning et al. 2020) (and potentially even sometimes dendrochronology), allied with larger, high-quality radiocarbon datasets for each site (compare Manning et al. 2018; 2019), then we could hope to aim at constructing a chronology independent of current expert knowledge/assumptions and so both test these and provide a resolved timescale. We do note one key point, however. In the studies where we have been able to construct an independent timescale and where we could then compare this to a well-based (from seriation of Indigenous material culture products and other criteria) relative sequence (e.g. site relocation series), then we found that the independent radiocarbon-based chronology was consistent with the sequence from the previous expert knowledge (Manning et al. 2018; 2019). The actual calendar dates change, yes, but the relative order was found to be the same nonetheless.

We highlight this point. In circumstances where the current relative relationships between sites are only vague or approximate, then we might expect some rearrangements with better dating (Manning and Hart 2019). But, where the current expert assessments are based on quantitative analysis and multiple sources of comparison, then we may likely expect these to be fairly robust. This scenario has played out all around the world as radiocarbon has replaced previous relative-historical chronologies (Manning 2015). The calendar dates have changed, sometimes radically, and analytical resolution to the scale of lifetimes may be achieved, and so a totally different anthropological archaeology becomes possible, but the relative ordering of cultural phases has usually proved fairly sound with only minor adjustments in various cases (e.g., Whittle et al. 2011; Whittle 2018). Thus we reasonably use, and take advantage of, many decades of archaeological investigation and critical assessment. Yes, in the future, it will hopefully be possible to test this expert knowledge in many cases against an entirely independent timeframe, but for now, the distilled set of archaeological expert knowledge offers our best guide. Do we have any check or control? Yes, the set of assumptions incorporated at least have to be compatible with the possible ranges from the radiocarbon data, otherwise the models will yield poor OxCal agreement indices and poor Convergence. The findings that each of our models achieve very good OxCal agreement indices (Amodel and Aoverall >60), that we have had to remove only a very few outliers overall across the models (no outliers in 4 models and 4 in each of two others – and one of those very marginal), and that we achieve good Convergence (C ≥95) values for all elements in all the models, all combine to suggest that the assumptions we have used are at least reasonable and could be correct. This is not the same as saying they are necessarily correct. However, it would seem that they are not importantly wrong.

**Reading the OxCal plots (Supplemental Figures 2–8). For the Date estimates for site Phases and Interval queries, see Table 2. For the start and end Boundaries for each site Phase, see Supplemental Table 13.**

The plots show the following elements:

For each radiocarbon date (blue) the light blue (semi-transparent) histogram shows the non-modelled calibrated calendar age probabilities. The smaller dark blue (solid) histogram shows the modelled calendar age probabilities.

The black histograms show the modelled Boundaries (on Boundaries in OxCal, see Bronk Ramsey 2001; 2009a).

The green histograms show the OxCal Date estimates for the site Phases (an estimate of the period of time between the start and end Boundaries and thus a reasonable estimate of the date of the site Phase).

The lines under each of these solid histograms (i) to (iii) indicate the 68.3% and 95.4% highest posterior density (hpd) ranges. Note these ranges are in fact calculated as 68.26895% and 95.44997%. The rounded values are 68.3% and 95.4%. Because of rounding errors when no more than 1 decimal place is shown, the stated probabilities, when there are sub-ranges, sometimes add up to 0.1% more, or less, than the stated 68.3% or 95.4%.

For individual radiocarbon dates, or for weighted averages of dates on the same sample (R\_Combine), the individual OxCal Agreement values (A), which should be ≥60 if data are in good agreement with the model, Convergence (C) values for each element, which should be ≥95 for good convergence, and Outlier (O) values, are each shown (on OxCal Outlier models, see Bronk Ramsey 2009b). For dates on short-lived samples the OxCal General Outlier model is applied. The prior is 5 (i.e. up to a 5% probability of being an outlier is accepted). The posterior should be ≤5. If larger than 5, there is the stated probability of being an outlier above the 5% threshold (see GrM-14960 in Supplemental Fig. 3A where there is “O:6/5” as an example). We comment in the OxCal runfiles (see Supplemental Tables 3–8) where we have excluded in total 8 dates as larger outliers. As examination of Supplemental Figs. 2–8 show, nearly all samples had outlier probabilities of ≤5%. Within R\_Combines the OxCal SSimple Outlier model is applied to the constituent dates (5% threshold); the OxCal General Outlier model is applied to the weighted average itself within the model. Where present, dates on wood-charcoal samples (unless in a tree-ring wiggle-match, where the SSimple Outlier is applied) have the OxCal Charcoal Outlier model applied. This tries to allow for the issue of likely in-built age (old-wood problem). The outlier probability is always shown as 100/100 for these dates.

The General and SSimple Outlier models do two things (Bronk Ramsey 2009b). First, they detect dates that are outliers from the stated assumptions (the model or the function, like R\_Combine). Second, they down-weight these dates by the scale of their being an outlier. Thus very little for a 6% outlier and a great deal for a 99% outlier. The results achieved by the model are therefore generally similar with the outlier samples included or with them excluded. However, occasionally, where a particular date would fit against a specific calibration curve feature, like a sharp wiggle up or down, manual removal of an outlier makes a little more difference, but still usually only a handful or so of years (see Supplemental Table 14, and for a case of some modest difference due to removal of a specific outlier, see the Pompey site dates comparing the two models in Supplemental Table 14 – if the view is taken that UGAMS-39594 from Pompey, >25% probability as a too-old outlier and individual OxCal Agreement value of only ~4.2%, is perhaps to be construed as a miss for the wiggle to older 14C ages ca. 1606-1607, then this might suggest that some portion of the site’s occupation period at least includes ca. 1606-1607 and would not favor allowing the site to run on too long into the 17th century). The difference between models, with both using Outlier models, when the larger outliers detected are manually removed before a re-run, is that the overall model agreement indices change. With the outliers left in, the Amodel and Aoverall values are typically marginal or poor, whereas if excluded these values become satisfactory to good (see Supplemental Table 14 for an example). In general, since only a very few data appear to be substantial outliers (see below), we preferred to use as many data as possible with the Outlier models modulating any remaining small discrepancies (yielding an average between a date being excluded versus included). In the few cases where an initial model run indicated a larger outlier, we adopted manual rejection of such dates, and then re-ran the model without them. We review these manual rejections below. A reasonable question is what difference does using an Outlier model make versus no Outlier model once such larger outliers are excluded. We consider this for the Onondaga case where we excluded 4 dates: see Supplemental Table 15. The answer is very little difference (as would be expected). The results in this case are almost identical (within variations of around 1 year). Hence we employ the date ranges from the models with Outlier models applied, but after manual exclusion of a few larger outliers (see Supplemental Tables 3 to 8), in Table 2 and Supplemental Table 8 as our best estimates.

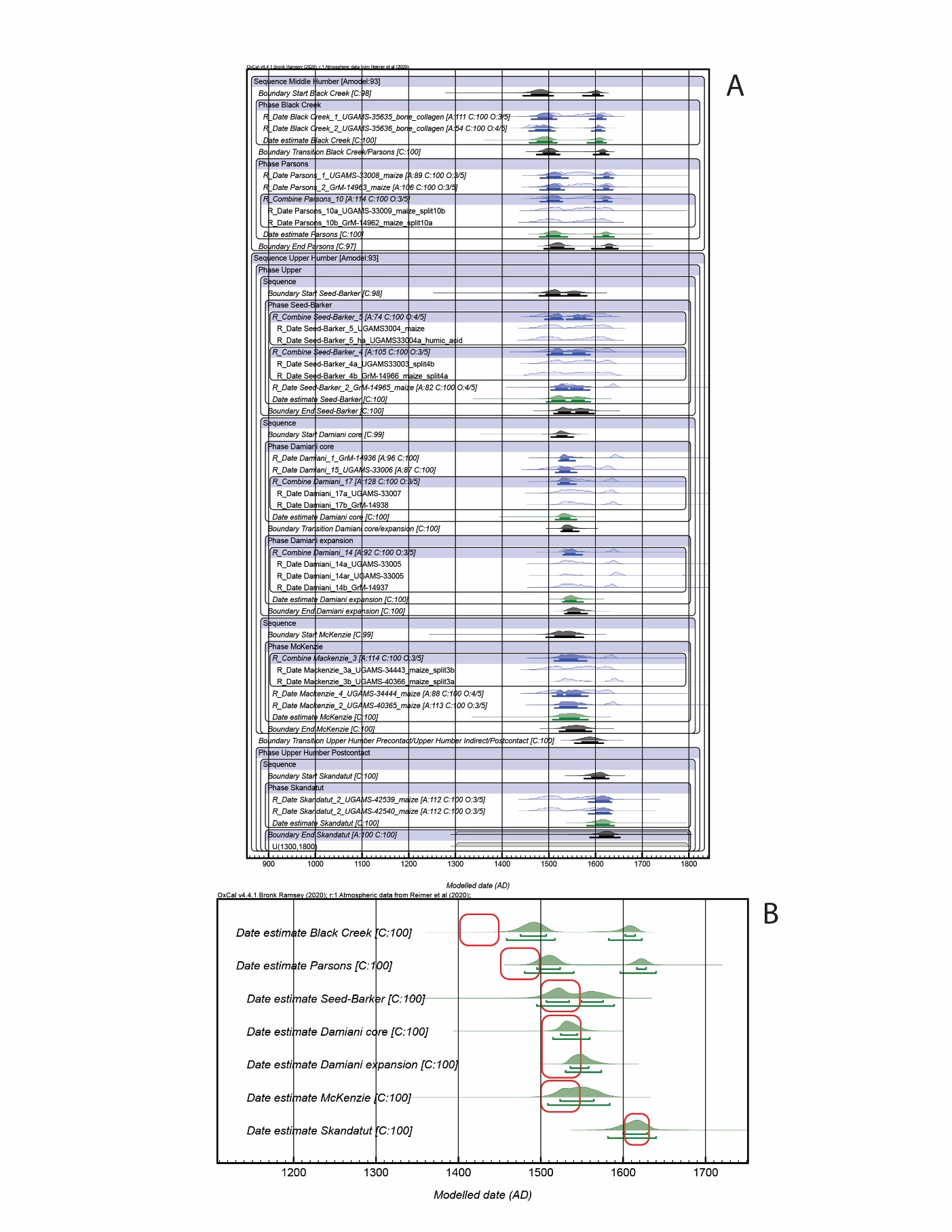
We consider and explain the two models where we have excluded outliers. (1) The Onondaga case in Supplemental Fig. 7 and Supplemental Table 8. The model runs with all the outliers included (these are Kelso\_5 at 7/5, GrM-14983 at 14/5, UGAMS-39590E at 12/5, UGAMS-39587 at 8/5, UGAMS-39594 at 16/5 and UGAMS-39595 at 6/5). But the Amodel value is ~35 and the Aoverall value is ~40, both less than 60. In this case, we see that the issue with Kelso\_5 was GrM-14983 which was an outlier at ~14% probability, so we excluded this date. UGAMS-39590E is an outlier at ~12% probability, so we exclude this date. UGAMS-39587 is an outlier at ~8%. For no good reason, i.e., just arbitrary, we decided that we would tolerate 6–7% outlier probability, but draw the line at ≥8% outlier probability. Why? Because in this case UGAMS-39587 had an individual OxCal agreement value of 23.7 < 60 and was very much contributing to the poor Amodel and Aoverall values (in contrast, UGAMS-39595, which has a ~6% outlier probability has an individual A value of >60 and thus we decided to draw the line here and to tolerate this very minor outlier and so left it in the model). UGAMS-39594 is an outlier at ~16% probability and we excluded it. The re-run model (as in Supplemental Table 8) achieves Amodel ~112 and Aoverall ~120, well above the satisfactory level of 60. As noted above, results from the original model with outliers included, then the model with the four outliers excluded and run whether with, or without, Outlier models applied can be compared in Supplemental Tables 14 and 14. All yield similar results, and the latter two versions offer near identical results. (2) The Trent case in Supplemental Fig. 4 and Supplemental Table 5 is different. The model runs fine with or without the outliers noted (and the outlier model appropriately down-weights the outliers so the results remain very similar). For the final model used, we exclude two outliers from the Warminster dataset: UGAMS-25451 (ca. 91% outlier probability) and UGAMS-25451-r (ca. 17% outlier probability). As discussed previously (Manning et al. 2018; 2019), both likely represent over-estimations of the wiggle upwards in the calibration curve at about 1606-1607 which is a feature of the radiocarbon record at this period (we note the possible similar case of UGAMS-39594 from Pompey, see above). We also exclude UGAMS-33102\_UID from Kirche. This date has only a ca. 7% outlier probability so the decision is borderline. Leaving the sample in makes very little difference. The Date estimate for Kirche Early including UGAMS-33102\_UID and the other outliers noted here is 1521–1535 68.3% hpd) and the Date estimate in the final model excluding UGAMS-33102\_UID and the other outliers noted here is 1525–1537 (68.3% hpd). Thus very similar. GrM-15545 from Benson (Benson 9b) was excluded from all runs as this was meant to be a replicate of Benson 9a (UGAMS-33016ha), but the GrM date in this case is much older and is also much older than all the other Benson data (other Benson data mid-point radiocarbon ages run in a consistent group from 320 to 289 BP – whereas GrM-15545 is 443±20 BP). There appears to be an unexplained issue here. We do not know if this derives from a possible laboratory issue, or sample mix-up, or other problem, but we exclude this sample accordingly.

**Supplemental Figures**

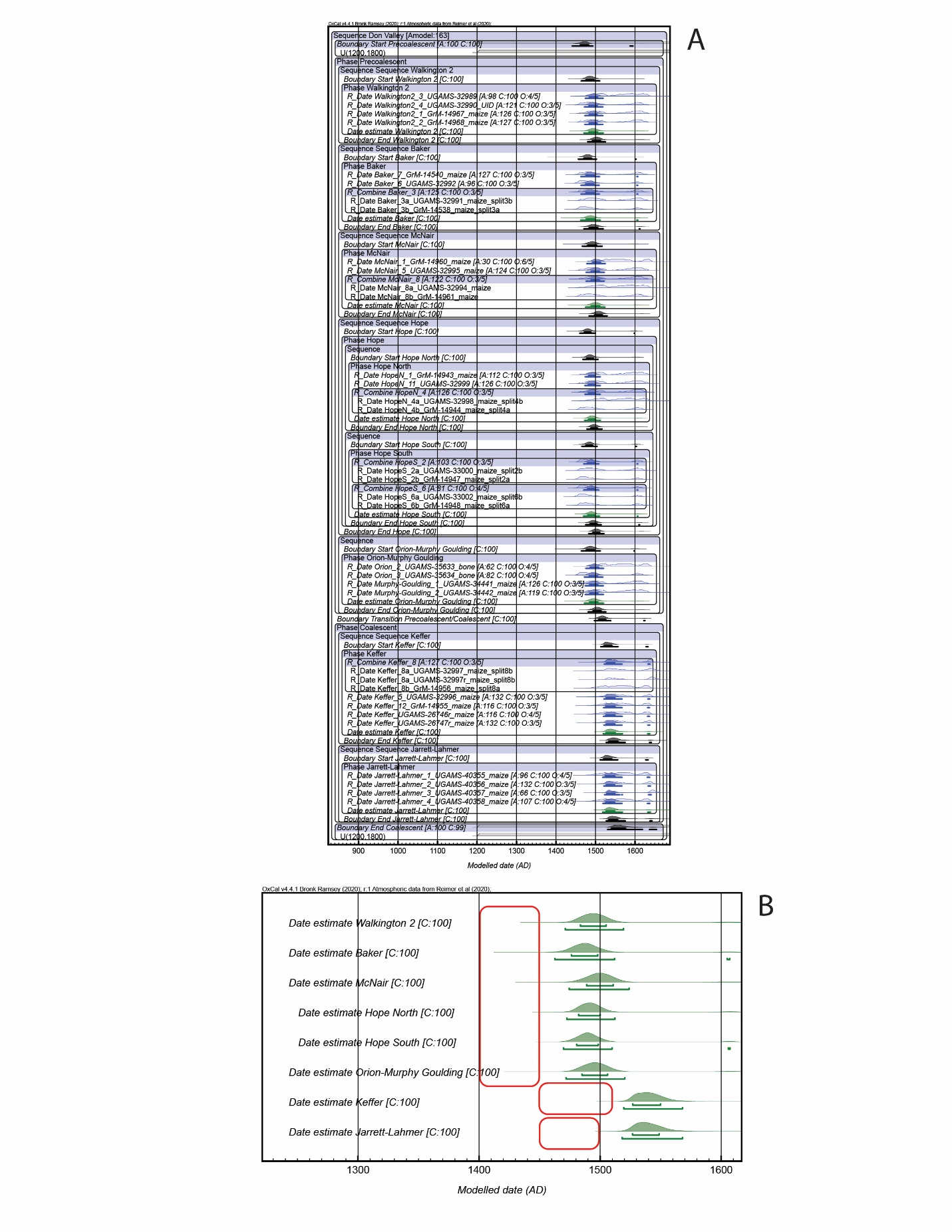
**Supplemental Figure 1.** A. The OxCal LnN(ln(20),ln(2)) prior probability distribution for site Phase duration. B. The Middle Humber model run *without* Interval constraints on the site Phase durations showing the (much longer) Interval estimates that result. C. The Interval estimates for the Middle Humber sites with the model using the LnN(ln(20),ln(2)) prior for each site Phase duration—compared to those from B.



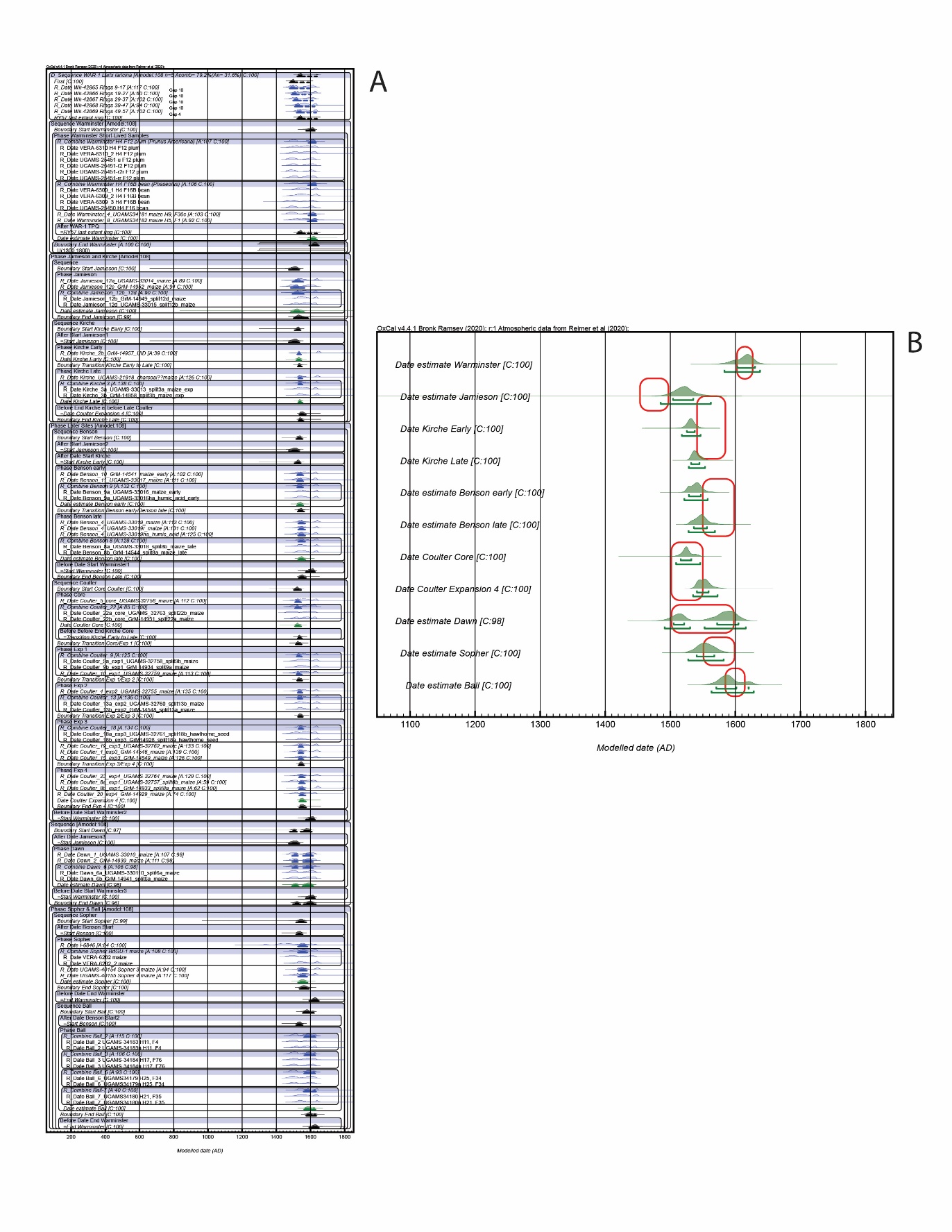
**Supplemental Figure 2.** A. Humber River Sequence plot and B. Date estimates with previous age-estimate indicated.



**Supplemental Figure 3.** A. Don Valley Sequence plot and B. Date estimates with previous age-estimate indicated by red line.



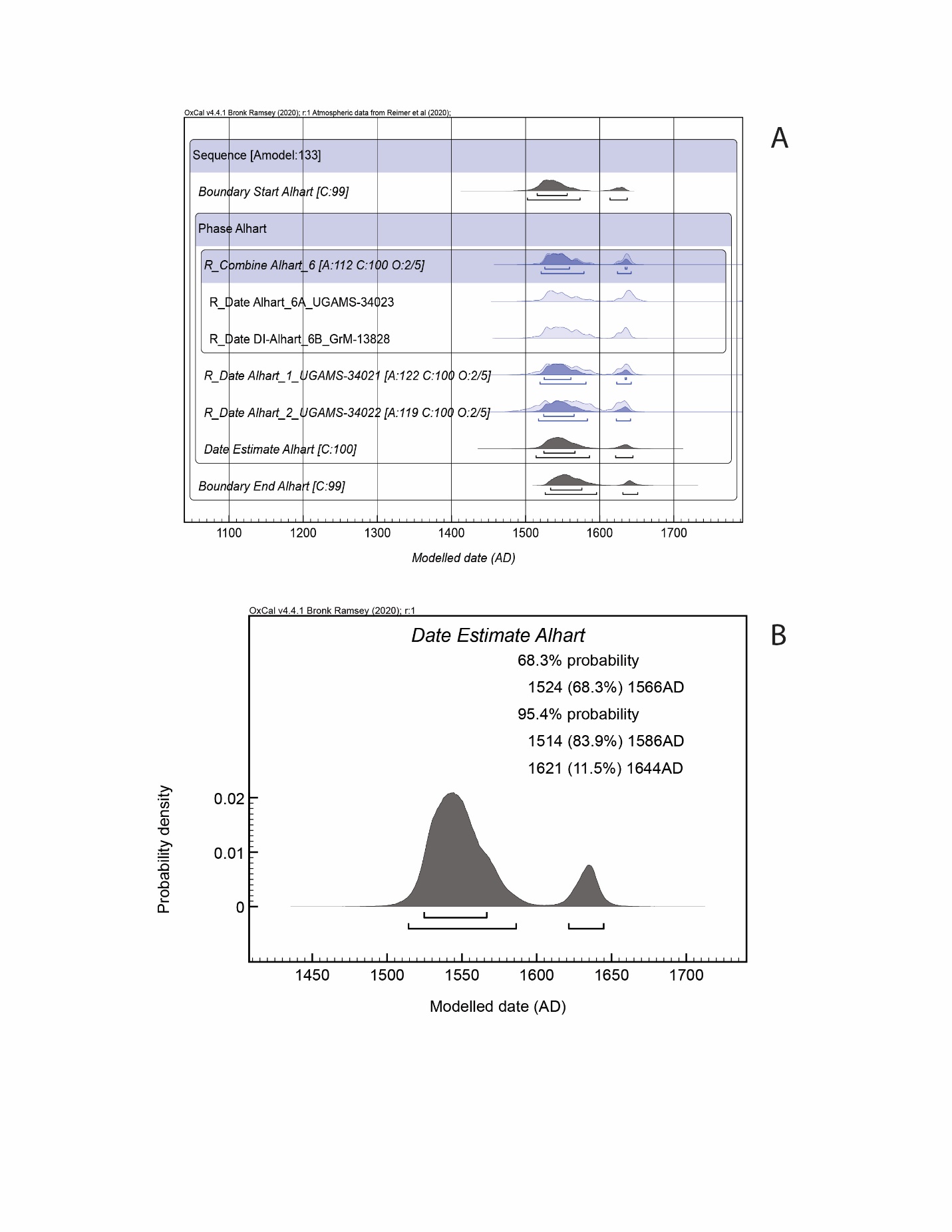
**Supplemental Figure 4.** A. Trent Valley Sequence plot and B. Date estimates with previous age-estimate indicated by red line.



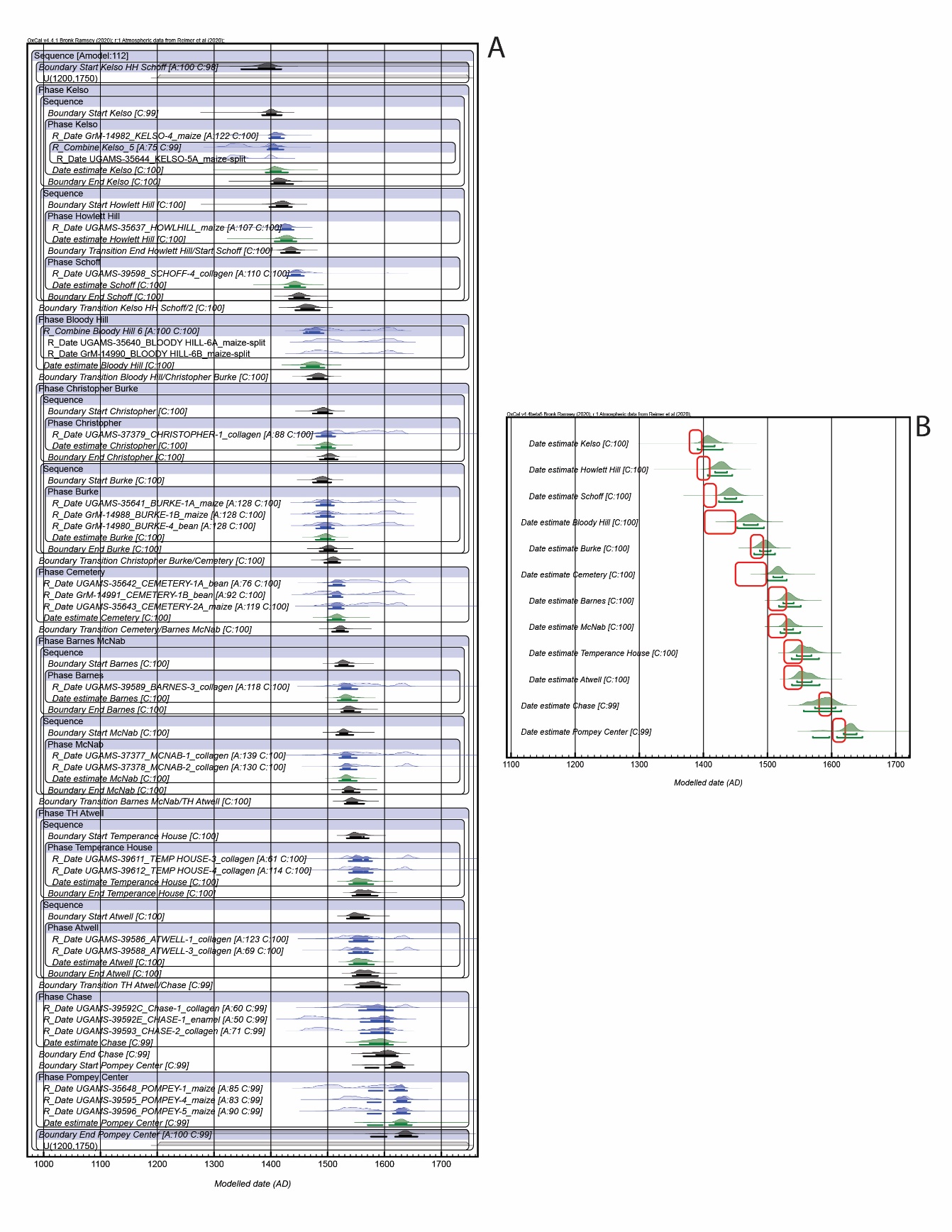
**Supplemental Fig 5.** A. Seneca Sequence plot and B. Date estimates with previous age-estimate indicated by red line.



**Supplemental Fig 6.** A. Alhart site Phase plot and B. Date estimate.



**Supplemental Figure 7.** A. Onondaga Sequence plot and B. Date estimates with previous age-estimate indicated by dashed red line.



**Supplemental Figure 8.** Hope site modelled in isolation. A. with no site Phase duration constraint. B with the site Phase duration constraints in the Supplemental Table 4model.

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**Supplemental Figure 9.** Intervals calculated from the models in Supplemental Figure 8. A. The Hope site modelled in isolation with no site Phase duration constraints. B. The Hope site modelled in isolation but including the site Phase constraints in Supplemental Table 4. C. The results of the Difference query applied to the period between the start and end Boundaries for the overall Hope site with a N(20,10) prior. Here is an example where the data indicate a slightly longer age range (the dark shaded histogram) than the prior (the light shaded histogram). The mean of the modelled distribution is 25 years – so perhaps a N(25,10) prior might be more appropriate – but, as shown in Supplementary Table 12, this makes just about 1–2 years difference.

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**Supplemental Figure 10.** Re-run of the Seneca model (Supplemental Table 6) without the assumed site relationships used there—i.e. all sites treated as independent.

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**Supplemental Figure 11.** The effect of incorporating prior expert knowledge for the Seneca model. A. Site Date estimates for the Seneca model from Supplemental Figure 10 with no prior expert knowledge. B. Site Date estimates for the Seneca model if we do incorporate prior expert knowledge about site relationships (as in Supplemental Table 6, Supplemental Figure 5).

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**Supplemental Figure 12.** Comparison of the 34 instances where the identical sample was split between the University of Georgia (UGAMS) and the Groningen (GrM) radiocarbon laboratories. In three cases UGAMS made two measurements on the same sample and these have been combined into a weighted average; in one case there are two GrM measurements on the same sample and these have also been combined into a weighted average. When the individual laboratory pairs are compared only one case fails a χ2 test for being consistent with representing the same radiocarbon age within 95% limits (indicated with blue arrow) (the Coulter\_8a and 8b pairing). The weighted average difference between UGAMS and GrM is small: -5.6 ± 4.8 14C years (UGAMS the more recent ages). Since these are different laboratories with different instruments and varying exact processing steps, such very good compatibility suggests that the results reported in each case (and together) are robust. Weighted average analysis follows Ward and Wilson (1978).



# Supplemental Tables

**Supplemental Table 1.** All 184 Radiocarbon Samples and Conventional Radiocarbon Ages (CRA) used in this study. The δ13C, 15N and C values are reported from separate IRMS measurements. For a measure of data robustness from a comparison of the 34 instances of UGAMS and GrM data on split samples, see Supplemental Figure 12.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Site** | **Project Sample ID** | **Lab number** | **Material** | **Context** | **CRA 14C age BP** | **±** | **δ13C** | **15N** | **C:N** | **Calibrated date range 95.4%** | **Calibrated date range 68.3%** |
| **SENECA** |  |  |  |  |  |  |  |  |  |  |  |
| Farrell | Farrell\_1 | GrM-14970 | 1 fragment of an unidentified carbonized nut | Test unit S45 W60, associated with Structure 1 | 558 | 20 | -24.56 |  |  | 1323 – 1423 | 1328 – 1414 |
| Farrell | Farrell\_3 | UGAMS-34030 | 1 carbonized maize (*Zea mays*) kernel fragment | Test unit S105 W15, associated with Structure 2 | 588 | 22 | -9.46 |  |  | 1306 – 1409 | 1323 – 1400 |
| Farrell | Farrell\_4 | GrM-14972 | 1 fragment of an unidentified carbonized nut | Test unit S105 W15, associated with Structure 2 | 518 | 20 | -26.13 |  |  | 1401 – 1438 | 1409 – 1426 |
| Footer | Footer\_1a | UGAMS-34031 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Footer\_1b | Test unit 350 R15, northern research area, associated with Structure 1 | 372 | 21 | -8.93 |  |  | 1454 – 1630 | 1464 – 1617 |
| Footer | Footer\_1b | GrM-13830 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Footer\_1a | Test unit 350 R15, northern research area, associated with Structure 1 | 384 | 15 | -7.62 |  |  | 1452 – 1619 | 1457 – 1607 |
| Footer | Footer\_5 | GrM-13832 | 1 carbonized maize (*Zea mays*) kernel | Test unit 330R 10N, associated with Structure 2 | 382 | 15 | -8.41 |  |  | 1452 – 1620 | 1458 – 1610 |
| Footer | Footer\_6 | UGAMS-34032 | 1 carbonized maize (*Zea mays*) kernel | Test unit 330 R0, northern research area, associated with Structure 2. Notes indicate potentially from post mold 2, unclear. | 374 | 21 | -9.34 |  |  | 1453 – 1627 | 1460 – 1616 |
| Belcher | Belcher\_4a | UGAMS-34024 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Belcher\_4b | No specific provenience beyond site level | 347 | 21 | -9.96 |  |  | 1472 – 1635 | 1490 – 1626 |
| Belcher | Belcher\_4b | GrM-13829 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Belcher\_4b | No specific provenience beyond site level | 343 | 15 | -9.33 |  |  | 1478 – 1634 | 1495 – 1628 |
| Belcher | Belcher\_3 | UGAMS-39603 | bone, collagen, *Canid* sp. premolar, indeterminate side | No specific provenience beyond site level | 379 | 20 | -22.09 | 9.1 | 3.2 | 1451 – 1624 | 1458 – 1615 |
| Richmond Mills | Richmond Mills\_1a | UGAMS-34033 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Richmond Mills\_1b | No specific provenience beyond site level | 352 | 21 | -9.9 |  |  | 1460 – 1635 | 1482 – 1623 |
| Richmond Mills | RichmondMills-1b | GrM-13756 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Richmond Mills\_1a | No specific provenience beyond site level | 355 | 15 | -8.3 |  |  | 1472 – 1632 | 1483 – 1620 |
| Richmond Mills | RichmondMills\_7a | UGAMS-35645 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Richmond Mills\_7b | No specific provenience beyond site level | 352 | 19 | -8.86 |  |  | 1468 – 1634 | 1483 – 1623 |
| Richmond Mills | RichmondMills\_7b | GrM-14985 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Richmond Mills\_7a | No specific provenience beyond site level | 332 | 18 | -8.75 |  |  | 1490 – 1638 | 1505 – 1633 |
| Richmond Mills | RichmondMills\_8a | UGAMS-35646 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Richmond Mills\_8b | No specific provenience beyond site level | 332 | 19 | -9.61 |  |  | 1490 – 1638 | 1504 – 1634 |
| Richmond Mills | RichmondMills\_8b | GrM-14986 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Richmond Mills\_8a | No specific provenience beyond site level | 328 | 18 | -8.35 |  |  | 1494 – 1638 | 1509 – 1634 |
| Richmond Mills | RichmondMills\_9a | UGAMS-35647 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Richmond Mills\_9b | No specific provenience beyond site level | 311 | 19 | -8.49 |  |  | 1500 – 1645 | 1522 – 1639 |
| Richmond Mills | RichmondMills\_9b | GrM-14987 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Richmond Mills\_9a | No specific provenience beyond site level | 341 | 20 | -8.69 |  |  | 1478 – 1635 | 1495 – 1631 |
| Alhart | Alhart\_1 | UGAMS-34021 | 1 carbonized bean (*Phaseolus* sp.) | Feature 304A, sample from bark container on the western side of a large storage pit | 305 | 21 | -28.75 |  |  | 1504 – 1649 | 1523 – 1641 |
| Alhart | Alhart\_2 | UGAMS-34022 | 1 carbonized bean (*Phaseolus* sp.) | Feature 304A, sample from bark container on the eastern side of a large storage pit | 316 | 21 | -26.66 |  |  | 1497 – 1644 | 1521 – 1637 |
| Alhart | Alhart\_6a | UGAMS-34023 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Alhart\_6b | Feature 312A, level 2, large storage pit. | 291 | 21 | -9.34 |  |  | 1516 – 1656 | 1524 – 1648 |
| Alhart | Alhart\_6b | GrM-13828 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Alhart\_6a | Feature 312A, level 2, large storage pit | 308 | 15 | -8.29 |  |  | 1515 – 1644 | 1524 – 1639 |
| Tram | Tram\_1 | GrM-14973 | 1 fragment of a carbonized hickory nut (*Carya* sp.) | Feature 2 in Test Unit 10N 92W, in the western end of the residential area | 351 | 20 | -24.54 |  |  | 1467 – 1635 | 1485 – 1623 |
| Tram | Tram\_2 | UGAMS-39607 | 1 piece of unidentified wood charcoal | Feature 1 in Test Unit 10N 92W, in the western end of the residential area | 287 | 20 | -24.84 |  |  | 1520 – 1658 | 1526 – 1650 |
| Cameron | Cameron\_1 | UGAMS-34025 | 1 carbonized maize (*Zea mays*) kernel | Test Unit 183N 80W, Level one, associated with the northern section of the site palisade | 338 | 21 | -9.85 |  |  | 1480 – 1636 | 1499 – 1631 |
| Cameron | Cameron\_5 | UGAMS-34027 | 1 carbonized maize (*Zea mays*) kernel | Test Unit 24.72N 4, associated with the eastern section of the site palisade | 344 | 21 | -8.54 |  |  | 1475 – 1635 | 1491 – 1631 |
| Cameron | Cameron\_4 | GrM-13759 | 1 carbonized maize (*Zea mays*) kernel | Test Unit 24.72N 4W, the northern half of feature 2. Associated with the eastern section of the site palisade. | 354 | 15 | -8.71 |  |  | 1473 – 1632 | 1485 – 1621 |
| Cameron | Cameron\_3a | UGAMS-34026 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Cameron\_3b | Test Unit 24.72N 4W, the eastern half of feature 4. Associated with the eastern section of the site palisade. | 372 | 21 | -8.89 |  |  | 1454 – 1630 | 1464 – 1617 |
| Cameron | Cameron\_3b | GrM-13760 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Cameron\_3a | Test Unit 24.72N 4W, the eastern half of feature 4. Associated with the eastern section of the site palisade. | 344 | 15 | -8.18 |  |  | 1479 – 1634 | 1495 – 1626 |
| Factory Hollow | Factory Hollow\_3a | UGAMS-34028 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Factory Hollow\_3b | From unspecified midden context | 372 | 22 | -10.18 |  |  | 1453 – 1631 | 1462 – 1617 |
| Factory Hollow | Factory Hollow\_3b | GrM-13827 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Factory Hollow\_3a | From unspecified midden context | 347 | 15 | -8.87 |  |  | 1478 – 1633 | 1491 – 1625 |
| Factory Hollow | Factory Hollow\_6a | UGAMS-34029 | 1/2 of a fragment of carbonized plum (*Prunus americana*) pit shell. Replicate Factory Hollow\_6b | From unspecified midden context | 355 | 21 | -26 |  |  | 1463 – 1633 | 1479 – 1623 |
| Factory Hollow | Factory Hollow\_6b | GrM-13757 | 1/2 of a fragment of carbonized plum (*Prunus americana*) pit shell. Replicate Factory Hollow\_6a | From unspecified midden context | 377 | 15 | -24.74 |  |  | 1455 – 1621 | 1460 – 1612 |
| **ONONDAGA** |  |  |  |  |  |  |  |  |  |  |  |
| Kelso | Kelso\_4 | GrM-14982 | 1 carbonized maize (*Zea mays*) kernel fragment | From a postmold in E10 S60 | 543 | 20 | -8.73 |  |  | 1326 – 1428 | 1400 – 1422 |
| Kelso | Kelso\_5a | UGAMS-35644 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Kelso\_5b | From postmold in structure 9, in E70 S10 | 576 | 19 | -8.66 |  |  | 1317 – 1413 | 1326 – 1404 |
| Kelso | Kelso\_5b | GrM-14983 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Kelso\_5a | From postmold in structure 9, in E70 S10 | 624 | 25 | -8.21 |  |  | 1298 – 1397 | 1302 – 1394 |
| Howlett Hill | Howlett Hill\_1 | UGAMS-35637 | 1 carbonized maize (*Zea mays*) kernel fragment | Feature 18 in Square E0 S50 | 506 | 19 | -7.94 |  |  | 1406 – 1440 | 1414 – 1433 |
| Schoff | Schoff\_4 | UGAMS-39598 | bone, collagen, groundhog (*Marmota monax*) mandible with embedded teeth, whole, right | North end of house | 434 | 25 | -26.97 | 4 | 3.3 | 1425 – 1486 | 1436 – 1463 |
| Bloody Hill | Bloody Hill\_6A | UGAMS-35640 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Bloody Hill\_6B | No specific provenience beyond site level | 362 | 19 | -8.14 |  |  | 1458 – 1631 | 1475 – 1620 |
| Bloody Hill | Bloody Hill\_6B | GrM-14990 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Bloody Hill\_6a | No specific provenience beyond site level | 373 | 20 | -8.7 |  |  | 1455 – 1625 | 1460 – 1617 |
| Christopher | Christopher\_1 | UGAMS-37379 | Bone, collagen, white-tailed deer (*Odocoileus virginianus*) metacarpal, distal end fragment, indeterminate side | No specific provenience beyond site level | 338 | 20 | -22.79 | 6.01 | 3.4 | 1480 – 1636 | 1500 – 1631 |
| Burke | Burke\_1A | UGAMS-35641 | 1 carbonized maize (*Zea mays*) kernel fragment | Square E0 N50 | 359 | 19 | -9.09 |  |  | 1460 – 1631 | 1478 – 1620 |
| Burke | Burke\_1B | GrM-14988 | 1 carbonized maize (*Zea mays*) kernel fragment | Square E0 N50 | 363 | 18 | -8.57 |  |  | 1458 – 1631 | 1474 – 1620 |
| Burke | Burke\_4 | GrM-14980 | 1/2 of a carbonized bean (*Phaseolus* sp.) | No specific provenience beyond site level | 360 | 18 | -24.45 |  |  | 1459 – 1631 | 1477 – 1620 |
| Cemetery | Cemetery\_1A | UGAMS-35642 | 1 carbonized bean (*Phaseolus* sp.) | Square W10 S30 | 316 | 19 | -27.18 |  |  | 1499 – 1644 | 1521 – 1637 |
| Cemetery | Cemetery\_1B | GrM-14991 | 1 carbonized bean (*Phaseolus* sp.) | Square W10 S30 | 359 | 18 | -26.27 |  |  | 1460 – 1631 | 1478 – 1620 |
| Cemetery | Cemetery\_2A | UGAMS-35643 | 1 carbonized maize (*Zea mays*) kernel | No specific provenience beyond site level | 335 | 20 | -7.98 |  |  | 1485 – 1637 | 1501 – 1633 |
| Barnes | Barnes\_3 | UGAMS-39589 | Bone, collagen, white-tailed deer (*Odocoileus virginianus*) molar, indeterminate side | No specific provenience beyond site level | 315 | 20 | -21.18 | 5.58 | 3.4 | 1499 – 1644 | 1521 – 1638 |
| McNab | McNab\_1 | UGAMS-37377 | Bone, collagen, white-tailed deer (*Odocoileus virginianus*) radius, distal end, right, cut marks | Feature 1 | 298 | 35 | -22.43 | 5.36 | 3.3 | 1487 – 1660 | 1520 – 1647 |
| McNab | McNab\_2 | UGAMS-37378 | Bone, collagen, white-tailed deer (*Odocoileus virginianus*) humerus, distal end, left, has cut marks | Feature 1 | 290 | 20 | -22.83 | 4.98 | 3.3 | 1517 – 1657 | 1525 – 1648 |
| Temperance House | Temperance House\_3 | UGAMS-39611 | Bone, collagen, white-tailed deer (*Odocoileus virginanus*) molar, fragment, indeterminate side | No specific provenience beyond site level | 282 | 20 | -22.36 | 7.22 | 3.2 | 1520 – 1660 | 1528 – 1650 |
| Temperance House | Temperance House\_4 | UGAMS-39612 | Bone, collagen, white-tailed deer (*Odocoileus virginanus*) molar, fragment, indeterminate side | No specific provenience beyond site level | 304 | 20 | -23.33 | 6.33 | 3.2 | 1506 – 1649 | 1524 – 1641 |
| Atwell | Atwell\_1 | UGAMS-39586 | Bone, collagen, white-tailed deer (*Odocoileus virginanus*) molar, indeterminate side | No specific provenience beyond site level | 312 | 20 | -22.08 | 6.38 | 3.4 | 1499 – 1645 | 1522 – 1638 |
| Atwell | Atwell\_3 | UGAMS-39588 | Bone, collagen, white-tailed deer (*Odocoileus virginanus*) premolar, indeterminate side | No specific provenience beyond site level | 285 | 20 | -21.98 | 7.04 | 3.4 | 1520 – 1659 | 1526 – 1650 |
| Chase | Chase\_1 | UGAMS-39592C | Bone, collagen, white-tailed deer (*Odocoileus virginianus*) molar, fragment, indeterminate side | No specific provenience beyond site level | 300 | 25 | -22.09 | 7.77 | 3.4 | 1500 – 1655 | 1522 – 1644 |
| Chase | Chase\_1 | UGAMS-39592E | Bone, enamel, white-tailed deer (*Odocoileus virginianus*) molar, fragment, indeterminate side | No specific provenience beyond site level | 388 | 25 | -16.85 |  |  | 1445 – 1625 | 1453 – 1615 |
| Chase | Chase\_2 | UGAMS-39593 | Bone, collagen, white-tailed deer (*Odocoileus virginianus*) mandible fragment with embedded molar, left | No specific provenience beyond site level | 372 | 20 | -23.78 | 5.15 | 3.4 | 1455 – 1627 | 1464 – 1617 |
| Pompey Center | Pompey\_1 | UGAMS-35648 | 1 carbonized maize (*Zea mays*) kernel fragment | No specific provenience beyond site level | 350 | 19 | -8.86 |  |  | 1470 – 1635 | 1487 – 1624 |
| Pompey Center | Pompey\_4 | UGAMS-39595 | 1 carbonized maize (*Zea mays*) kernel; originally identified as carbonized bean (*Phaseolus* sp.) but 13C value suggests maize | No specific provenience beyond site level | 300 | 20 | -9.73 |  |  | 1510 – 1650 | 1524 – 1643 |
| Pompey Center | Pompey\_5 | UGAMS-39596 | 1 carbonized maize (*Zea mays*) kernel fragment | No specific provenience beyond site level | 306 | 20 | -9.23 |  |  | 1506 – 1648 | 1523 – 1640 |
| **HUMBER** |  |  |  |  |  |  |  |  |  |  |  |
| Black Creek | Black Creek\_1 | UGAMS-35635 | Bone, collagen, white-tailed deer (*Odocoileus virginianus*) metatarsal, distal end, indeterminate side | "BC III 20R26" | 351 | 21 | -22.27 | 6.126 | 3.3 | 1466 – 1635 | 1484 – 1624 |
| Black Creek | Black Creek\_2 | UGAMS-35636 | Bone, collagen, white-tailed deer (*Odocoileus virginianus*) ulna, proximal end, right | "BC II 15R24" | 400 | 20 | -22.55 | 5.511 | 3.2 | 1444 – 1618 | 1450 – 1483 |
| Parsons | Parsons\_1 | UGAMS-33008 | 1 carbonized maize (*Zea mays*) kernel | Feature 113, a large pit associated with House 3, in square 190-535 | 324 | 21 | -9.24 |  |  | 1493 – 1640 | 1515 – 1635 |
| Parsons | Parsons\_2 | GrM-14963 | 1 carbonized maize (*Zea mays*) kernel | From wall trench in house 7, in square 195-560 | 334 | 20 | -8.9 |  |  | 1486 – 1637 | 1501 – 1633 |
| Parsons | Parsons\_10a | UGAMS-33009 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Parsons\_10b | From Midden 3, square 209-534 | 342 | 21 | -9.81 |  |  | 1477 – 1636 | 1494 – 1631 |
| Parsons | Parsons\_10b | GrM-14962 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Parsons\_10a | From Midden 3, square 209-534 | 353 | 30 | -9.2 |  |  | 1459 – 1635 | 1478 – 1626 |
| Seed-Barker | Seed Barker\_2 | GrM-14965 | 1 carbonized maize (*Zea mays*) kernel | From house 18, 136S 72W | 297 | 18 | -10.4 |  |  | 1516 – 1650 | 1524 – 1644 |
| Seed-Barker | Seed Barker\_4a | UGAMS-33003 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Seed Barker\_4b | Feature 100, part of a midden associated with House 13 in square 54S 78W | 335 | 21 | -10.27 |  |  | 1484 – 1637 | 1500 – 1633 |
| Seed-Barker | Seed Barker\_4b | GrM-14966 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Seed Barker\_4a | Feature 100, part of a midden associated with House 13 in square 54S 78W | 345 | 40 | -8.93 |  |  | 1460 – 1638 | 1485 – 1631 |
| Seed-Barker | Seed Barker\_5 | UGAMS-33004 | 1 carbonized maize (*Zea mays*) cob fragment | Feature "TA 3" in 66-62 | 350 | 20 | -10.2 |  |  | 1470 – 1635 | 1485 – 1624 |
| Seed-Barker | Seed Barker\_5 | UGAMS-33004ha | Humic acid from UGAMS-33004 | Feature "TA 3" in 66-62 | 357 | 21 | -10 |  |  | 1460 – 1633 | 1477 – 1623 |
| Damiani | Damiani\_1 | GrM-14936 | 1 carbonized maize (*Zea mays*) kernel | From the fill of postmold 18 in House 10, 390-200 | 280 | 20 | -8.5 |  |  | 1521 – 1662 | 1528 – 1651 |
| Damiani | Damiani\_14a | UGAMS-33005 | 1 carbonized maize (*Zea mays*) kernel | From the fill of feature 6, an irregular-shaped refuse pit in the center of House 3 in square 495-245 | 295 | 21 | -9.64 |  |  | 1513 – 1653 | 1524 – 1645 |
| Damiani | Damiani\_14a | UGAMS-33005r | Rerun of UGAMS-33005; 1 carbonized maize (*Zea mays*) kernel | From the fill of Feature 6, an irregular-shaped refuse pit in the center of House 3 in square 495-245 | 272 | 21 | -9.64 |  |  | 1522 – 1794 | 1529 – 1658 |
| Damiani | Damiani\_14b | GrM-14937 | 1 carbonized maize (*Zea mays*) kernel | From the fill of Feature 6, an irregular-shaped refuse pit in the center of House 3 in square 495-245 | 305 | 18 | -8.99 |  |  | 1511 – 1646 | 1524 – 1641 |
| Damiani | Damiani\_15 | UGAMS-33006 | 1 carbonized maize (*Zea mays*) kernel | From the fill of postmold 26 in House 1, square 505-195 | 330 | 221 | -8.89 |  |  | 1300 – ? | 1411 – ? |
| Damiani | Damiani\_17a | UGAMS-33007 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Damiani 17b | From the fill of Feature 64, a support post in the south bunkline of House 2, Square 490-215 | 311 | 20 | -9.09 |  |  | 1500 – 1645 | 1522 – 1639 |
| Damiani | Damiani\_17b | GrM-14938 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Damiani 17a | From the fill of Feature 64, a support post in the south bunkline of House 2, Square 490-215 | 298 | 20 | -9.26 |  |  | 1512 – 1650 | 1524 – 1644 |
| Mackenzie-Woodbridge | Mackenzie\_2 | UGAMS-40365 | 1 carbonized maize (*Zea mays*) kernel | Feature 10 in House 6 (Squares 16N 24E, 16N 26E) | 301 | 21 | -9 | 6.86 |  | 1506 – 1650 | 1524 – 1643 |
| Mackenzie-Woodbridge | Mackenzie\_3a | UGAMS-434443 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Mackenzie\_3b | Feature 81, Square N75-E50 | 338 | 21 | -9.49 |  |  | 1480 – 1636 | 1499 – 1631 |
| Mackenzie-Woodbridge | Mackenzie\_3b | UGAMS-40366 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Mackenzie\_3a | Feature 81, Square N75-E50 | 287 | 20 | -9.66 | 4.2 |  | 1520 – 1658 | 1526 – 1650 |
| Mackenzie-Woodbridge | Mackenzie\_4 | UGAMS-34444 | 1 carbonized maize (*Zea mays*) kernel | From level 2 (6-9in.) of Square S195 E65 | 339 | 21 | -9.82 |  |  | 1480 – 1636 | 1498 – 1631 |
| Skandatut | Skandatut\_2 | UGAMS-42536 | 1 carbonized maize (*Zea mays*) kernel | From a floatation sample taken from general trench backdirt | 350 | 20 | -9.39 |  |  | 1470 – 1635 | 1485 – 1624 |
| Skandatut | Skandatut\_3 | UGAMS-42540 | 1 carbonized maize (*Zea mays*) cupule fragment | From a floatation sample taken from general trench backdirt | 351 | 20 | -10.16 |  |  | 1467 – 1635 | 1485 – 1623 |
| **DON** |  |  |  |  |  |  |  |  |  |  |  |
| Walkington 2 | Walkington2\_3 | UGAMS-32989 | 1 carbonized maize (*Zea mays*) kernel fragment | From Feature 179, an irregular-shaped pit in the south end of House 3 | 343 | 21 | -9.93 |  |  | 1476 – 1636 | 1493 – 1631 |
| Walkington 2 | Walkington2\_4 | UGAMS-32990 | Unidentified carbonized botanical sample; originally identified as carbonized maize (*Zea mays*), but 13C value suggests that this identification is incorrect. | From a living floor surface in the NW quad of F193, a semi-subterranean sweatlodge attached to House 1 in Square 550-220 | 373 | 21 | -26.57 |  |  | 1453 – 1629 | 1460 – 1617 |
| Walkington 2 | Walkington2\_1 | GrM-14967 | 1 carbonized maize (*Zea mays*) cupule | From the fill of feature 107, a support post in the southern part of House 1 in Square 515-215 | 359 | 20 | -9.46 |  |  | 1460 – 1632 | 1477 – 1621 |
| Walkington 2 | Walkington2\_2 | GrM-14968 | 1 carbonized maize (*Zea mays*) kernel fragment | From the fill of feature 165, an circular-to-irregular shaped pit in the southern end of House 3 in Square 245-225 | 365 | 20 | -8.93 |  |  | 1457 – 1631 | 1471 – 1620 |
| Baker | Baker\_7 | GrM-14540 | 1 carbonized maize (*Zea mays*) kernel | From the living floor in the southeast quadrant of F201, a semisubterranean sweatlodge inside House 2 in Square 460N 225E | 377 | 20 | -10.51 |  |  | 1452 – 1625 | 1459 – 1615 |
| Baker | Baker\_6 | UGAMS-32992 | 1 carbonized maize (*Zea mays*) kernel | From feature 32, a support post in the northern end of House 1 in Square 505N 200E | 387 | 21 | -9.31 |  |  | 1447 – 1623 | 1455 – 1611 |
| Baker | Baker\_3a | UGAMS-32991 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Baker\_3b | From the living floor in the SW quadrant of Feature 286, a semi-subterranean sweatlodge inside House 4 in square 495N 180E | 364 | 21 | -9.4 |  |  | 1457 – 1631 | 1473 – 1620 |
| Baker | Baker\_3b | GrM-14538 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Baker\_3a | From the living floor in the SW quadrant of Feature 286, a semisubterranean sweatlodge inside House 4 in Square 495N 180E | 387 | 20 | -9.09 |  |  | 1448 – 1621 | 1455 – 1610 |
| McNair | McNair\_1 | GrM-14960 | 1 carbonized maize (*Zea mays*) kernel fragment | From Feature 10, a support post located near the center of House 1 in square 570-345 | 316 | 18 | -9.31 |  |  | 1500 – 1644 | 1521 – 1637 |
| McNair | McNair\_5 | UGAMS-32995 | 1 carbonized maize (*Zea mays*) cob fragment | From the bulk between quadrants 1 and 2 of Feature 196, a semisubterranean sweatlodge located inside House 4 | 360 | 21 | -9.7 |  |  | 1459 – 1632 | 1476 – 1622 |
| McNair | McNair\_8a | UGAMS-32994 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate McNair 8b | From the NW quadrant of Feature 78, a refuse pit located under the east bunkline of House 2, in square 590-320 | 343 | 25 | -10.32 |  |  | 1475 – 1636 | 1492 – 1631 |
| McNair | McNair\_8b | GrM-14961 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate McNair 8a | From the NW quadrant of Feature 78, a refuse pit located under the east bunkline of House 2, in square 590-320 | 373 | 20 | -9.56 |  |  | 1455 – 1625 | 1460 – 1617 |
| HopeN | HopeN\_1 | GrM-14943 | 1 carbonized maize (*Zea mays*) kernel | From Feature 302, an ash pit adjacent to a central hearth in the southern end of House 1 in square 485-430 | 352 | 18 | -8.88 |  |  | 1471 – 1634 | 1483 – 1623 |
| HopeN | HopeN\_11 | UGAMS-32999 | 1 carbonized maize (*Zea mays*) cob fragment | From Feature 387, a support post in the northern end of House 6 in Square 480-400 | 358 | 21 | -10.22 |  |  | 1460 – 1632 | 1476 – 1622 |
| HopeN | HopeN\_4a | UGAMS-32998 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate HopeN\_4b | From F103, an ovate-shaped hearth in the northern end of House 4 in Square 595-415 | 337 | 21 | -9.52 |  |  | 1481 – 1636 | 1499 – 1632 |
| HopeN | HopeN\_4b | GrM-14944 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate HopeN\_4a | From F103, an ovate-shaped hearth in the northern end of House 4 in Square 595-415 | 377 | 18 | -8.99 |  |  | 1453 – 1624 | 1459 – 1615 |
| HopeS | HopeS\_2a | UGAMS-33000 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate HopeS\_2b | From the fill of Feature 21, a support post near the center of House 1 in square 510-365 | 373 | 21 | -9.55 |  |  | 1453 – 1629 | 1460 – 1617 |
| HopeS | HopeS\_2b | GrM-14947 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate HopeS\_2a | From the fill of Feature 21, a support post near the center of House 1 in Square 510-365 | 388 | 17 | -8.48 |  |  | 1449 – 1619 | 1456 – 1607 |
| HopeS | HopeS\_6a | UGAMS-33002 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate HopeS\_6b | From the fill of F106, a support post in the southern end of House 2 in Square 525-440 | 393 | 21 | -8.01 |  |  | 1445 – 1621 | 1452 – 1607 |
| HopeS | HopeS\_6b | GrM-14948 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate HopeS\_6a | From the fill of F106, a support post in the southern end of House 2 in Square 525-440 | 383 | 18 | -7.8 |  |  | 1451 – 1621 | 1457 – 1611 |
| Orion | Orion\_2 | UGAMS-35633 | Bone, collagen, white-tailed deer (*Odocoileus virginianus*) phalanx, distal end, indeterminate side | From F77, a shallow, ovate-shaped pit in House 3 in Square 470-220 | 330 | 20 | -22.64 | 3.916 | 3.2 | 1490 – 1639 | 1505 – 1634 |
| Orion | Orion\_3 | UGAMS-35634 | Bone, collagen, white-tailed deer (*Odocoileus virginianus*) tibia, distal end fragment, indeterminate side | From Feature 3, a shallow basin-shaped pit inside of House 2 in Square 495-195 | 385 | 19 | -22.08 | 6.603 | 3.3 | 1450 – 1621 | 1456 – 1612 |
| Murphy-Goulding | Murphy-Goulding\_1 | UGAMS-34441 | 1 carbonized maize (*Zea mays*) kernel | From Quadrant 3 of Feature 74, a semi-subterranean sweatlodge located inside of House 1 in Square 490-120 | 358 | 21 | -9.68 |  |  | 1460 – 1632 | 1476 – 1622 |
| Murphy-Goulding | Murphy-Goulding\_2 | UGAMS-34442 | 1/2 of a carbonized maize (*Zea mays*) kernel | From Feature 120, an irregular-shaped pit located in an external activity area which has been interpreted as a plant-food processing feature. | 352 | 22 | -9.07 |  |  | 1460 – 1635 | 1481 – 1623 |
| Keffer | Keffer\_8a | UGAMS-32997 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Keffer\_8b | From House 7, Square 500-525 | 288 | 28 | -12.13 |  |  | 1504 – 1662 | 1524 – 1651 |
| Keffer | Keffer\_8a | UGAMS-32997r | Rerun of UGAMS-32997; 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Keffer\_8b | From House 7, Square 500-525 | 278 | 21 | -12.13 |  |  | 1521 – 1792 | 1528 – 1653 |
| Keffer | Keffer\_8b | GrM-14956 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Keffer\_8a | From House 7, Square 500-525 | 324 | 20 | -7.96 |  |  | 1494 – 1640 | 1515 – 1635 |
| Keffer | Keffer\_5 | UGAMS-32996 | 1 carbonized maize (*Zea mays*) kernel | From House 1, Square 520-495 | 305 | 20 | -9.43 |  |  | 1506 – 1648 | 1524 – 1641 |
| Keffer | Keffer\_12 | GrM-14955 | 1 carbonized maize (*Zea mays*) kernel | From House 8, Square 490-520 | 317 | 18 | -9.48 |  |  | 1500 – 1643 | 1521 – 1637 |
| Keffer | Keffer-AkGv-14-1 | UGAMS-26746r | 1 carbonized maize (*Zea mays*) kernel | From Feature 45 in House 1, Square 520-505 | 318 | 20 | -9.58 |  |  | 1497 – 1643 | 1520 – 1637 |
| Keffer | Keffer-AkGv-14-2 | UGAMS-26747r | 1 carbonized maize (*Zea mays*) kernel | From House 9, Square 455-540 | 305 | 20 | -10.17 |  |  | 1506 – 1648 | 1524 – 1641 |
| Jarrett-Lahmer | Jarrett-Lahmer\_1 | UGAMS-40355 | 1 carbonized maize (*Zea mays*) kernel | From Level 3 of a midden deposit in Square 508-175 | 326 | 20 | -8.52 |  |  | 1491 – 1640 | 1510 – 1635 |
| Jarrett-Lahmer | Jarrett-Lahmer\_2 | UGAMS-40356 | 1 carbonized maize (*Zea mays*) kernel | From the top organic layer in quadrant 1 of Feature 4 | 298 | 20 | -9.86 | 5.37 |  | 1512 – 1650 | 1524 – 1644 |
| Jarrett-Lahmer | Jarrett-Lahmer\_3 | UGAMS-40357 | 1 carbonized maize (*Zea mays*) kernel | From Level 4 of a midden deposit in Square 546-174 | 272 | 20 | -9.25 | 4.96 |  | 1522 – 1794 | 1529 – 1658 |
| Jarrett-Lahmer | Jarrett-Lahmer\_4 | UGAMS-40358 | 1 carbonized maize (*Zea mays*) kernel | From Level 4 of a midden deposit in Square 548-173 | 322 | 21 | -7.95 | 6.43 |  | 1495 – 1641 | 1516 – 1636 |
| **TRENT** |  |  |  |  |  |  |  |  |  |  |  |
| Warminster | Warminster F13 Rings 9-17 | Wk-42865 | Rings 9-17 of a fragment of a *Larix laricina* post | A support post for the western bunkline of House 4, found inside Feature 13, an irregular-shaped storage/refuse pit, in the north village | 355 | 17 |  |  |  | 1470 – 1633 | 1481 – 1621 |
| Warminster | Warminster F13 Rings 19-27 | Wk-42866 | Rings 19-27 of a fragment of a *Larix laricina* post | A support post for the western bunkline of House 4, found inside Feature 13, an irregular-shaped storage/refuse pit, in the north village | 325 | 15 |  |  |  | 1499 – 1639 | 1515 – 1634 |
| Warminster | Warminster F13 Rings 29-37 | Wk-42867 | Rings 29-37 of a fragment of a *Larix laricina* post | A support post for the western bunkline of house 4, found inside Feature 13, an irregular-shaped storage/refuse pit, in the north village | 349 | 13 |  |  |  | 1478 – 1632 | 1491 – 1623 |
| Warminster | Warminster F13 Rings 39-47 | Wk-42868 | Rings 39-47 of a fragment of a *Larix laricina* post | A support post for the western bunkline of House 4, found inside Feature 13, an irregular-shaped storage/refuse pit, in the north village | 321 | 15 |  |  |  | 1500 – 1640 | 1520 – 1635 |
| Warminster | Warminster F13 Rings 49-57 | Wk-42869 | Rings 49-57 of a fragment of a *Larix laricina* post | A support post for the western bunkline of House 4, found inside Feature 13, an irregular-shaped storage/refuse pit, in the north village | 317 | 14 |  |  |  | 1507 – 1641 | 1522 – 1636 |
| Warminster | Warminster Feature 12 | VERA-6310 | 1 fragment of carbonized plum (*Prunus americana*) pit | From Feature 12, a circular, basin-shaped feature interpreted as a possible hearth in House 4 in the north village | 334 | 28 | -27.6 |  |  | 1479 – 1639 | 1497 – 1634 |
| Warminster | Warminster Feature 12 | VERA-6310\_2 | Rerun of VERA-6310; 1 fragment of carbonized plum (*Prunus americana*) pit | From Feature 12, a circular, basin-shaped feature interpreted as a possible hearth in House 4 in the north village | 340 | 31 | 27 |  |  | 1472 – 1639 | 1494 – 1632 |
| Warminster | Warminster-2 | UGAMS-25451-u | 1 carbonized plum (*Prunus americana*) pit, no pretreatment ("An aliquot of the original un-pretreated sample was combusted, without additional pretreatment, at 900° C in an | From Feature 12, a circular, basin-shaped feature interpreted as a possible hearth in House 4 in the north village | 365 | 21 | -27.61 |  |  | 1457 – 1631 | 1471 – 1620 |
| Warminster | Warminster-2 | UGAMS-25451-r2 | 1 carbonized plum (*Prunus americana*) pit, realanysis, single pretreatment ("An aliquot of the original un-pretreated sample was combusted, without additional pretreatment, at 900° C in an evacuated and sealed quartz tube in the presence of CuO to produce CO2. | From Feature 12, a circular, basin-shaped feature interpreted as a possible hearth in House 4 in the north village | 355 | 22 | -27.27 |  |  | 1460 – 1633 | 1479 – 1623 |
| Warminster | Warminster-2 | UGAMS-25451-r2r | 1 carbonized plum (*Prunus americana*) pit, reanalysis, double pretreatment ("The remnants of UGAMS25451-r2 (above) was subjected to a second AAA treatment protocol and combusted at 900° C in an evacuated and sealed quartz tube in the presence of CuO to produce CO2.") | From Feature 12, a circular, basin-shaped feature interpreted as a possible hearth in House 4 in the north village | 368 | 21 | -27.81 |  |  | 1456 – 1631 | 1467 – 1619 |
| Warminster | Warminster-2 | UGAMS-25451-rr | 1 carbonized plum (*Prunus americana*) pit, re-measurement of original, double pretreatment ("A remnant of the original pretreated sample was subjected to a second AAA treatment protocol and combusted at 900° C in an evacuated and sealed quartz tube in the presence of CuO to produce CO2.") | From Feature 12, a circular, basin-shaped feature interpreted as a possible hearth in House 4 in the north village | 346 | 21 | -27.96 |  |  | 1474 – 1635 | 1490 – 1629 |
| Warminster | Warminster Feature 16B | VERA-6309\_1 | 1 carbonized bean (*Phaseolus* sp.) | From Feature 16B, a basin-shaped storage/refuse pit inside House 4 in the north village | 314 | 28 | -22.7 |  |  | 1490 – 1647 | 1516 – 1640 |
| Warminster | Warminster Feature 16B | VERA-6309\_2 | 1 carbonized bean (*Phaseolus* sp.) | From Feature 16B, a basin-shaped storage/refuse pit inside House 4 in the north village | 311 | 28 | -24.7 |  |  | 1491 – 1649 | 1520 – 1640 |
| Warminster | Warminster Feature 16B | VERA-6309\_3 | 1 carbonized bean (*Phaseolus* sp.) | From Feature 16B, a basin-shaped storage/refuse pit inside House 4 in the north village | 374 | 40 | -26.8 |  |  | 1446 – 1635 | 1456 – 1623 |
| Warminster | Warminster-1 | UGAMS-25450 | 1 carbonized bean (*Phaseolus* sp.) | From Feature 16B, a basin-shaped storage/refuse pit inside House 4 in the north village | 363 | 22 | -24.6 |  |  | 1457 – 1632 | 1474 – 1620 |
| Warminster | Warminster-4 | UGAMS-34181 | 1 carbonized maize (*Zea mays*) kernel | From Feature 30C, an ovate-shaped storage/refuse pit in House 9 in the north village | 365 | 21 | -9.46 |  |  | 1457 – 1631 | 1471 – 1620 |
| Warminster | Warminster-8 | UGAMS-34182 | 1 carbonized maize (*Zea mays*) kernel | From Feature 1, an ovate storage/refuse pit in House 5 in the north village | 326 | 21 | -10.85 |  |  | 1490 – 1640 | 1510 – 1635 |
| Jamieson | Jamieson\_12a | UGAMS-33014 | 1 carbonized maize (*Zea mays*) kernel | From a test unit in Midden 205, Square 500-145 | 298 | 22 | -9.41 |  |  | 1507 – 1653 | 1524 – 1644 |
| Jamieson | Jamieson\_12c | GrM-14952 | 1 carbonized maize (*Zea mays*) kernel | From a test unit in Midden 205, Square 500-145 | 353 | 20 | -8.03 |  |  | 1465 – 1634 | 1480 – 1623 |
| Jamieson | Jamieson\_12b | GrM-14949 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Jamieson 12d | From a test unit in Midden 205, Square 500-145 | 311 | 18 | -8.6 |  |  | 1505 – 1645 | 1522 – 1639 |
| Jamieson | Jamieson\_12d | UGAMS-33015 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Jamieson 12b | From a test unit in Midden 205, Square 500-145 | 334 | 21 | -8.67 |  |  | 1485 – 1637 | 1500 – 1633 |
| Kirche | Kirche\_2b | GrM-14957 | Unidentified carbonized botanical sample; originally identified as carbonized maize (*Zea mays*), but 13C value suggests that this identification is incorrect. | From Midden 11 in Square 265-215, just inside and against the site's western palisade | 264 | 20 | -28.76 |  |  | 1525 – 1796 | 1636 – 1661 |
| Kirche | Kirche | UGAMS-21918 | 1 carbonized maize (*Zea mays*) kernel; originally identified as unidentified wood charcoal, but 13C value suggests maize. | From House 15 Square 275-140, in a cluster of houses and middens located outside of the site's palisade | 285 | 21 | -8.5 |  |  | 1517 – 1660 | 1526 – 1650 |
| Kirche | Kirche\_3a | UGAMS-33013 | 1/2 of a carbonized maize (*Zea mays*) kernel | From Square 275-175 in Midden 9, in a cluster of houses and middens located outside of the site palisade | 315 | 21 | -9.4 |  |  | 1497 – 1644 | 1521 – 1638 |
| Kirche | Kirche\_3b | GrM-14958 | 1/2 of a carbonized maize (*Zea mays*) kernel | From Square 275-175 in Midden 9, in a cluster of houses and middens located outside of the site palisade | 293 | 18 | -9.39 |  |  | 1519 – 1653 | 1526 – 1646 |
| Benson | Benson\_10 | GrM-14541 | 1 carbonized maize (*Zea mays*) kernel | From Feature 1 in the eastern extension of House 10, early occupation of the site | 323 | 20 | -8.87 |  |  | 1495 – 1640 | 1515 – 1636 |
| Benson | Benson\_11 | UGAMS-33017 | 1 carbonized maize (*Zea mays*) kernel | From Feature 2 in House 10, Square 195-340, in the early occupation of the site | 320 | 21 | -8.98 |  |  | 1495 – 1642 | 1518 – 1636 |
| Benson | Benson\_9a | UGAMS-33016 | 1 carbonized maize (*Zea mays*) cob fragment | From the intact floor of House 6 in Square 250-340, beneath Midden 63 | 304 | 21 | -9.76 |  |  | 1505 – 1649 | 1523 – 1641 |
| Benson | Benson\_9a | UGAMS-33016ha | Humic acid from UGAMS-33016 | From the intact floor of House 6 in Square 250-340, beneath Midden 63 | 307 | 21 | -10.26 |  |  | 1502 – 1648 | 1523 – 1641 |
| Benson | Benson\_4 | UGAMS-33019 | 1 carbonized maize (*Zea mays*) kernel | From Feature 2 in the extension of House 14, Square 260-310; in the late occupation of the site | 289 | 21 | -9.27 |  |  | 1516 – 1658 | 1525 – 1649 |
| Benson | Benson\_4 | UGAMS-33019r | Rerun of UGAMS-33019; 1 carbonized maize (*Zea mays*) kernel | From Feature 2 in the extension of House 14, Square 260-310; in the late occupation of the site | 304 | 21 | -9.27 |  |  | 1505 – 1649 | 1523 – 1641 |
| Benson | Benson\_4 | UGAMS-33019ha | Humic acid from UGAMS-33019 | From Feature 2 in the extension of House 14, Square 260-310; in the late occupation of the site | 314 | 21 | -9.92 |  |  | 1498 – 1644 | 1521 – 1638 |
| Benson | Benson\_8a | UGAMS-33018 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Benson\_8b | From Level 1 (0-10 cm) of Midden 63, overlying House 6; from the later occupation of the site | 302 | 21 | -9.28 |  |  | 1506 – 1650 | 1524 – 1642 |
| Benson | Benson\_8b | GrM-14544 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Benson\_8a | From Level 1 (0-10 cm) of Midden 63, overlying House 6; from the later occupation of the site | 305 | 20 | -7.97 |  |  | 1506 – 1648 | 1524 – 1641 |
| Coulter | Coulter\_4 | UGAMS-32755 | 1 carbonized maize (*Zea mays*) kernel | From Midden 57, associated with a longhouse in the 2nd expansion of the site | 307 | 25 | -9.47 |  |  | 1496 – 1649 | 1521 – 1642 |
| Coulter | Coulter\_5 | UGAMS-32756 | 1 carbonized maize (*Zea mays*) kernel | From Midden 55, associated with a house in the village core | 318 | 25 | -9.31 |  |  | 1490 – 1644 | 1517 – 1637 |
| Coulter | Coulter\_8a | UGAMS-32757 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Coulter\_8b | From Midden 70, in expansion 4,built up against the outside of the palisade enclosing the village core | 345 | 25 | -9.28 |  |  | 1473 – 1636 | 1490 – 1630 |
| Coulter | Coulter\_8b | GrM-14933 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Coulter\_8a | From Midden 70, in expansion 4,built up against the outside of the palisade enclosing the village core | 276 | 20 | -8.57 |  |  | 1522 – 1792 | 1528 – 1655 |
| Coulter | Coulter\_9a | UGAMS-32758 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Coulter\_9b | From Midden 71, built up against the inside of the palisade encircling the first expansion of the site | 313 | 25 | -9.64 |  |  | 1495 – 1645 | 1520 – 1639 |
| Coulter | Coulter\_9b | GrM-14934 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Coulter\_9a | From Midden 71, built up against the inside of the palisade encircling the first expansion of the site | 305 | 20 | -9.39 |  |  | 1506 – 1648 | 1524 – 1641 |
| Coulter | Coulter\_10 | UGAMS-32759 | 1 carbonized maize (*Zea mays*) kernel | From Midden 71, built up against the inside of the palisade encircling the first expansion of the site | 323 | 25 | -8.94 |  |  | 1490 – 1642 | 1514 – 1636 |
| Coulter | Coulter\_13a | UGAMS-32760 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Coulter\_13b | From Midden 60, built up against the inside of the palisade encircling the second expansion of the village | 296 | 25 | -9.14 |  |  | 1504 – 1657 | 1524 – 1645 |
| Coulter | Coulter\_13b | GrM-14548 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Coulter\_13a | From Midden 60, built up against the inside of the palisade encircling the second expansion of the village | 298 | 18 | -9 |  |  | 1516 – 1650 | 1524 – 1644 |
| Coulter | Coulter\_18a | UGAMS-32761 | 1/2 of a carbonized hawthorn (*Crataegus* sp.) seed. Replicate Coulter\_18b | From the subsoil of F78 in House 12, the only structure in the third expansion of the site | 330 | 25 | -26.63 |  |  | 1484 – 1639 | 1504 – 1635 |
| Coulter | Coulter\_18b | GrM-14928 | 1/2 of a carbonized hawthorn (*Crataegus* sp.) seed. Replicate Coulter\_18a | From the subsoil of Feature 78 in House 12, the only structure in the third expansion of the site | 391 | 20 | -26.15 |  |  | 1446 – 1620 | 1454 – 1607 |
| Coulter | Coulter\_19 | UGAMS-32762 | 1 carbonized maize (*Zea mays*) kernel | From the subsoil of F1 in House 12, the only structure in the third expansion of the site | 309 | 25 | -9.03 |  |  | 1495 – 1648 | 1521 – 1641 |
| Coulter | Coulter\_22a | UGAMS-32763 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Coulter\_22b | From Feature 1 in House 8 in the site core | 362 | 30 | -9.78 |  |  | 1455 – 1635 | 1471 – 1623 |
| Coulter | Coulter\_22b | GrM-14931 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Coulter\_22a | From Feature 1 in House 8 in the site core | 334 | 18 | -8.78 |  |  | 1490 – 1637 | 1505 – 1632 |
| Coulter | Coulter\_23 | UGAMS-32764 | 1 carbonized maize (*Zea mays*) kernel | From Midden 76, associated with a house in the fourth expansion of the site | 296 | 25 | -9.81 |  |  | 1504 – 1657 | 1524 – 1645 |
| Coulter | Coulter\_20 | GrM-14929 | 1 carbonized maize (*Zea mays*) kernel | From 30-40 cm level of Midden 78, located in the fourth expansion of the site | 335 | 18 | -9.16 |  |  | 1487 – 1637 | 1503 – 1632 |
| Dawn | Dawn\_1 | UGAMS-33010 | 1 carbonized maize (*Zea mays*) kernel | From Level 1 of Subsquare 3 in Midden 204 | 352 | 21 | -9.59 |  |  | 1460 – 1635 | 1482 – 1623 |
| Dawn | Dawn\_2 | GrM-14939 | 1 carbonized maize (*Zea mays*) kernel | From Level 2 of Subsquare 3 in Midden 204 | 347 | 18 | -8.2 |  |  | 1474 – 1635 | 1491 – 1626 |
| Dawn | Dawn\_6a | UGAMS-33011 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Dawn\_6b | From Subsquare 2 of Midden 205 | 354 | 21 | -8.48 |  |  | 1462 – 1634 | 1480 – 1623 |
| Dawn | Dawn\_6b | GrM-14941 | 1/2 of a carbonized maize (*Zea mays*) kernel. Replicate Dawn\_6a | From Subsquare 2 of Midden 205 | 346 | 20 | -8.71 |  |  | 1474 – 1635 | 1490 – 1628 |
| Ball | Ball\_2 | UGAMS-34183 | 1 carbonized maize (*Zea mays*) kernel | From Feature 4 of House 11 in the village core | 353 | 22 | -11.37 |  |  | 1460 – 1634 | 1480 – 1623 |
| Ball | Ball\_3 | UGAMS-34184 | 1 carbonized maize (*Zea mays*) kernel | From Feature 76 of House 17 in the village core | 344 | 22 | -9.28 |  |  | 1475 – 1636 | 1491 – 1631 |
| Ball | Ball\_6 | UGAMS-34179 | 1 carbonized maize (*Zea mays*) kernel | From Feature 34 of House 25 in the expanded section of the village | 358 | 21 | -9.73 |  |  | 1460 – 1632 | 1476 – 1622 |
| Ball | Ball\_6\_UGAMS-34179n | UGAMS-34179n | 1 carbonized maize (*Zea mays*) kernel; reanalysis of remaining sample from UGAMS-34179; different round of pretreatment on same kernel of maize | From Feature 34 of House 25 in the expanded section of the village | 351 | 21 | -9.28 |  |  | 1466 – 1635 | 1484 – 1624 |
| Ball | Ball\_7 | UGAMS-34180 | 1 carbonized maize (*Zea mays*) kernel | From Feature 35 of House 21 in the expanded section of the village | 307 | 22 | -10.39 |  |  | 1500 – 1649 | 1522 – 1641 |
| Ball | Ball\_7\_UGAMS-34180n | UGAMS-34180n | 1 Carbonized maize (*Zea mays*) kernel; reanalysis of remaining sample from UGAMS-34180; different round of pretreatment on same kernel of maize | From Feature 35 of House 21 in the expanded section of the village | 298 | 19 | -9.34 |  |  | 1515 – 1650 | 1524 – 1644 |
| Ball | Ball\_7\_UGAMS-34180r | UGAMS-34180r | 1 carbonized maize (*Zea mays*) kernel; reanalysis of remaining treated sample from UGAMS-34180; second AMS measurement on leftover material from same pretreatment as UGAMS-34180 | From Feature 35 of House 21 in the expanded section of the village | 325 | 19 | -10.4 |  |  | 1494 – 1640 | 1514 – 1635 |
| Ball | Ball\_2\_UGAMS-34183n | UGAMS-34183n | 1 carbonized maize (*Zea mays*) kernel; reanalysis of remaining sample from UGAMS-34183; different round of pretreatment on same kernel of maize | From F4 of House 11 in the village core | 333 | 19 | -10.62 |  |  | 1489 – 1637 | 1504 – 1633 |
| Ball | Ball\_3\_UGAMS-34184n | UGAMS-34184n | 1 carbonized maize (*Zea mays*) kernel; reanalysis of remaining sample from UGAMS-34184; different round of pretreatment on same kernel of maize | From F76 of House 17 in the village core | 353 | 19 | -8.74 |  |  | 1468 – 1634 | 1480 – 1623 |
| Sopher | Sopher\_3 | UGAMS-40154 | 1 carbonized maize (*Zea mays*) kernel | No specific provenience beyond site level | 287 | 23 | -9.1 |  |  | 1515 – 1659 | 1525 – 1651 |
| Sopher | Sopher\_4 | UGAMS-40155 | 1 carbonized maize (*Zea mays*) kernel | No specific provenience beyond site level | 323 | 23 | -9.28 |  |  | 1492 – 1642 | 1515 – 1636 |

**Supplemental Table 2.** Descriptive information for all sites dated in this study.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Site Name** | **Site ID** | **Sequence** | **Nature of investigation** | **Evidence for Coalescence and Conflict** | | | | **European-manufactured goods** | **Primary References** |
| **Palisade** | **Site size (ha)** | **Defensive Location** | **Human remains indicative of violence** |
| Baker | AkGu-15 | Don Valley | CRM (cultural resource management); full excavation | no | 1 | no | no | no | ASI 2006 |
| Walkington 2 | AlGu-341 | Don Valley | CRM; full excavation | no | 0.7 | no | no | no | ASI 2011a |
| McNair | AlGu-8 | Don Valley | CRM; full excavation | no | 1 | no | no | no | ASI 2012 |
| Hope | AlGv-199 | Don Valley | CRM; full excavation | no; one area has a partial internal palisade or "fence" | 3 total; north component 1.5; south component 1.2 | no | no | no | ASI 2011b |
| Orion-Murphy Goulding | AlGu-45 and AlGu-3 | Don Valley | CRM; partial excavation | no | 3 | no | no | no | ASI 1998, 2008; This Land Archaeology Inc. 2016 |
| Keffer | AkGv-14 | Don Valley | Professional excavation; completely excavated | yes; evidence for at least one palisade expansion | 2.5 | no | yes, 1000+  scattered human remains from midden context | no | Finalyson et al. 1987; Williamson 2007 |
| Jarrett-Lahmer | AlGv-18 | Don Valley | CRM; survey and partial excavation | yes; double palisade, sections located 10m apart suggests expansion | 1.2 | yes; on a narrow promontory between 2 tributaries of the Don river | yes; scattered in midden deposits, some with cut marks | no | ASI 2001; DPA 2003 |
| Black Creek | AkGv-11 | Middle Humber River | Field school; partial excavation of mainly middens | yes; double palisade | 2 | yes; on a creek terrace, with the slope forming one boundary of the site | no | no; Emerson reported "two flakes of French copper kettle" (p. 142) but they are interpreted as intrusive or Native. | Emerson 1954 |
| Parsons | AkGv-8 | Middle Humber River | CRM; survey and partial excavation | yes; one to seven rows | 2.4 | no | yes; scattered and modified human remains in middens and features | no | Williamson and Robertson 1998 |
| Seed-Barker | AkGv-1 | Upper Humber River | Field schools; partial excavation | yes; up to seven rows, evidence of three separate construction events | 2 | yes; on a plateau above the Humber River | yes; one modified skull cap only) | yes; two European copper beads | Burgar 1989, 1993 |
| Damiani | AlGv-231 | Upper Humber River | CRM; nearly complete excavation | yes; two or three rows, evidence of palisade expansion | 1.5 | no | yes; cranial and phalanx fragments in midden | no | ASI 2015 |
| McKenzie-Woodbridge | AkGv-2 | Upper Humber River | Field schools; partial excavation | yes; two rows | 3.6 | yes; on end of a terrace above confluence of east and west branches of the Humber River | no | yes; 13 pieces of brass and other European metals | Johnson 1980 |
| Skandatut | AlGv-193 | Upper Humber River | CRM; partial excavation | yes; one or two rows | 2.6 | yes; on a promontory and flanked on 3 sides by steep slopes | no | yes; brass and glass beads | AMICK 2008; ASI 2014 |
| Jamieson | BcGr-2 | Trent Valley | Limited professional excavation | yes; earthwork with palisade on top along one side of site | total area unknown; approx. 0.4 excavated | no | no | no | Ramsden 1990, 2016a |
| Kirche | BcGr-1 | Trent Valley | Professional excavation; partially excavated; full settlement plan exposed | yes; two to three rows; evidence of palisade expansion | 1.4 | no | yes; human remains in midden and surface scatter | yes; one piece of European copper | Nasmith 2008; Ramsden 1990, 2016a |
| Benson | BdGr-1 | Trent Valley | Professional excavation, partially excavated; full settlement plan exposed | yes; 2-6 rows | 1.5 | no | no; scattered teeth and 1-2 fragments of human skull | yes; European metal | Ramsden 1990, 2009, 2016a, 2016b |
| Coulter | BdGr-6 | Trent Valley | Professional excavation; partially excavated; full settlement plan exposed | yes; one to five rows; evidence for four expansions | 3.3 | yes | yes | yes; European metal | Damkjar 2009; Ramsden 1990, 2016a |
| Dawn | BdGq-1 | Trent Valley | Limited professional excavation | unknown | approx.  1.5-2 | unknown | unknown | unknown | Ramsden 2016a |
| Sopher | BdGu-1 | Trent Valley | Professional excavation; partially excavated | no | 1.5 | no | yes | yes; an iron bar celt in ossuary conext and one knife point | Noble 1968, 1971 |
| Ball | BdGv-3 | Trent Valley | Professional and field school excavation; full settlement plan exposed | yes; three to seven rows; evidence for one expansion | 4 | no | no | yes; glass beads and European metal | Knight 1987; Fitzgerald et al. 1995; Michelaki et al. 2013 |
| Warminster | BdGv-1 | Trent Valley | Professional Excavation, partially excavated | yes, 2-7 rows about both sections of the site | 6.0; two separate components, 2.6 and 3.4 ha each | yes | no | yes; 1000+ beads, European metal | McIlwraith 1946; Sykes 1983 |
| Farrell | Hne016 | Seneca | Professional and avocational salvage excavation; partial excavation of burials and residential areas; Destroyed by 20th century mining operations | no | original size unknown, 0.2 ha remained after 19th century railroad construction | no | no | no | Hayes and Prisch 1973; Wray 1965 |
| Footer | Can029 | Seneca | Professional excavation; partial excavation of residential area | yes; single row, two 7-8 meter long sections excavated | 0.8 | yes; on a hilltop with one steep slope | no | no | Hayes 1962; 1963 |
| Belcher | Hne008 NYSM1038 | Seneca | Professional and avocational excavation and surface collection; partial excavation of burials and middens | no | 1.2-2.0 | yes; on a hilltop with one steep slope | yes; one secondary burial of a decapitated skull on top of a primary burial | no | Wray et al. 1987 |
| Richmond Mills | Hne005 NYSM1036 | Seneca | Professional excavation; partial excavation and surface collection of middens, residential areas, and burials | no | 2.0 | yes, on a hilltop with three steep slopes | yes, charred human remains in middens | yes, small amounts of European metal | Hamell 1966; Hayes 1967; Parker 1918 |
| Alhart | Bgn015 | Located north of Seneca region | Professional excavation and surface collection, partial excavation of burials and residential areas | no | unknown | no | yes, human remains in hearths and pit features, 15 decapitated skulls in one such feature; residential areas burned | no | Hamell 1977; Ritchie 1930 |
| Tram | Hne006 | Seneca | Professional excavation of burials; field school excavation of residential area; partial excavation | unclear; partial earthen embankment and ditch | 4 | yes; on a hilltop with two steep slopes | yes; one human skull gorget | yes; almost 300 pieces of European metal, nine glass beads | Wray et al. 1991 |
| Cameron | Hne029 | Seneca | Professional excavation and surface collection; partial excavation of burials, middens, and residential areas, field school excavations of residential areas | yes; one to three rows; two 16-22-meter-long sections excavated with evidence of a northward contraction | 2-3 | yes; on a hilltop with one steep slope | yes; one torture victim partially buried in cemetery | yes; almost 200 pieces of European metal, 500+ glass beads | Wray et al. 1991 |
| Factory Hollow | Hne007 | Seneca | Professional and avocational excavation and surface collection; partial excavation of burials, middens, and residential areas | no | 3.4 | yes; on a hilltop with three steep slopes | yes; two human skull rattle discs | yes; 400+ pieces of European metal, 13,000+ glass beads | Sempowski and Saunders 2001 |
| Kelso | Bwv012 | Onondaga | Professional excavation; partial excavation of residential area | yes; two circular palisades, each two to three rows, they overlap slightly, multiple sections of each palisade excavated | two separate segments, each 0.8 | no | yes, one human skull gorget | no | Ritchie and Funk 1973 |
| Howlett Hill | Syr012 | Onondaga | Professional and avocational salvage excavation and surface collection; partial excavation of residential area. Late 20th century construction of a housing development destroyed remainder of site | no, but partial earthen ditch | unknown; 0.7 remained after rerouting of a nearby stream. | no | no | no | Tuck 1971 |
| Schoff | Tly002 | Onondaga | Professional excavation; partial excavation of residential area | no | 0.8 | yes; on a hilltop with two steep slopes | no | no | Tuck 1971 |
| Bloody Hill | Tly005 | Onondaga | Professional and avocational and field school excavation; partial excavation of burials and residential area | no | 0.2 | yes; on a hilltop with three steep slopes | yes; human remains in roasting pit, some with evidence of butchering | no | Bradley 2005; Tuck 1971 |
| Christopher | Tly007 | Onondaga | Professional and avocational and field school excavation; Partial excavation of residential area | unclear | 0.4-1.0 | no | no | no | Bradley 2005; Tuck 1971 |
| Burke | Tly006 | Onondaga | Professional and avocational excavation and surface collection; partial excavation of residential area | yes, 7 rows; 3-6m of each row excavated, suggesting rebuilding event, with surrounding ditch | 0.8-1.6 | yes; on a hilltop with two steep slopes | yes; one carved human patella effigy; one longhouse burned | no | Bradley 2005; Tuck 1971 |
| Cemetery | Cza002 | Onondaga | Very limited professional and avocational and field school excavation and survey | no | 0.4 | yes; on a triangular hilltop with two steep slopes | no | no | Bradley 2005; Tuck 1971 |
| McNab | unknown | Onondaga | Avocational excavation and survey, very limited | no | 0.5-2.3 | yes; on a hilltop with one steep slope | no | no | Bradley 2005; Tuck 1971 |
| Barnes | Cza015 NYSM0628 | Onondaga | Professional and avocational and field school excavation and survey, partial excavation of burials and residential area | yes, 1 row, about 60m excavated across multiple trenches | 2.4-3.2 | yes; on a hilltop with one steep slope | yes; scattered human remains in middens | yes; one piece European metal | Bradley 2005; Gibson 1968; Tuck 1971 |
| Atwell | Cza001 NYSM0625 | Onondaga | Avocational excavation and surface collection, partial excavation of residential area | yes; 2 rows, 18m excavated, partial earthen ditch | 1.2 | yes; on a hilltop with three steep slopes | yes; one human skull gorget | yes; small amounts of European metal | Bradley 2005; Ricklis 1967; Tuck 1971 |
| Temperance House | Cza004 | Onondaga | Avocational excavation and surface collection; partial excavation of residential area | yes; one to two rows; partial earthen embankment and ditch | 1.8 | yes; on a hilltop with three steep slopes | no | yes; small amounts of European metal | Bradley 2005; Ricklis 1965; Tuck 1971 |
| Chase | Cza005 | Onondaga | Avocational excavation and surface collection; partial excavation of residential area | unclear | 1.6 | yes; on a hilltop with two steep slopes | no | yes; small amounts of European metal, at least 1 glass bead | Bradley 2005; LaFrance 1977; Ricklis 1966 |
| Pompey Center | Cza007 | Onondaga | Avocational excavation and surface collection, partial excavation of residential area | unclear | 0.8-1.6 | yes; on a hilltop with three steep slopes | yes; human remains in middens; two human skull gorgets, | yes;  over 300 pieces of European metal; over 1400 glass beads | Bradley 1977, 2005 |

**Supplemental Table 3.** OxCal runfiles for Middle and then Upper Humber Valley sequences. It should be noted that results from different OxCal runs can vary slightly. Because the Damiani site comprises earlier and later elements we use a Difference query to apply the overall site duration constraint via the LnN(ln(20),ln(2))prior (to the period between the start Boundary and the end Boundary for the site). We use the same approach in other cases with intra-Phase Sequences (see below). Sometimes the models find possible probability long after it is archaeologically/historically possible, e.g. after 1700 or 1800. In such cases we apply a constraint on the initial and final Boundaries to restrict the period of analysis, e.g.: Boundary("End Skandatut",Date(U(1300,1800))); This sets the period that is possible for the model anywhere (uniform probability) between 1300–1800. This is a wide range and neutral to the model, but excludes irrelevant very late possible probability (or the reverse). Note, in each of the models here with multiple site Phases we use a much higher (x100 from the OxCal default) “kIterations=3000;” value in the Options. This is to try to avoid model runs, in cases like these where there is not necessarily a clear/obvious solution (the whole issue across the ~1480–1620 plateau in the radiocarbon curve that we are dealing with), where either the model does not converge, or completes with poor Convergence solutions – the downside is that model runs take a long time to complete. Only model runs where elements exhibit good Convergence (C) ≥95 are used. (Note: our analyses use IntCal20. This is the default calibration curve for OxCal from summer 2020 until a future IntCal iteration. If a user is not using OxCal 4.4 and the IntCal20 default, then IntCal20 needs to be selected in OxCal (Tools>Options), or a call needs to be inserted in each of the runfiles below.)

Options()

{

Resolution=1;

kIterations=3000;

};

Plot()

{

Outlier\_Model("General",T(5),U(0,4),"t");

Outlier\_Model("SSimple",N(0,2),0,"s");

Sequence("Middle Humber")

{

Boundary("Start Black Creek");

Phase("Black Creek")

{

R\_Date("Black Creek\_1\_UGAMS-35635\_bone\_collagen", 351, 21)

{

Outlier("General",0.05);

};

R\_Date("Black Creek\_2\_UGAMS-35636\_bone\_collagen", 400, 20)

{

Outlier("General",0.05);

};

Interval("Interval Black Creek",LnN(ln(20),ln(2)));

Date("Date estimate Black Creek")

{

color="green";

};

};

Boundary("Transition Black Creek/Parsons");

Phase("Parsons")

{

R\_Date("Parsons\_1\_UGAMS-33008\_maize", 324, 21)

{

Outlier("General",0.05);

};

R\_Date("Parsons\_2\_GrM-14963\_maize", 334, 20)

{

Outlier("General",0.05);

};

R\_Combine("Parsons\_10",8)

{

Outlier("General",0.05);

R\_Date("Parsons\_10a\_UGAMS-33009\_maize\_split10b", 342, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("Parsons\_10b\_GrM-14962\_maize\_split10a", 353, 20)

{

Outlier("SSimple",0.05);

};

};

Interval("Interval Parsons",LnN(ln(20),ln(2)));

Date("Date estimate Parsons")

{

color="green";

};

};

Boundary("End Parsons");

};

Sequence("Upper Humber")

{

Phase(Upper Humber Precontact)

{

Sequence()

{

Boundary("Start Seed-Barker");

Phase("Seed-Barker")

{

R\_Combine("Seed-Barker\_5",8)

{

Outlier("General",0.05);

R\_Date("Seed-Barker\_5\_UGAMS3004\_maize", 350, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("Seed-Barker\_5\_ha\_UGAMS33004a\_humic\_acid", 357, 21)

{

Outlier("SSimple",0.05);

};

};

R\_Combine("Seed-Barker\_4",8)

{

Outlier("General",0.05);

R\_Date("Seed-Barker\_4a\_UGAMS33003\_split4b", 335, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("Seed-Barker\_4b\_GrM-14966\_maize\_split4a", 345, 40)

{

Outlier("SSimple",0.05);

};

};

R\_Date("Seed-Barker\_2\_GrM-14965\_maize", 297, 18)

{

Outlier("General",0.05);

};

Interval("Interval Seed-Barker",LnN(ln(20),ln(2)));

Date("Date estimate Seed-Barker")

{

color="green";

};

};

Boundary("End Seed-Barker");

};

Sequence()

{

Boundary("Start Damiani core");

Phase("Damiani core")

{

R\_Date("Damiani\_1\_GrM-14936", 280, 20);

R\_Date("Damiani\_15\_UGAMS-33006", 330, 21);

R\_Combine("Damiani\_17",8)

{

Outlier("General",0.05);

R\_Date("Damiani\_17a\_UGAMS-33007", 311, 20)

{

Outlier("SSimple",0.05);

};

R\_Date("Damiani\_17b\_GrM-14938", 298, 20)

{

Outlier("SSimple",0.05);

};

};

Interval("Interval Damiani core");

Date("Date estimate Damiani core")

{

color="green";

};

};

Boundary("Transition Damiani core/expansion");

Phase("Damiani expansion")

{

R\_Combine("Damiani\_14",8)

{

Outlier("General",0.05);

R\_Date("Damiani\_14a\_UGAMS-33005", 295, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("Damiani\_14ar\_UGAMS-33005", 272, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("Damiani\_14b\_GrM-14937", 305, 18)

{

Outlier("SSimple",0.05);

};

};

Interval("Interval Damiani expansion");

Date("Date estimate Damiani expansion")

{

color="green";

};

};

Boundary("End Damiani expansion");

};

Sequence()

{

Boundary("Start McKenzie");

Phase("McKenzie")

{

R\_Combine("Mackenzie\_3",8)

{

Outlier("General",0.05);

R\_Date("Mackenzie\_3a\_UGAMS-34443\_maize\_split3b", 338, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("Mackenzie\_3b\_UGAMS-40366\_maize\_split3a", 287, 20)

{

Outlier("SSimple",0.05);

};

};

R\_Date("Mackenzie\_4\_UGAMS-34444\_maize", 339, 21)

{

Outlier("General",0.05);

};

R\_Date("Mackenzie\_2\_UGAMS-40365\_maize", 301, 21)

{

Outlier("General",0.05);

};

Interval("Interval McKenzie",LnN(ln(20),ln(2)));

Date("Date estimate McKenzie")

{

color="green";

};

};

Boundary("End McKenzie");

};

};

Boundary("Transition Upper Humber Precontact/Upper Humber Indirect/Postcontact");

Phase("Upper Humber Postcontact")

{

Sequence()

{

Boundary("Start Skandatut");

Phase("Skandatut")

{

R\_Date("Skandatut\_2\_UGAMS-42539\_maize", 350, 20)

{

Outlier("General",0.05);

};

R\_Date("Skandatut\_2\_UGAMS-42540\_maize", 351, 20)

{

Outlier("General",0.05);

};

Interval("Interval Skandatut",LnN(ln(20),ln(2)));

Date("Date estimate Skandatut")

{

color="green";

};

};

Boundary("End Skandatut",Date(U(1300,1800)));

};

};

};

Difference("Duration Damiani Overall","End Damiani expansion","Start Damiani core",LnN(ln(20),ln(2)));

};

**Supplemental Table 4.** OxCal runfile for Don Valley sequence. See above on the modelling of the overall Hope site within a Normal Distribution prior of 20±10 years, applied via a Difference query between the start and end Boundaries (and for two alternatives). See Supplemental Table 12 for the outcomes for the Hope site from these three approaches. We also include Order queries within the two macro-groupings of Precoalescent and Coalescent (see Supplemental Table 9 for the former). We applied uniform probability constraint limits of 1200 to 1800 to the model.

Options()

{

Resolution=1;

kIterations=3000;

};

Plot()

{

Outlier\_Model("General",T(5),U(0,4),"t");

Outlier\_Model("SSimple",N(0,2),0,"s");

Sequence("Don Valley")

{

Boundary("Start Precoalescent",U(1200,1800));

Phase("Precoalescent")

{

Sequence("Sequence Walkington 2")

{

Boundary("Start Walkington 2");

Phase("Walkington 2")

{

R\_Date("Walkington2\_3\_UGAMS-32989", 343, 21)

{

Outlier("General",0.05);

};

R\_Date("Walkington2\_4\_UGAMS-32990\_UID", 373, 21)

{

Outlier("General",0.05);

};

R\_Date("Walkington2\_1\_GrM-14967\_maize", 359, 20)

{

Outlier("General",0.05);

};

R\_Date("Walkington2\_2\_GrM-14968\_maize", 365, 20)

{

Outlier("General",0.05);

};

Interval("Interval Walkington 2",LnN(ln(20),ln(2)));

Date("Date estimate Walkington 2")

{

color="green";

};

};

Boundary("End Walkington 2");

};

Sequence("Sequence Baker")

{

Boundary("Start Baker");

Phase("Baker")

{

R\_Date("Baker\_7\_GrM-14540\_maize", 377, 20)

{

Outlier("General",0.05);

};

R\_Date("Baker\_6\_UGAMS-32992", 390, 20)

{

Outlier("General",0.05);

};

R\_Combine("Baker\_3",8)

{

Outlier("General",0.05);

R\_Date("Baker\_3a\_UGAMS-32991\_maize\_split3b", 364, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("Baker\_3b\_GrM-14538\_maize\_split3a", 387, 20)

{

Outlier("SSimple",0.05);

};

};

Interval("Interval Baker",LnN(ln(20),ln(2)));

Date("Date estimate Baker")

{

color="green";

};

};

Boundary("End Baker");

};

Sequence("Sequence McNair")

{

Boundary("Start McNair");

Phase("McNair")

{

R\_Date("McNair\_1\_GrM-14960\_maize", 316, 18)

{

Outlier("General",0.05);

};

R\_Date("McNair\_5\_UGAMS-32995\_maize", 360, 21)

{

Outlier("General",0.05);

};

R\_Combine("McNair\_8",8)

{

Outlier("General",0.05);

R\_Date("McNair\_8a\_UGAMS-32994\_maize", 343, 25)

{

Outlier("SSimple",0.05);

};

R\_Date("McNair\_8b\_GrM-14961\_maize", 373, 20)

{

Outlier("SSimple",0.05);

};

};

Interval("Interval McNair",LnN(ln(20),ln(2)));

Date("Date estimate McNair")

{

color="green";

};

};

Boundary("End McNair");

};

Sequence("Sequence Hope")

{

Boundary("Start Hope");

Phase("Hope")

{

Sequence()

{

Boundary("Start Hope North");

Phase("Hope North")

{

R\_Date("HopeN\_1\_GrM-14943\_maize", 352, 18)

{

Outlier("General",0.05);

};

R\_Date("HopeN\_11\_UGAMS-32999", 358, 21)

{

Outlier("General",0.05);

};

R\_Combine("HopeN\_4",8)

{

Outlier("General",0.05);

R\_Date("HopeN\_4a\_UGAMS-32998\_maize\_split4b", 337, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("HopeN\_4b\_GrM-14944\_maize\_split4a", 377, 18)

{

Outlier("SSimple",0.05);

};

};

Interval("Interval Hope N",LnN(ln(20),ln(2)));

Date("Date estimate Hope North")

{

color="green";

};

};

Boundary("End Hope North");

};

Sequence()

{

Boundary("Start Hope South");

Phase("Hope South")

{

R\_Combine("HopeS\_2",8)

{

Outlier("General",0.05);

R\_Date("HopeS\_2a\_UGAMS-33000\_maize\_split2b", 373, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("HopeS\_2b\_GrM-14947\_maize\_split2a", 388, 17)

{

Outlier("SSimple",0.05);

};

};

R\_Combine("HopeS\_6",8)

{

Outlier("General",0.05);

R\_Date("HopeS\_6a\_UGAMS-33002\_maize\_split6b", 393, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("HopeS\_6b\_GrM-14948\_maize\_split6a", 383, 18)

{

Outlier("SSimple",0.05);

};

};

Interval("Interval Hope South",LnN(ln(20),ln(2)));

Date("Date estimate Hope South")

{

color="green";

};

};

Boundary("End Hope South");

};

};

Boundary("End Hope");

};

Sequence()

{

Boundary("Start Orion-Murphy Goulding");

Phase("Orion-Murphy Goulding")

{

R\_Date("Orion\_2\_UGAMS-35633\_bone", 330, 20)

{

Outlier("General",0.05);

};

R\_Date("Orion\_3\_UGAMS-35634\_bone", 385, 19)

{

Outlier("General",0.05);

};

R\_Date("Murphy-Goulding\_1\_UGAMS-34441\_maize", 358, 21)

{

Outlier("General",0.05);

};

R\_Date("Murphy-Goulding\_2\_UGAMS-34442\_maize", 352, 22)

{

Outlier("General",0.05);

};

Interval("Interval Orion-Murphy Goulding",LnN(ln(20),ln(2)));

Date("Date estimate Orion-Murphy Goulding")

{

color="green";

};

};

Boundary("End Orion-Murphy Goulding");

};

Interval("Interval Precoalescent");

Order("Order Precoalescent");

};

Boundary("Transition Precoalescent/Coalescent");

Phase("Coalescent")

{

Sequence("Sequence Keffer")

{

Boundary("Start Keffer");

Phase("Keffer")

{

R\_Combine("Keffer\_8",8)

{

Outlier("General",0.05);

R\_Date("Keffer\_8a\_UGAMS-32997\_maize\_split8b", 288, 28)

{

Outlier("SSimple",0.05);

};

R\_Date("Keffer\_8a\_UGAMS-32997r\_maize\_split8b", 278, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("Keffer\_8b\_GrM-14956\_maize\_split8a", 324, 20)

{

Outlier("SSimple",0.05);

};

};

R\_Date("Keffer\_5\_UGAMS-32996\_maize", 305, 20)

{

Outlier("General",0.05);

};

R\_Date("Keffer\_12\_GrM-14955\_maize", 317, 18)

{

Outlier("General",0.05);

};

R\_Date("Keffer\_UGAMS-26746r\_maize", 318, 20)

{

Outlier("General",0.05);

};

R\_Date("Keffer\_UGAMS-26747r\_maize", 305, 20)

{

Outlier("General",0.05);

};

Interval("Interval Keffer",LnN(ln(20),ln(2)));

Date("Date estimate Keffer")

{

color="green";

};

};

Boundary("End Keffer");

};

Sequence("Sequence Jarrett-Lahmer")

{

Boundary("Start Jarrett-Lahmer");

Phase("Jarrett-Lahmer")

{

R\_Date("Jarrett-Lahmer\_1\_UGAMS-40355\_maize", 326, 20)

{

Outlier("General",0.05);

};

R\_Date("Jarrett-Lahmer\_2\_UGAMS-40356\_maize", 298, 20)

{

Outlier("General",0.05);

};

R\_Date("Jarrett-Lahmer\_3\_UGAMS-40357\_maize", 272, 20)

{

Outlier("General",0.05);

};

R\_Date("Jarrett-Lahmer\_4\_UGAMS-40358\_maize", 322, 21)

{

Outlier("General",0.05);

};

Interval("Interval Jarrett-Lahmer",LnN(ln(20),ln(2)));

Date("Date estimate Jarrett-Lahmer")

{

color="green";

};

};

Boundary("End Jarrett-Lahmer");

};

Order("Order Coalescent");

Interval("Coalescent");

};

Boundary("End Coalescent",U(1200,1800));

};

Difference("Duration Hope Overall","End Hope","Start Hope",N(20,10));

};

**Supplemental Table 5.** OxCal runfile for Trent Valley sequence. This model applies some After and Before constraints between the site Phases. These are based on the current best assessment of the archaeological relationships (see text). These are of course relative, versus objective, categories of evidence. The model including the outliers noted below, which are down-weighted by the General and SSimple outlier models, and excluded in the final model used, runs perfectly well (Amodel ca.91 and Aoverall ca. 102). The final model has Amodel ca. 108 and Aoverall ca. 117. There is very little difference in results with/without the outliers noted. A difference compared to the modelling in Manning et al. (2019) is that we do not assume a contiguous order of the Ball and then Warminster sites (with at most a brief end/start overlap), much though this is the general assumption of the field. We merely require the end of Ball to be before the end of Warminster (a very minimalist ordering in this case). We compare the difference in results for Sopher, Ball and Warminster between this model and a revised model where the usual assumption of an approximate contiguous order of Ball then Warminster is applied in Supplemental Table 10. Note: this model runs slowly.

Options()

{

Resolution=1;

kIterations=3000;

};

Plot()

{

Outlier\_Model("General",T(5),U(0,4),"t");

Outlier\_Model("SSimple",N(0,2),0,"s");

Outlier\_Model("Charcoal",Exp(1,-10,0),U(0,3),"t");

D\_Sequence("WAR-1 Larix laricina")

{

First ();

R\_Date ("Wk-42865 Rings 9-17",355,17)

{

Outlier ("SSimple",0.05);

};

Gap(10);

R\_Date ("Wk-42866 Rings 19-27",325,15)

{

Outlier ("SSimple",0.05);

};

Gap(10);

R\_Date ("Wk-42867 Rings 29-37",349,13)

{

Outlier ("SSimple",0.05);

};

Gap(10);

R\_Date ("Wk-42868 Rings 39-47",321,15)

{

Outlier ("SSimple",0.05);

};

Gap(10);

R\_Date ("Wk-42869 Rings 49-57",317,14)

{

Outlier ("SSimple",0.05);

};

Gap(4);

Date ("RY57 last extant ring");

};

Sequence("Warminster")

{

Boundary("Start Warminster");

Phase ("Warminster Short-Lived Samples")

{

R\_Combine ("Warminster H4 F12 plum (Prunus Americana)",8)

{

Outlier("General", 0.05);

R\_Date ("VERA-6310 H4 F12 plum",334,28)

{

Outlier("SSimple", 0.05);

};

R\_Date ("VERA-6310\_2 H4 F12 plum",340,31)

{

Outlier("SSimple", 0.05);

};

//R\_Date ("UGAMS-25451 F12 plum",427,22)

//{

// Outlier("SSimple", 0.05);

//};

//Excluded as Outlier ca. 91%

R\_Date ("UGAMS-25451-u F12 plum",365,21)

{

Outlier("SSimple", 0.05);

};

R\_Date ("UGAMS-25451-r2 F12 plum",355,22)

{

Outlier("SSimple", 0.05);

};

R\_Date ("UGAMS-25451-r2r F12 plum",368,21)

{

Outlier("SSimple", 0.05);

};

//R\_Date ("UGAMS-25451-r F12 plum",396,21)

//{

// Outlier("SSimple", 0.05);

//};

//Excluded as Outlier ca. 17%

R\_Date ("UGAMS-25451-rr F12 plum",346,21)

{

Outlier("SSimple", 0.05);

};

};

R\_Combine ("Warminster H4 F16B bean (Phaseolus)",8)

{

Outlier("General", 0.05);

R\_Date ("VERA-6309\_1 H4 F16B bean",314,28)

{

Outlier("SSimple", 0.05);

};

R\_Date ("VERA-6309\_2 H4 F16B bean",311,28)

{

Outlier("SSimple", 0.05);

};

R\_Date ("VERA-6309\_3 H4 F16B bean",374,40)

{

Outlier("SSimple", 0.05);

};

R\_Date ("UGAMS-25450 H4 F16 bean",363,22)

{

Outlier("SSimple", 0.05);

};

};

R\_Date ("Warminster\_4\_UGAMS34181 maize H9, F30c",365,21)

{

Outlier ("General",0.05);

};

R\_Date ("Warminster\_8\_UGAMS34182 maize H5, F1",326,21)

{

Outlier ("General",0.05);

};

After ("WAR-1 TPQ")

{

Date ("=RY57 last extant ring");

};

Date ("Date estimate Warminster")

{

color="green";

};

Interval("Interval Warminster Overall",LnN(ln(20),ln(2)));

};

Boundary ("End Warminster",U(1300,1800));

};

Phase("Jamieson and Kirche")

{

Sequence()

{

Boundary("Start Jamieson");

Phase ("Jamieson")

{

R\_Date("Jamieson\_12a\_UGAMS-33014\_maize", 298, 22)

{

Outlier("General",0.05);

};

R\_Date("Jamieson\_12c\_GrM-14952\_maize", 353, 20)

{

Outlier("General",0.05);

};

R\_Combine("Jamieson\_12b\_12d",8)

{

Outlier("General",0.05);

R\_Date("Jamieson\_12b\_GrM-14949\_split12d\_maize", 311, 18)

{

Outlier("SSimple",0.05);

};

R\_Date("Jamieson\_12d\_UGAMS-33015\_split12b\_maize", 334, 21)

{

Outlier("SSimple",0.05);

};

};

Date("Date estimate Jamieson")

{

color="green";

};

Interval("Interval Jamieson",LnN(ln(20),ln(2)));

};

Boundary("End Jamieson");

};

Sequence("Kirche")

{

Boundary("Start Kirche Early");

After("Start Jamieson1")

{

Date("=Start Jamieson");

};

Phase ("Kirche Early")

{

//R\_Date("Kirche\_2a\_UGAMS-33102\_UID", 354, 21)

//{

// Outlier("General",0.05);

//};

//Excluded as Outlier 7% - borderline (and makes very little difference)

R\_Date("Kirche\_2b\_GrM-14957\_UID", 264, 20)

{

Outlier("General",0.05);

};

Date("Date Kirche Early")

{

color="green";

};

Interval ("Interval Kirche Early");

};

Boundary("Transition Kirche Early to Late");

Phase("Kirche Late")

{

R\_Date("Kirche\_UGAMS-21918\_charcoal??maize", 285, 21)

{

Outlier("General",0.05);

};

//given d13C of -8.5 likely maize, not wood charcoal

R\_Combine("Kirche 3",8)

{

Outlier("General",0.05);

R\_Date("Kirche\_3a\_UGAMS-33013\_split3a\_maize\_exp", 315, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("Kirche\_3b\_GrM-14958\_split3b\_maize\_exp", 293, 18)

{

Outlier("SSimple",0.05);

};

};

Date("Date Kirche Late")

{

color="green";

};

Interval ("Interval Kirche Late");

};

Before("End Kirche is before Late Coulter")

{

Date("=Date Coulter Expansion 4");

};

Boundary("End Kirche Late");

};

};

Phase("Later Sites")

{

Sequence(Benson early and late)

{

Boundary("Start Benson");

After ("Start Jamieson2")

{

Date("=Start Jamieson");

};

After("Date Start Kirche")

{

Date("=Start Kirche Early");

};

Phase("Benson early")

{

R\_Date("Benson\_10\_GrM-14541\_maize\_early", 323, 20)

{

Outlier("General",0.05);

};

R\_Date("Benson\_11\_UGAMS-33017\_maize", 320, 21)

{

Outlier("General",0.05);

};

R\_Combine("Benson 9",8)

{

Outlier("General",0.05);

R\_Date("Benson\_9a\_UGAMS-33016\_maize\_early", 304, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("Benson\_9a\_UGAMS-33016ha\_humic\_acid\_early", 307, 21)

{

Outlier("SSimple",0.05);

};

//R\_Date("Benson\_9b\_GrM-14545\_maize\_early", 443, 20)

//{

// Outlier("General",0.05);

//};

//Excluded as cannot be same sample as 9a - or lab issue – disagrees with other Benson data – unexplained problem

};

Date("Date estimate Benson early")

{

color="green";

};

Interval("Interval Benson early");

};

Boundary("Transition Benson early/Benson late");

Phase("Benson late")

{

R\_Date("Benson\_4\_UGAMS-33019\_maize", 289, 21)

{

Outlier("General",0.05);

};

R\_Date("Benson\_4\_UGAMS-33019r\_maize", 304, 21)

{

Outlier("General",0.05);

};

R\_Date("Benson\_4\_UGAMS-33019ha\_humic\_acid", 314, 20)

{

Outlier("General",0.05);

};

R\_Combine("Benson 8",8)

{

Outlier("General",0.05);

R\_Date("Benson\_8a\_UGAMS-33018\_split8b\_maize\_late", 302, 20)

{

Outlier("SSimple",0.05);

};

R\_Date("Benson\_8b\_GrM-14544\_split8a\_maize\_late", 307, 21)

{

Outlier("SSimple",0.05);

};

};

Date("Date estimate Benson late")

{

color="green";

};

Interval("Interval Benson late");

};

Before("Date Start Warminster1")

{

Date("=Start Warminster");

};

Boundary("End Benson Late");

};

Sequence("Coulter")

{

Boundary("Start Core Coulter");

Phase("Core")

{

R\_Date("Coulter\_5\_core\_UGAMS-32756\_maize", 318, 25)

{

Outlier("General",0.05);

};

R\_Combine("Coulter\_22",8)

{

Outlier("General",0.05);

R\_Date("Coulter\_22a\_core\_UGAMS\_32763\_split22b\_maize", 360, 30)

{

Outlier("SSimple",0.05);

};

R\_Date("Coulter\_22b\_core\_GrM-14931\_split22a\_maize", 334, 18)

{

Outlier("SSimple",0.05);

};

};

Date("Date Coulter Core")

{

color="green";

};

Interval("Interval Coulter Core");

Before("Before End Kirche Core")

{

Date("=Transition Kirche Early to Late");

};

};

Boundary("Transition Core/Exp 1");

Phase("Exp 1")

{

R\_Combine("Coulter\_9",8)

{

Outlier("General",0.05);

R\_Date("Coulter\_9a\_exp1\_UGAMS-32758\_split9b\_maize", 310, 25)

{

Outlier("SSimple",0.05);

};

R\_Date("Coulter\_9b\_exp1\_GrM-14934\_split9a\_maize", 305, 20)

{

Outlier("SSimple",0.05);

};

};

R\_Date("Coulter\_10\_exp1\_UGAMS-32759\_maize", 320, 25)

{

Outlier("General",0.05);

};

};

Boundary("Transition Exp 1/Exp 2");

Phase("Exp 2")

{

R\_Date("Coulter\_4\_exp2\_UGAMS-32755\_maize", 307, 25)

{

Outlier("General",0.05);

};

R\_Combine("Coulter\_13",8)

{

Outlier("General",0.05);

R\_Date("Coulter\_13a\_exp2\_UGAMS-32760\_split13b\_maize", 296, 25)

{

Outlier("SSimple",0.05);

};

R\_Date("Coulter\_13b\_exp2\_GrM-14548\_split13a\_maize", 298, 18)

{

Outlier("SSimple",0.05);

};

};

};

Boundary("Transition Exp 2/Exp 3");

Phase("Exp 3")

{

R\_Combine("Coulter\_18",8)

{

Outlier("General",0.05);

R\_Date("Coulter\_18a\_exp3\_UGAMS-32761\_split18b\_hawthorne\_seed", 330, 25)

{

Outlier("SSimple",0.05);

};

R\_Date("Coulter\_18b\_exp3\_GrM14928\_split18a\_hawthorne\_seed", 291, 20)

{

Outlier("SSimple",0.05);

};

};

R\_Date("Coulter\_19\_exp3\_UGAMS-32762\_maize", 309, 25)

{

Outlier("General",0.05);

};

R\_Date("Coulter\_1\_exp3\_GrM-14546\_maize", 299, 25)

{

Outlier("General",0.05);

};

R\_Date("Coulter\_15\_exp3\_GrM-14549\_maize", 313, 20)

{

Outlier("General",0.05);

};

};

Boundary("Transition Exp 3/Exp 4");

Phase("Exp 4")

{

R\_Date("Coulter\_23\_exp4\_UGAMS-32764\_maize", 296, 25)

{

Outlier("General",0.05);

};

//Coulter 8 fails X2 for same age even with extra 8 years for annual noise - so separate NOT R\_Combine

R\_Date("Coulter\_8a\_exp1\_UGAMS-32757\_split8b\_maize", 345, 25)

{

Outlier("General",0.05);

};

R\_Date("Coulter\_8b\_exp1\_GrM-14933\_split8a\_maize", 276, 20)

{

Outlier("General",0.05);

};

};

R\_Date("Coulter\_20\_exp4\_GrM-14929\_maize", 335, 18)

{

Outlier("General",0.05);

};

Date("Date Coulter Expansion 4")

{

color="green";

};

Interval("Interval Coulter Expansion 4");

Boundary("End Exp 4");

};

Before("Date Start Warminster2")

{

Date("=Start Warminster");

};

};

Sequence()

{

Boundary("Start Dawn");

After ("Date Jamieson3")

{

Date("=Start Jamieson");

};

Phase("Dawn")

{

R\_Date("Dawn\_1\_UGAMS-33010\_maize", 352, 21)

{

Outlier("General",0.05);

};

R\_Date("Dawn\_2\_GrM-14939\_maize", 347, 18)

{

Outlier("General",0.05);

};

R\_Combine("Dawn\_6",8)

{

Outlier("General",0.05);

R\_Date("Dawn\_6a\_UGAMS-330110\_split6a\_maize", 354, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("Dawn\_6b\_GrM-14941\_split6a\_maize", 346, 20)

{

Outlier("SSimple",0.05);

};

};

Date("Date estimate Dawn")

{

color="green";

};

Interval("Interval Dawn",LnN(ln(20),ln(2)));

};

Before("Date Start Warminster3")

{

Date("=Start Warminster");

};

Boundary("End Dawn");

};

Phase ("Sopher & Ball")

{

Sequence ("Sopher")

{

Boundary ("Start Sopher");

After ("Date Benson Start")

{

Date("=Start Benson");

};

Phase ("Sopher")

{

R\_Date("I-6846", 445, 85)

{

Outlier("Charcoal",1);

};

R\_Combine ("Sopher BdGU-1 maize",8)

{

Outlier ("General",0.05);

R\_Date("VERA-6282 maize", 364, 27)

{

Outlier("SSimple", 0.05);

//ca. 8% Outlier but weighted average OK, so leave in.

};

R\_Date("VERA-6282\_2 maize", 292, 27)

{

Outlier("SSimple", 0.05);

};

};

R\_Date("UGAMS-40154 Sopher 3 maize", 287, 23)

{

Outlier ("General",0.05);

};

R\_Date("UGAMS-40155 Sopher 4 maize", 323, 23)

{

Outlier ("General",0.05);

};

Date ("Date estimate Sopher")

{

color="green";

};

Interval("Interval Sopher",LnN(ln(20),ln(2)));

};

Boundary ("End Sopher");

Before ("Date End Warminster")

{

Date("=End Warminster");

};

Sequence ("Ball")

{

Boundary ("Start Ball");

After ("Date Benson Start2")

{

Date("=Start Benson");

};

Phase ("Ball")

{

R\_Combine ("Ball\_2",8)

{

Outlier ("General",0.05);

R\_Date ("Ball\_2 UGAMS-34183 H11, F4",353,22)

{

Outlier("SSimple", 0.05);

};

R\_Date ("Ball\_2 UGAMS-34183n H11, F4",333,19)

{

Outlier("SSimple", 0.05);

};

};

R\_Combine ("Ball\_3",8)

{

Outlier ("General",0.05);

R\_Date ("Ball\_3 UGAMS-34184 H17, F76",344,22)

{

Outlier("SSimple", 0.05);

};

R\_Date ("Ball\_3 UGAMS-34184n H17, F76",353,19)

{

Outlier("SSimple", 0.05);

};

};

R\_Combine ("Ball\_6",8)

{

Outlier ("General",0.05);

R\_Date ("Ball\_6\_UGAMS34179 H25, F34",358,21)

{

Outlier("SSimple", 0.05);

};

R\_Date ("Ball\_6\_UGAMS34179n H25, F34",351,21)

{

Outlier("SSimple", 0.05);

};

};

R\_Combine ("Ball-7",8)

{

Outlier ("General",0.05);

//ca. 6% Outlier – leave in. Agreement ca. 40% - borderline

R\_Date ("Ball\_7\_UGAMS34180 H21, F35",307,22)

{

Outlier("SSimple", 0.05);

};

R\_Date ("Ball\_7\_UGAMS34180n H21, F35",298,19)

{

Outlier("SSimple", 0.05);

//ca. 6% Outlier – leave in, see above

};

};

Date ("Date estimate Ball")

{

color="green";

};

Interval("Interval Ball",LnN(ln(20),ln(2)));

};

Boundary("End Ball");

Before ("Date End Warminster")

{

Date("=End Warminster");

};

};

};

};

Difference("Duration Kirche Overall","End Kirche Late","Start Kirche Early",LnN(ln(20),ln(2)));

Difference("Duration Benson Overall","End Benson Late","Start Benson",LnN(ln(20),ln(2)));

Difference("Duration Coulter Overall","End Exp 4","Start Core Coulter",LnN(ln(20),ln(2)));

};

**Supplemental Table 6.** OxCal runfile for Seneca sequence. The model is based on the current best assessment of the archaeological relationships (see text). These assessments are of course somewhat relative, versus objective, categories of evidence.

Options()

{

Resolution=1;

kIterations=3000;

};

Plot()

{

Outlier\_Model("Charcoal",Exp(1,-10,0),U(0,3),"t");

Outlier\_Model("General",T(5),U(0,4),"t");

Outlier\_Model("SSimple",N(0,2),0,"s");

Sequence("Seneca Model")

{

Boundary("Start Farrell and Footer");

Phase("Farrell and Footer")

{

Sequence("Farrell")

{

Boundary("Start Farrell");

Phase("Farrell")

{

R\_Date("GrM-14970\_FARRELL-1\_nut", 558, 20)

{

Outlier( "General",0.05);

};

R\_Date("UGAMS-34030\_FARRELL-3\_maize", 588, 22)

{

Outlier( "General",0.05);

};

R\_Date("GrM-14972\_FARRELL-4\_nut", 518, 20)

{

Outlier( "General",0.05);

};

Interval("Interval Farrell",LnN(ln(20),ln(2)));

Date("Date estimate Farrell")

{

color="green";

};

};

Boundary("End Farrell");

};

Sequence("Footer")

{

Boundary("Start Footer");

Phase("Footer")

{

R\_Combine("FOOTER-1\_maize",8)

{

Outlier("General",0.05);

R\_Date("UGAMS-34031\_FOOTER-1A\_maize-split", 372, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("GrM-13830\_FOOTER-1B\_maize-split", 384, 15)

{

Outlier("SSimple",0.05);

};

};

R\_Date("GrM-13832\_FOOTER-5\_maize", 382, 15)

{

Outlier( "General",0.05);

};

R\_Date("UGAMS-34032\_FOOTER-6\_maize", 374, 21)

{

Outlier( "General",0.05);

};

Interval("Interval Footer",LnN(ln(20),ln(2)));

Date("Date estimate Footer")

{

color="green";

};

};

Boundary("End Footer");

};

};

Phase("Richmond Hill, Belcher")

{

Sequence()

{

Boundary("Start Belcher");

Phase("Belcher")

{

R\_Combine("BELCHER-4\_maize",8)

{

Outlier("General",0.05);

R\_Date("UGAMS-34024\_BELCHER-4A\_maize-split", 347, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("GrM-13829\_BELCHER-4B\_maize-split", 343, 15)

{

Outlier("SSimple",0.05);

};

};

R\_Date("UGAMS-39603\_BELCHER-3-collagen", 379, 20)

{

Outlier( "General",0.05);

};

Interval("Interval Belcher",LnN(ln(20),ln(2)));

Date("Date estimate Belcher")

{

color="green";

};

};

Boundary("End Belcher");

};

Sequence()

{

Boundary("Start Richmond Mills");

Phase("Richmond Mills")

{

R\_Combine("RICH MILLS-1\_maize",8)

{

Outlier("General",0.05);

R\_Date("UGAMS-34033\_RICH MILLS-1A\_maize-split", 352, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("GrM-13756\_RICH MILLS-1B\_maize-split", 355, 15)

{

Outlier("SSimple",0.05);

};

};

R\_Combine("RICH MILLS-7\_maize",8)

{

Outlier("General",0.05);

R\_Date("UGAMS-35645\_RICH MILLS-7A\_maize-split", 352, 19)

{

Outlier("SSimple",0.05);

};

R\_Date("GrM-14985\_RICH MILLS-7B\_maize-split", 332, 18)

{

Outlier("SSimple",0.05);

};

};

R\_Combine("RICH MILLS-8\_maize",8)

{

Outlier("General",0.05);

R\_Date("UGAMS-35646\_RICH MILLS-8A\_maize-split", 332, 19)

{

Outlier("SSimple",0.05);

};

R\_Date("GrM-14986\_RICH MILLS-8B\_maize-split", 328, 18)

{

Outlier("SSimple",0.05);

};

};

R\_Combine("RICH MILLS-9\_maize",8)

{

Outlier("General",0.05);

R\_Date("UGAMS-35647\_RICH MILLS-9A\_maize-split", 311, 19)

{

Outlier("SSimple",0.05);

};

R\_Date("GrM-14987\_RICH MILLS-9B\_maize-split", 341, 20)

{

Outlier("SSimple",0.05);

};

};

Interval("Interval Richmond Mills",LnN(ln(20),ln(2)));

Date("Date estimate Richmond Mills")

{

color="green";

};

};

Boundary("End Richmond Mills");

};

};

Boundary("Start Tram");

Phase("Tram")

{

R\_Date("GrM-14973\_TRAM-1\_nut", 351, 20)

{

Outlier( "General",0.05);

};

R\_Date("UGAMS-39607\_TRAM-2\_charcoal", 287, 20)

{

Outlier("Charcoal",1);

};

Interval("Interval Tram",LnN(ln(20),ln(2)));

Date("Date estimate Tram")

{

color="green";

};

};

Boundary ("Transition Tram to Cameron");

Phase("Cameron")

{

R\_Date("UGAMS-34025\_CAMERON-1\_maize", 340, 20)

{

Outlier( "General",0.05);

};

R\_Date("UGAMS-34027\_CAMERON-5\_maize", 345, 20)

{

Outlier( "General",0.05);

};

R\_Date("GrM-13759\_CAMERON-4\_maize", 354, 15)

{

Outlier( "General",0.05);

};

R\_Combine("CAMERON-3\_maize",8)

{

Outlier("General",0.05);

R\_Date("UGAMS-34026\_CAMERON-3A\_maize-split", 372, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("GrM-13760\_CAMERON-3B\_maize-split", 344, 15)

{

Outlier("SSimple",0.05);

};

};

Interval("Interval Cameron",LnN(ln(20),ln(2)));

Date("Date estimate Cameron")

{

color="green";

};

};

Boundary("Transition Cameron to Factory Hollow");

Phase("Factory Hollow")

{

R\_Combine("FACT HOLL-3\_maize",8)

{

Outlier("General",0.05);

R\_Date("UGAMS-34028\_FACT HOLL\_3A-maize-split", 372, 22)

{

Outlier("SSimple",0.05);

};

R\_Date("GrM-13827\_FACT HOLL\_3B-maize-split", 347, 15)

{

Outlier("SSimple",0.05);

};

};

R\_Combine("FACT HOLL-6\_maize",8)

{

Outlier("General",0.05);

R\_Date("UGAMS-34029\_FACT HOLL\_6A-maize-split", 355, 21)

{

Outlier("SSimple",0.05);

};

R\_Date("GrM-13757\_FACT HOLL\_6B-maize-split", 377, 15)

{

Outlier("SSimple",0.05);

};

};

Interval("Interval Factory Hollow",LnN(ln(20),ln(2)));

Date("Date estimate Factory Hollow")

{

color="green";

};

};

Boundary("End Factory Hollow");

};

};

**Supplemental Table 7.** OxCal runfile for the Alhart site.

Options()

{

Resolution=1;

};

Plot()

{

Outlier\_Model("General",T(5),U(0,4),"t");

Outlier\_Model("SSimple",N(0,2),0,"s");

Sequence()

{

Boundary("Start Alhart");

Phase("Alhart")

{

R\_Combine("Alhart\_6",8)

{

Outlier("General", 0.05);

R\_Date("Alhart\_6A\_UGAMS-34023", 291, 21)

{

Outlier("SSimple", 0.05);

};

R\_Date("DI-Alhart\_6B\_GrM-13828", 308, 15)

{

Outlier("SSimple", 0.05);

};

};

R\_Date("Alhart\_1\_UGAMS-34021", 305, 21)

{

Outlier("General", 0.05);

};

R\_Date("Alhart\_2\_UGAMS-34022", 316, 21)

{

Outlier("General", 0.05);

};

Interval ("Interval Alhart",LnN(ln(20),ln(2)));

Date("Date Estimate Alhart")

{

Color=”green”;

};

};

Boundary("End Alhart");

};

};

**Supplemental Table 8.** OxCal runfile for the Onondaga sequence. The Sequence is based on the current best assessment of the archaeological relationships (see text), and we acknowledge few samples with firm contextual data for multiple sites and samples (see Supplemental Table 1).

Options()

{

Resolution=1;

kIterations=3000;

};

Plot()

{

Outlier\_Model("General",T(5),U(0,4),"t");

Outlier\_Model("SSimple",N(0,2),0,"s");

Sequence()

{

Boundary("Start Kelso HH Schoff",U(1200,1750));

//To facilitate model run we limit to uniform probability between 1200 and 1750

Phase (Kelso Howlett Hill Schoff)

{

Sequence()

{

Boundary("Start Kelso");

Phase("Kelso")

{

R\_Date("GrM-14982\_KELSO-4\_maize", 543, 18)

{

Outlier("General",0.05);

};

R\_Combine("Kelso\_5",8)

{

Outlier("General",0.05);

R\_Date("UGAMS-35644\_KELSO-5A\_maize-split", 576, 19)

{

Outlier("SSimple",0.05);

};

//R\_Date("GrM-14983\_KELSO-5B\_maize-split", 624, 25)

//{

// Outlier("SSimple",0.05);

//};

//Outlier typically ca. 14%

};

Interval("Interval Kelso",LnN(ln(20),ln(2)));

Date("Date estimate Kelso")

{

color="green";

};

};

Boundary("End Kelso");

};

Sequence()

{

Boundary("Start Howlett Hill");

Phase("Howlett Hill")

{

R\_Date("UGAMS-35637\_HOWLHILL\_maize", 506, 19)

{

Outlier("General",0.05);

};

Interval("Interval Howlett Hill",LnN(ln(20),ln(2)));

Date("Date estimate Howlett Hill")

{

color="green";

};

};

Boundary("Transition End Howlett Hill/Start Schoff");

Phase("Schoff")

{

R\_Date("UGAMS-39598\_SCHOFF-4\_collagen", 434, 25)

{

Outlier("General",0.05);

};

Interval("Interval Schoff",LnN(ln(20),ln(2)));

Date("Date estimate Schoff")

{

color="green";

};

};

Boundary("End Schoff");

};

};

Boundary("Transition Kelso HH Schoff/2");

Phase("Bloody Hill")

{

R\_Combine("Bloody Hill 6",8)

{

Outlier("General",0.05);

R\_Date("UGAMS-35640\_BLOODY HILL-6A\_maize-split", 362, 19)

{

Outlier("SSimple",0.05);

};

R\_Date("GrM-14990\_BLOODY HILL-6B\_maize-split", 373, 20)

{

Outlier("SSimple",0.05);

};

};

Interval("Interval Bloody Hill",LnN(ln(20),ln(2)));

Date("Date estimate Bloody Hill")

{

color="green";

};

};

Boundary("Transition Bloody Hill/Christopher Burke");

Phase("Christopher Burke")

{

Sequence()

{

Boundary("Start Christopher");

Phase("Christopher")

{

R\_Date("UGAMS-37379\_CHRISTOPHER-1\_collagen", 338, 20)

{

Outlier("General",0.05);

};

Interval("Interval Christopher",LnN(ln(20),ln(2)));

Date("Date estimate Christopher")

{

color="green";

};

};

Boundary("End Christopher");

};

Sequence()

{

Boundary("Start Burke");

Phase("Burke")

{

R\_Date("UGAMS-35641\_BURKE-1A\_maize", 359, 19)

{

Outlier("General",0.05);

};

R\_Date("GrM-14988\_BURKE-1B\_maize", 363, 18)

{

Outlier("General",0.05);

};

R\_Date("GrM-14980\_BURKE-4\_bean", 360, 18)

{

Outlier("General",0.05);

};

Interval("Interval Burke",LnN(ln(20),ln(2)));

Date("Date estimate Burke")

{

color="green";

};

};

Boundary("End Burke");

};

};

Boundary("Transition Christopher Burke/Cemetery");

Phase("Cemetery")

{

R\_Date("UGAMS-35642\_CEMETERY-1A\_bean", 316, 19)

{

Outlier("General",0.05);

};

R\_Date("GrM-14991\_CEMETERY-1B\_bean", 359, 18)

{

Outlier("General",0.05);

};

R\_Date("UGAMS-35643\_CEMETERY-2A\_maize", 335, 19)

{

Outlier("General",0.05);

};

Interval("Interval Cemetery",LnN(ln(20),ln(2)));

Date("Date estimate Cemetery")

{

color="green";

};

};

Boundary("Transition Cemetery/Barnes McNab");

Phase("Barnes McNab")

{

Sequence()

{

Boundary("Start Barnes");

Phase("Barnes")

{

R\_Date("UGAMS-39589\_BARNES-3\_collagen", 315, 20)

{

Outlier ("General",0.05);

};

//R\_Date("UGAMS-39590E\_BARNES-4\_enamel", 374, 24)

//{

// Outlier ("General",0.05);

//};

//Outlier typically ca. 12%

Interval("Interval Barnes",LnN(ln(20),ln(2)));

Date("Date estimate Barnes")

{

color="green";

};

};

Boundary("End Barnes");

};

Sequence()

{

Boundary("Start McNab");

Phase("McNab")

{

R\_Date("UGAMS-37377\_MCNAB-1\_collagen", 298, 35)

{

Outlier("General",0.05);

};

R\_Date("UGAMS-37378\_MCNAB-2\_collagen", 290, 20)

{

Outlier("General",0.05);

};

Interval("Interval McNab",LnN(ln(20),ln(2)));

Date("Date estimate McNab")

{

color="green";

};

};

Boundary("End McNab");

};

};

Boundary("Transition Barnes McNab/TH Atwell");

Phase("TH Atwell")

{

Sequence()

{

Boundary("Start Temperance House");

Phase("Temperance House")

{

R\_Date("UGAMS-39611\_TEMP HOUSE-3\_collagen", 282, 20)

{

Outlier ("General",0.05);

};

R\_Date("UGAMS-39612\_TEMP HOUSE-4\_collagen", 304, 20)

{

Outlier ("General",0.05);

};

Interval("Interval Temperance House",LnN(ln(20),ln(2)));

Date("Date estimate Temperance House")

{

color="green";

};

};

Boundary("End Temperance House");

};

Sequence()

{

Boundary("Start Atwell");

Phase("Atwell")

{

R\_Date("UGAMS-39586\_ATWELL-1\_collagen", 312, 20)

{

Outlier ("General",0.05);

};

//R\_Date("UGAMS-39587\_ATWELL-2\_collagen", 366, 20)

//{

// Outlier ("General",0.05);

//};

//Outlier typically ca. 8%

R\_Date("UGAMS-39588\_ATWELL-3\_collagen", 285, 20)

{

Outlier ("General",0.05);

};

Interval("Interval Atwell",LnN(ln(20),ln(2)));

Date("Date estimate Atwell")

{

color="green";

};

};

Boundary("End Atwell");

};

};

Boundary("Transition TH Atwell/Chase");

Phase("Chase")

{

R\_Date("UGAMS-39592C\_Chase-1\_collagen", 300, 25)

{

Outlier ("General",0.05);

};

R\_Date("UGAMS-39592E\_CHASE-1\_enamel", 388, 25)

{

Outlier ("General",0.05);

};

R\_Date("UGAMS-39593\_CHASE-2\_collagen", 372, 20)

{

Outlier ("General",0.05);

};

Interval("Interval Chase",LnN(ln(20),ln(2)));

Date("Date estimate Chase")

{

color="green";

};

};

Boundary("End Chase");

Interval("Interval Between Chase and Pompey");

Boundary("Start Pompey Center");

Phase("Pompey Center")

{

R\_Date("UGAMS-35648\_POMPEY-1\_maize", 350, 19)

{

Outlier ("General",0.05);

};

//R\_Date("UGAMS-39594\_POMPEY-3\_maize", 418, 20)

//{

// Outlier ("General",0.05);

//};

//Outlier typically ca.16%

R\_Date("UGAMS-39595\_POMPEY-4\_maize", 300, 20)

{

Outlier ("General",0.05);

};

//Outlier at ca. 6% but we tolerate and leave in the model

R\_Date("UGAMS-39596\_POMPEY-5\_maize", 306, 20)

{

Outlier ("General",0.05);

};

Interval("Interval Pompey Center",LnN(ln(20),ln(2)));

Date("Date estimate Pompey Center")

{

color="green";

};

};

Boundary("End Pompey Center",U(1200,1750));

};

};

**Supplemental Table 9.** Order analysis from the Don Valley model for the precoalescent site Phase. Probability that t1 (left column) is older than t2. If P>0.50 then older (**red, bold**), if P<0.50 then more recent. The overall precoalescent Phase is estimated to last about 31–61 years (68.3% hpd) or 22–80 years (95.4% hpd). Thus several (if not all) of these sites likely overlap to varying extents (especially Hope South and Hope North; Hope North and Walkingdon are not far apart, and the Walkingdon and Orion-Murphy Goulding sites are also likely very close /overlapping in time). How to read the table: the probabilities (from 80% to 58%) indicate that Baker is likely older than all the other sites (closest to Hope South); Hope South is older than all sites except Baker with probabilities of 78% to 60% (closest to Baker and Hope North), etc. … and McNair is more recent than every other site with probabilities of 80% to 61% (closest is Orion-Murphy Goulding). The probability that Walkington is older than Orion-Murphy Goulding is only 53%, thus these two sites especially may well be more or less contemporary/overlapping. In all cases we are not suggesting these probabilities indicate entirely separate sites and contiguous order, rather this table indicates an order within a set of overlapping sites. We might interpret at 70%-80% probability of being older that Baker is likely almost entirely earlier than Walkington and Orion-Murphy Goulding and especially McNair. But, while starting earlier, it likely overlapped with some of Hope South and Hope North at least. Hope South was perhaps more or less entirely older than McNair too (78% probability) and likely started later than Baker and finished earlier than Walkington and Orion-Murphy Goulding, but also overlapped in between. And so on.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Probability *t*1 < *t*2** | | | | | | |
| ***t*1** |  | | | | | |
| **Date Estimate Baker** | **Date Estimate Hope S** | **Date Estimate Hope N** | **Date Estimate Walkington** | **Date Estimate Orion-Murphy Goulding** | **Date Estimate McNair** |
| **Date Estimate Baker** | 0 | **0.58** | **0.64** | **0.70** | **0.72** | **0.8** |
| **Date Estimate Hope S** | 0.42 | 0 | **0.6** | **0.65** | **0.68** | **0.78** |
| **Date Estimate Hope N** | 0.36 | 0.4 | 0 | **0.59** | **0.63** | **0.73** |
| **Date Estimate Walkington** | 0.3 | 0.35 | 0.41 | 0 | **0.53** | **0.64** |
| **Date Estimate Orion-Murphy Goulding** | 0.28 | 0.32 | 0.37 | 0.47 | 0 | **0.61** |
| **Date Estimate McNair** | 0.2 | 0.22 | 0.27 | 0.36 | 0.39 | 0 |

**Supplemental Table 10.** Comparison of the dating ranges for the Sopher, Ball and Warminster sites from the Trent model depending on whether or not an approximate contiguous order of Ball then Warminster is used. The model in Supplemental Table 5 only required Ball to end before Warminster ended – thus permitting substantial overlap. We compare this model here with a revised version where the end Boundary of Ball is required to be earlier than the start Boundary of Warminster – this view better corresponds with the general assessment of the sites and assemblages (and was the assumption used in Manning et al. 2019).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Supplemental Table 5 Model, Supplemental Figure 4 Model (no order Ball to Warminster assumed),**  **Amodel=108, Aoverall=117** | | **Alternative version of Model with contiguous order of Ball then Warminster as generally assumed,**  **Amodel=109.2, Aoverall=118** | |
|  | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3%*** | ***95.4%*** |
| **Sopher Start Boundary** | 1531-1559 | 1515-1575 | 1531-1558 | 1516-1571 |
| **Date estimate Sopher** | 1540-1567 | 1527-1582 | 1540-1565 | 1527-1577 |
| **Sopher End Boundary** | 1549-1576 | 1536-1591 | 1549-1573 | 1536-1584 |
| **Ball Start Boundary** | 1563-1591 | 1554-1601 (81.6%),  1602-1621 (13.8%) | 1566-1588 | 1552-1596 |
| **Date estimate Ball** | 1570-1601 (67.6%),  1620 (0.6%) | 1563-1628 | 1573-1596 | 1559-1607 |
| **Ball End Boundary** | 1580-1606 (61.7%),  1623-1627 (6.6%) | 1573-1635 | 1580-1604 | 1566-1622 |
| **Warminster Start Boundary** | 1593-1619 | 1573-1626 | 1598-1619 | 1585-1625 |
| **Date estimate Warminster** | 1603-1630 | 1583-1637 | 1607-1628 | 1590-1636 |
| **Warminster End Boundary** | 1613-1639 | 1593-1648 | 1613-1638 | 1596-1645 |

**Supplemental Table 11.** Comparison of Date estimate results for the Humber model (Supplemental Table 3) using no prior, versus several different priors (given archaeological and ethno-historical expectations of average sites lengths, with a maximum of around 40 years: see main text).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **No Prior**  **Amodel=101.9, Aoverall=104** | | **U(0,40)**  **Amodel=82.5, Aoverall=87.3** | | **U(0,80)**  **Amodel=96.5, Aoverall=98.8** | | **N(20,10)**  **Amodel=85.9, Aoverall=91.4** | | **N(25,10)**  **Amodel=91.1, Aoverall=94.4** | | **LnN(ln(20),ln(2))**  **Amodel=90.3, Aoverall=102.3** | | **LnN(ln(25),ln(2))**  **Amodel=98.9, Aoverall=109.2** | |
| ***Date Estimates*** | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3% hpd*** | ***95.4% hpd*** |
| **Black Creek** | 1452-1516 (66.4%),  1606-1610 (1.9%) | 1412-1569 (83.5%),  1570-1621 (12.0%) | 1476-1507 (51.1%),  1602-1616 (17.2%) | 1462-1518 (64.4%),  1520-1622 (31.1%) | 1464-1518 (64.4%),  1605-1611 (4.3%) | 1442-1524 (76.4%),  1576-1622 (19.1%) | 1475-1505 (53.8%),  1602-1613 (14.5%) | 1461-1516 (66.6%),  1584-1622 (28.9%) | 1469-1505 (63.3%),  1603-1608 (5.0%) | 1456-1515 (73.6%),  1582-1620 (21.9%) | 1475-1506 (53.1%),  1602-1614 (15.1%) | 1458-1517 (67.0%),  1583-1622 (28.5%) | 1470-1506 (58.2%),  1602-1612 (10.1%) | 1452-1518 (71.4%),  1580-1622 (24.0%) |
| **Parsons** | 1494-1533 (38.7%),  1557-1589 (17.3%),  1611-1629 (12.3%) | 1483-1641 | 1494-1522 (52.9%),  1615-1626 (15.3%) | 1481-1533 (64.4%),  1592-1637 (31.3%) | 1492-1531 (58.3%),  1615-1627 (10.0%) | 1482-1578 (76.6%),  1592-1636 (18.8%) | 1494-1523 (53.7%),  1617-1627 (14.6%) | 1481-1535 (66.8%),  1602-1639 (28.6%) | 1494-1526 (61.6%),  1619-1626 (6.7%) | 1482-1540 (73.7%),  1605-1640 (21.8%) | 1495-1523 (52.8%),  1616-1627 (15.4%) | 1480-1539 (66.6%),  1597-1639 (28.9%) | 1494-1525 (56.4%),  1617-1627 (11.8%) | 1480-1555(71.1%),  1599-1640 (24.4%) |
| **Seed-Barker** | 1500-1566 | 1444-1595 | 1506-1534 (41.0%),  1551-1575 (27.3%) | 1497-1588 | 1504-1547 (54.4%),  1548-1563 (13.9%) | 1485-1587 | 1506-1534 (42.8%),  1551-1574 (25.5%) | 1497-1587 | 1505-1538 (48.9%),  1551-1570 (19.4%) | 1495-1586 | 1506-1535 (43.1%),  1550-1574 (25.2%) | 1494-1589 | 1505-1538 (46.5%),  1549-1570 (21.8%) | 1492-1588 |
| **Damiani core** | 1525-1546 | 1510-1563 | 1526-1545 | 1518-1559 | 1525-1546 | 1512-1561 | 1525-1545 | 1518-1559 | 1525-1544 | 1516-1559 | 1526-1545 | 1518-1559 | 1525-1545 | 1516-1560 |
| **Damiani expansion** | 1532-1556 | 1527-1574 | 1532-1553 | 1527-1569 | 1532-1556 | 1527-1573 | 1533-1553 | 1528-1568 | 1539-1562 | 1531-1576 | 1533-1553 | 1528-1569 | 1533-1554 | 1528-1570 |
| **McKenzie** | 1518-1567 | 1472-1591 | 1523-1563 | 1509-1582 | 1520-1564 | 1500-1584 | 1523-1562 | 1509-1581 | 1522-1563 | 1507-1581 | 1522-1563 | 1507-1583 | 1522-1563 | 1505-1583 |
| **Skandatut** | 1595-1635 | 1574-1701 | 1599-1628 | 1580-1638 | 1598-1631 | 1578-1651 | 1599-1628 | 1580-1638 | 1599-1629 | 1581-1641 | 1599-1629 | 1579-1639 | 1599-1629 | 1579-1643 |

**Supplemental Table 12.** Comparison of date ranges for the Hope site considering three different prior assumptions for the overall duration of the site (the Difference query in the model in Supplemental Table 4) versus no prior assumptions for any of the site Phase durations in the Don Valley model (Supplemental Table 4).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **N(20,10) prior (Hope site overall)** | | **N(25,10) prior (Hope site overall)** | | **U(0,50) prior (Hope site overall)** | | **No site Interval constraints prior in Don Valley model** | |
|  | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3% hpd*** | ***95.4% hpd*** |
| **Boundary Start Hope** | 1471-1488 | 1460-1499 (95.3%)  1598-1599 (0.2%) | 1470-1487 | 1458-1498 | 1469-1487 | 1456-1499 (95.1%)  1597-1599 (0.3%) | 1473-1495 | 1455-1505 (92.2%)  1599-1609 (3.3%) |
| **Boundary Start Hope North** | 1477-1494 | 1468-1506 | 1477-1494 | 1467-1506 | 1477-1494 | 1467-1507 (95.3%)  1602-1603 (0.2%) | 1479-1497 | 1470-1508 (92.1%)  1602-1611 (3.4%) |
| **Date estimate Hope North** | 1482-1500 | 1472-1512 | 1482-1500 | 1472-1513 | 1482-1500 | 1472-1513 (95.2%)  1607-1608 (0.2%) | 1481-1499 | 1474-1510 (92.0)  1603-1613 (3.5%) |
| **Boundary End Hope North** | 1487-1504 | 1478-1516 | 1488-1506 | 1479-1517 | 1488-1506 | 1478-1518 | 1483-1502 | 1476-1514 (91.9%)  1604-1614 (3.5%) |
| **Interval Hope North (years)** | 4-13 | 2-20 | 5-14 | 2-22 | 4-14 | 2-23 | 0-6 | 0-21 |
| **Boundary Start Hope South** | 1475-1492 | 1465-1503 (94.9%)  1601-1603 (0.5%) | 1475-1492 | 1464-1503 (95.1%)  1601-1603 (0.4%) | 1474-1492 | 1463-1503 (94.7%)  1601-1604 (0.7%) | 1477-1497 | 1464-1507 (92.1%)  1601-1610 (3.4%) |
| **Date estimate Hope South** | 1480-1498 | 1469-1509 (95.1%)  1605-1607 (0.4%) | 1480-1498 | 1468-1510 | 1479-1498 | 1468-1510 (94.8%)  1605-1607 (0.6%) | 1479-1498 | 1469-1508 (91.9%)  1603-1612 (3.5%) |
| **Boundary End Hope South** | 1486-1503 | 1475-1514 (95.0%)  1609-1611 (0.5%) | 1486-1504 | 1474-1514 (95.1%)  1609-1611 (0.3%) | 1485-1504 | 1474-1515 (94.9%)  1609-1611 (0.6%) | 1481-1500 | 1472-1511 (91.8)  1604-1614 (3.7) |
| **Interval Hope South (years)** | 4-13 | 2-20 | 4-14 | 2-22 | 4-14 | 2-23 | 0-6 | 0-21 |
| **Boundary End Hope** | 1493-1510 | 1482-1521 | 1494-1512 | 1483-1523 | 1494-1513 | 1483-1525 | 1485-1507 | 1477-1524 (92.2%)  1606-1616 (3.2%) |

**Supplemental Table 13.** The start and end Boundaries calculated for each of the sites from the modelled site sequences (see Table 2 for the modelled Date estimates—the period of time between the start and end Boundaries for each site Phase—for each site, and for the Interval query results). For the site models, see Supplemental Tables 3-8 and Supplemental Figures 2-7. As noted earlier, note that rounding errors mean some probabilities, when there are sub-ranges, add up to 0.1% more or less than 68.3% and 95.4%.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Humber Model (Amodel 90.3, Aoverall 102.3)*** | | | | |  |  |
| **Name** | ***Modelled (AD)*** | | | | | |
|  | **from** | **to** | **68.3%** | **from** | **to** | **95.4%** |
| **Boundary Start Black Creek** | 1463 1594 | 1498 1607 | 52.8 15.4 | 1445 1573 | 1509 1615 | 66.9 28.6 |
| **Boundary Transition Black Creek/Parsons** | 1488 1610 | 1513 1620 | 52.3 15.9 | 1474 1595 | 1523 1628 | 67.1 28.4 |
| **Boundary End Parsons** | 1504 1622 | 1531 1635 | 50.7 17.6 | 1490 1594 1597 1601 1609 | 1554 1595 1599 1605 1648 | 66.1 0.2 0.3 0.5 28.4 |
| **Boundary Start Seed-Barker** | 1493 1542 | 1523 1564 | 46.4 21.9 | 1479 | 1580 | 95 |
| **Boundary End Seed-Barker** | 1520 1558 | 1547 1582 | 39.5 28.8 | 1510 | 1596 | 95 |
| **Boundary Start Damiani core** | 1521 | 1542 | 68 | 1510 | 1556 | 95 |
| **Boundary Transition Damiani core/expansion** | 1529 | 1548 | 68 | 1524 | 1563 | 95 |
| **Boundary End Damiani expansion** | 1536 | 1558 | 68 | 1530 | 1575 | 95 |
| **Boundary Start McKenzie** | 1513 | 1554 | 68 | 1494 | 1573 | 95 |
| **Boundary End McKenzie** | 1532 1537 | 1534 1574 | 3.8 64.5 | 1522 | 1591 | 95 |
| **Boundary Transition Upper Humber Precontact/ Upper Humber Indirect/Postcontact** | 1569 | 1603 | 68 | 1552 | 1616 | 95 |
| **Boundary Start Skandatut** | 1591 | 1619 | 68 | 1574 | 1628 | 95 |
| **Boundary End Skandatut** | 1608 | 1638 | 68 | 1587 | 1653 | 95 |
| ***Don Valley (Amodel 163.4, Aoverall 165.6)*** | | | | |  |  |
| **Name** | ***Modelled (AD)*** | | | | | |
|  | **from** | **to** | **68.3%** | **from** | **to** | **95.4%** |
| **Boundary Start Precoalescent** | 1461 | 1482 | 68.3 | 1441 1587 | 1493 1594 | 94.3 1.2 |
| **Boundary Start Walkington 2** | 1476 | 1496 | 68.3 | 1463 | 1510 | 95.4 |
| **Boundary End Walkington 2** | 1492 | 1512 | 68.3 | 1480 | 1525 | 95.4 |
| **Boundary Start Baker** | 1470 | 1489 | 68.3 | 1456 1600 | 1502 1602 | 95.0 0.5 |
| **Boundary End Baker** | 1483 | 1505 | 68.3 | 1470 1610 | 1519 1612 | 95.1 0.4 |
| **Boundary Start McNair** | 1480 | 1502 | 68.3 | 1466 | 1516 | 95.4 |
| **Boundary End McNair** | 1497 | 1517 | 68.3 | 1483 | 1529 | 95.4 |
| **Boundary Start Hope** | 1471 | 1488 | 68.3 | 1460 1598 | 1499 1599 | 95.3 0.2 |
| **Boundary Start Hope North** | 1477 | 1494 | 68.3 | 1468 | 1506 | 95.4 |
| **Boundary End Hope North** | 1487 | 1504 | 68.3 | 1478 | 1516 | 95.4 |
| **Boundary Start Hope South** | 1475 | 1492 | 68.3 | 1465 1601 | 1503 1603 | 94.9 0.5 |
| **Boundary End Hope South** | 1486 | 1503 | 68.3 | 1475 1609 | 1514 1611 | 95.0 0.4 |
| **Boundary End Hope** | 1493 | 1510 | 68.3 | 1482 | 1521 | 95.4 |
| **Boundary Start Orion-Murphy Goulding** | 1477 | 1497 | 68.3 | 1464 1597 | 1511 1598 | 95.3 0.1 |
| **Boundary End Orion-Murphy Goulding** | 1493 | 1513 | 68.3 | 1481 | 1526 | 95.4 |
| **Boundary Transition Precoalescent/Coalescent** | 1507 | 1525 | 68.3 | 1497 1622 | 1538 1625 | 94.8 0.7 |
| **Boundary Start Keffer** | 1521 | 1541 | 68.3 | 1513 1627 | 1557 1633 | 93.7 1.8 |
| **Boundary End Keffer** | 1534 | 1557 | 68.3 | 1527 1637 | 1575 1641 | 93.9 1.6 |
| **Boundary Start Jarrett-Lahmer** | 1520 | 1540 | 68.3 | 1511 1627 | 1556 1633 | 93.5 1.9 |
| **Boundary End Jarrett-Lahmer** | 1533 | 1556 | 68.3 | 1527 1637 | 1575 1642 | 93.7 1.7 |
| ***Trent Valley (Amodel 108, Aoverall 117)*** | | | | |  |  |
| **Name** | ***Modelled (AD)*** | | | | | |
|  | **from** | **to** | **68.3%** | **from** | **to** | **95.4%** |
| **Boundary Start Jamieson** | 1494 | 1522 | 68.3 | 1473 | 1534 | 95.4 |
| **Boundary End Jamieson** | 1515 | 1549 | 68.3 | 1502 | 1586 | 95.4 |
| **Boundary Start Kirche Early** | 1520 | 1534 | 68.3 | 1507 | 1542 | 95.4 |
| **Boundary Transition Kirche Early to Late** | 1529 | 1541 | 68.3 | 1526 | 1549 | 95.4 |
| **Boundary End Kirche Late** | 1534 | 1548 | 68.3 | 1529 | 1558 | 95.4 |
| **Boundary Start Benson** | 1524 | 1543 | 68.3 | 1516 | 1553 | 95.4 |
| **Boundary Transition Benson early/Benson late** | 1531 1533 | 1532 1552 | 2.2 66.1 | 1524 | 1562 | 95.4 |
| **Boundary End Benson Late** | 1539 | 1560 | 68.3 | 1530 | 1574 | 95.4 |
| **Boundary Start Core Coulter** | 1512 | 1530 | 68.3 | 1503 | 1544 | 95.4 |
| **Boundary Transition Core/Exp 1** | 1519 | 1534 | 68.3 | 1514 | 1547 | 95.4 |
| **Boundary Transition Exp 1/Exp 2** | 1525 | 1540 | 68.3 | 1522 | 1551 | 95.4 |
| **Boundary Transition Exp 2/Exp 3** | 1532 | 1547 | 68.3 | 1527 | 1555 | 95.4 |
| **Boundary Transition Exp 3/Exp 4** | 1537 | 1553 | 68.3 | 1530 | 1562 | 95.4 |
| **Boundary End Exp 4** | 1541 | 1559 | 68.3 | 1535 | 1574 | 95.4 |
| **Boundary Start Dawn** | 1496 1561 | 1514 1596 | 18.9 49.4 | 1479 1541 | 1521 1607 | 30.7 64.8 |
| **Boundary End Dawn** | 1513 1580 | 1528 1614 | 18.3 50.0 | 1498 1560 | 1541 1631 | 30.2 65.3 |
| **Boundary Start Sopher** | 1531 | 1559 | 68.3 | 1515 | 1575 | 95.4 |
| **Boundary End Sopher** | 1549 | 1576 | 68.3 | 1536 | 1591 | 95.4 |
| **Boundary Start Ball** | 1563 | 1591 | 68.3 | 1554 1602 | 1601 1621 | 81.6 13.8 |
| **Boundary End Ball** | 1580 1623 | 1606 1627 | 61.7 6.6 | 1573 | 1635 | 95.4 |
| **Boundary Start Warminster** | 1593 | 1619 | 68.3 | 1573 | 1626 | 95.4 |
| **Boundary End Warminster** | 1613 | 1639 | 68.3 | 1593 | 1648 | 95.4 |
| ***Seneca (Amodel 132.4, Aoverall 133.4)*** | | | | |  |  |
| **Name** | ***Modelled (AD)*** | | | | | |
|  | **from** | **to** | **68.3%** | **from** | **to** | **95.4%** |
| **Boundary Start Farrell and Footer** | 1374 | 1403 | 68.3 | 1337 | 1413 | 95.4 |
| **Boundary Start Farrell** | 1392 | 1406 | 68.3 | 1383 | 1416 | 95.4 |
| **Boundary End Farrell** | 1407 | 1424 | 68.3 | 1401 | 1437 | 95.4 |
| **Boundary Start Footer** | 1455 | 1474 | 68.3 | 1444 | 1486 | 95.4 |
| **Boundary End Footer** | 1470 | 1489 | 68.3 | 1462 | 1497 | 95.4 |
| **Boundary Start Belcher** | 1483 | 1505 | 68.3 | 1473 | 1516 | 95.4 |
| **Boundary End Belcher** | 1500 | 1525 | 68.3 | 1486 | 1540 | 95.4 |
| **Boundary Start Richmond Mills** | 1495 | 1515 | 68.3 | 1478 1554 | 1523 1558 | 94.7 0.8 |
| **Boundary End Richmond Mills** | 1512 | 1530 | 68.3 | 1498 1561 | 1548 1570 | 93.6 1.9 |
| **Boundary Start Tram** | 1535 | 1571 | 68.3 | 1520 | 1585 | 95.4 |
| **Boundary Transition Tram to Cameron** | 1571 | 1593 | 68.3 | 1555 | 1601 | 95.4 |
| **Boundary Transition Cameron to Factory Hollow** | 1591 | 1607 | 68.3 | 1581 | 1616 | 95.4 |
| **Boundary End Factory Hollow** | 1604 | 1624 | 68.3 | 1594 | 1639 | 95.4 |
| ***Alhart (Amodel 133.2, Aoverall 129.3)*** | | | | |  |  |
| **Name** | ***Modelled (AD)*** | | | | | |
|  | **from** | **to** | **68.3%** | **from** | **to** | **95.4%** |
| **Boundary Start Alhart** | 1515 | 1556 | 68.3 | 1502 1614 | 1573 1637 | 83.7 11.7 |
| **Boundary End Alhart** | 1533 | 1576 | 68.3 | 1526 1631 | 1595 1651 | 84.0 11.4 |
| ***Onondaga (Amodel 112.2, Aoverall 120.2)*** | | | | |  |  |
| **Name** | ***Modelled (AD)*** | | | | | |
|  | **from** | **to** | **%** | **from** | **to** | **%** |
| **Boundary Start Kelso HH Schoff** | 1378 | 1406 | 68.3 | 1347 | 1418 | 95.4 |
| **Boundary Start Kelso** | 1392 | 1408 | 68.3 | 1384 | 1419 | 95.4 |
| **Boundary End Kelso** | 1406 | 1424 | 68.3 | 1400 | 1439 | 95.4 |
| **Boundary Start Howlett Hill** | 1410 | 1429 | 68.3 | 1397 | 1436 | 95.4 |
| **Boundary Transition End Howlett Hill/Start Schoff** | 1427 | 1443 | 68.3 | 1418 | 1450 | 95.4 |
| **Boundary End Schoff** | 1441 | 1458 | 68.3 | 1432 | 1468 | 95.4 |
| **Boundary Transition Kelso HH Schoff/2** | 1453 | 1475 | 68.3 | 1443 | 1486 | 95.4 |
| **Boundary Transition Bloody Hill/Christopher Burke** | 1474 | 1493 | 68.3 | 1464 | 1500 | 95.4 |
| **Boundary Start Christopher** | 1483 | 1500 | 68.3 | 1473 | 1507 | 95.4 |
| **Boundary End Christopher** | 1495 | 1511 | 68.3 | 1486 | 1517 | 95.4 |
| **Boundary Start Burke** | 1482 | 1499 | 68.3 | 1474 | 1506 | 95.4 |
| **Boundary End Burke** | 1494 | 1510 | 68.3 | 1485 | 1516 | 95.4 |
| **Boundary Transition Christopher Burke/Cemetery** | 1502 | 1516 | 68.3 | 1494 | 1522 | 95.4 |
| **Boundary Transition Cemetery/Barnes McNab** | 1515 | 1528 | 68.3 | 1507 | 1535 | 95.4 |
| **Boundary Start Barnes** | 1520 | 1535 | 68.3 | 1513 | 1545 | 95.4 |
| **Boundary End Barnes** | 1529 | 1545 | 68.3 | 1523 | 1557 | 95.4 |
| **Boundary Start McNab** | 1521 | 1534 | 68.3 | 1515 | 1545 | 95.4 |
| **Boundary End McNab** | 1530 | 1544 | 68.3 | 1526 | 1556 | 95.4 |
| **Boundary Transition Barnes McNab/TH Atwell** | 1534 | 1551 | 68.3 | 1529 | 1564 | 95.4 |
| **Boundary Start Temperance House** | 1539 1562 | 1559 1563 | 66.0 2.2 | 1533 | 1572 | 95.4 |
| **Boundary End Temperance House** | 1551 | 1575 | 68.3 | 1543 | 1587 | 95.4 |
| **Boundary Start Atwell** | 1540 1561 | 1559 1562 | 65.2 3.0 | 1533 | 1572 | 95.4 |
| **Boundary End Atwell** | 1551 | 1575 | 68.3 | 1543 | 1588 | 95.4 |
| **Boundary Transition TH Atwell/Chase** | 1558 1566 | 1563 1591 | 9.1 59.2 | 1550 | 1603 | 95.4 |
| **Boundary End Chase** | 1585 1587 | 1586 1618 | 0.9 67.4 | 1563 | 1623 | 95.4 |
| **Boundary Start Pompey Center** | 1612 | 1631 | 68.3 | 1566 1601 | 1589 1635 | 11.5 83.9 |
| **Boundary End Pompey Center** | 1626 | 1647 | 68.3 | 1576 1618 | 1603 1658 | 10.9 84.6 |

**Supplemental Table 14.** Comparison of the Date estimates for the Benson, Sopher, Ball and Warminster sites from the models in this paper versus those from the Manning et al. (2019) paper re-run with IntCal20. The effect of adding in the several additional elements in the Trent model in the present paper and some slightly different assumptions (in the model in Supplemental Table 5 and Supplemental Figure 4) leads to some small variations in the date ranges for these sites by a few years in some cases. However, they remain very similar. The dates for Ball and Warminster in Supplemental Table 10 in the alternative model better reflect the generally understood specific site histories of Ball and Warminster (and as used in the Manning et al. 2019) paper.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Manning et al. 2019**  **Model 4 re-run with IntCal20** | | **Manning et al. 2019**  **Model 6 re-run with IntCal20** | | **Birch et al. 2020 (this paper)** | |
| ***Date estimate*** | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3% hpd*** | ***95.4% hpd*** | ***68.3% hpd*** | ***95.4% hpd*** |
| **Benson** | 1517-1552 | 1508-1570 | 1517-1553 | 1503-1572 | 1528-1556 | 1521-1568 |
| **Sopher** | 1546-1571 | 1534-1579 | 1563-1586 | 1549-1593 | 1540-1567  1540-1565\* | 1527-1582  1527-1577\* |
| **Ball** | 1567-1590 | 1555-1599 | 1564-1585 | 1553-1594 | 1570-1601  (67.6% of 68.3%)  1573-1596\* | 1563-1628  1559-1607\* |
| **Warminster** | 1589-1621 | 1578-1630 | 1585-1615 | 1574-1630 | 1603-1630  1607-1628\* | 1583-1637  1590-1636\* |

\*Supplemental Table 10 alternative version with the site order of Ball and then Warminster. Note: the model assuming no order between Ball and Warminster (Supplemental Table 5) runs contrary our understanding of these two site histories—hence we believe that the red values with the asterisk (from Supplemental Table 10) are more realistic age estimates for these particular sites. The detailed chronology of the Ball and Warminster sites is not the focus of the current paper—we were more concerned with the remainder of the Trent sequence.

**Supplemental Table 15.** The results from the model for the Onondaga Sequence in Table 2 and Supplemental Tables 13 run, as in Supplemental Table 8 (after excluding 4 dates as outliers – see Supplemental Discussion above and Supplemental Table 8), and applying the OxCal outlier models, compared to running the same model with the 4 outliers included but with the outlier models applied. The results obtained are largely similar, with differences only small (showing how the outlier models down-weight the outlier values). The small exception is at the end of the Sequence. Here the removal especially of UGAMS-39594 from Pompey (>25% probability as a too-old outlier and individual OxCal Agreement value of only ~4.2% – perhaps to be construed as a miss for the wiggle to older 14C ages ca. 1606-1607) allows some shift (and in fact indicates that we have less clarity) in date ranges by several years comparing the results from the two model runs. As noted earlier, note that rounding errors mean some probabilities, when there are sub-ranges, add up to 0.1% more or less than 68.3% and 95.4%.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Onondaga (Amodel 112.2, Aoverall 120.2) with outlier models applied (as Table 2, Supplemental Table 13) and with the 4 outlier dates identified removed (see Supplemental Material; the 4 dates excluded are indicated in Supplemental Table 8) compared with same model run including the 4 outliers (but applying the outlier models): Amodel 39.5, Aoverall 34.5*** | | | | | | | | | | | | |
| **Name** | ***Modelled (AD) 4 Outliers Removed,***  ***Outlier models applied***  ***Table 2, Supplemental Table 13*** | | | | | | ***Modelled (AD) Outliers Included,***  ***Outlier models applied*** | | | | | |
|  | **from** | **to** | **%** | **from** | **to** | **%** | **from** | **to** | **%** | **from** | **to** | **%** |
| **Boundary Start Kelso HH Schoff** | 1378 | 1406 | 68.3 | 1347 | 1418 | 95.4 | 1372 | 1402 | 68.3 | 1336 | 1414 | 95.4 |
| **Boundary Start Kelso** | 1392 | 1408 | 68.3 | 1384 | 1419 | 95.4 | 1389 | 1404 | 68.3 | 1377 | 1417 | 95.4 |
| **Date Estimate Kelso** | 1399 | 1417 | 68.3 | 1390 | 1430 | 95.4 | 1395 | 1413 | 68.3 | 1385 | 1429 | 95.4 |
| **Boundary End Kelso** | 1406 | 1424 | 68.3 | 1400 | 1439 | 95.4 | 1403 | 1421 | 68.3 | 1397 | 1440 | 95.4 |
| **Boundary Start Howlett Hill** | 1410 | 1429 | 68.3 | 1397 | 1436 | 95.4 | 1409 | 1429 | 68.3 | 1396 | 1436 | 95.4 |
| **Date Estimate Howlett Hill** | 1418 | 1437 | 68.3 | 1406 | 1444 | 95.4 | 1418 | 1437 | 68.3 | 1406 | 1445 | 95.4 |
| **Boundary Transition End Howlett Hill/Start Schoff** | 1427 | 1443 | 68.3 | 1418 | 1450 | 95.4 | 1426 | 1443 | 68.3 | 1417 | 1450 | 95.4 |
| **Date Estimate Schoff** | 1433 | 1451 | 68.3 | 1424 | 1460 | 95.4 | 1433 | 1451 | 68.3 | 1424 | 1460 | 95.4 |
| **Boundary End Schoff** | 1441 | 1458 | 68.3 | 1432 | 1468 | 95.4 | 1440 | 1458 | 68.3 | 1431 | 1467 | 95.4 |
| **Boundary Transition Kelso HH Schoff/2** | 1453 | 1475 | 68.3 | 1443 | 1486 | 95.4 | 1453 | 1475 | 68.3 | 1443 | 1485 | 95.4 |
| **Date Estimate Bloody Hill** | 1463 | 1485 | 68.3 | 1452 | 1494 | 95.4 | 1463 | 1484 | 68.3 | 1452 | 1493 | 95.4 |
| **Boundary Transition Bloody Hill/Christopher Burke** | 1474 | 1493 | 68.3 | 1464 | 1500 | 95.4 | 1473 | 1491 | 68.3 | 1464 | 1499 | 95.4 |
| **Boundary Start Christopher** | 1483 | 1500 | 68.3 | 1473 | 1507 | 95.4 | 1481 | 1499 | 68.3 | 1472 | 1506 | 95.4 |
| **Date Estimate Christopher** | 1488 | 1506 | 68.3 | 1479 | 1513 | 95.4 | 1487 | 1504 | 68.3 | 1478 | 1512 | 95.4 |
| **Boundary End Christopher** | 1495 | 1511 | 68.3 | 1486 | 1517 | 95.4 | 1493 | 1509 | 68.3 | 1484 | 1516 | 95.4 |
| **Boundary Start Burke** | 1482 | 1499 | 68.3 | 1474 | 1506 | 95.4 | 1481 | 1497 | 68.3 | 1473 | 1505 | 95.4 |
| **Date Estimate Burke** | 1487 | 1504 | 68.3 | 1479 | 1511 | 95.4 | 1486 | 1503 | 68.3 | 1478 | 1510 | 95.4 |
| **Boundary End Burke** | 1494 | 1510 | 68.3 | 1485 | 1516 | 95.4 | 1492 | 1508 | 68.3 | 1484 | 1514 | 95.4 |
| **Boundary Transition Christopher Burke/Cemetery** | 1502 | 1516 | 68.3 | 1494 | 1522 | 95.4 | 1500 | 1515 | 68.3 | 1492 | 1521 | 95.4 |
| **Date Estimate Cemetery** | 1508 | 1523 | 68.3 | 1499 | 1529 | 95.4 | 1505 | 1521 | 68.3 | 1497 | 1530 | 95.4 |
| **Boundary Transition Cemetery/Barnes McNab** | 1515 | 1528 | 68.3 | 1507 | 1535 | 95.4 | 1511 | 1526 | 68.3 | 1504 | 1537 | 95.4 |
| **Boundary Start Barnes** | 1520 | 1535 | 68.3 | 1513 | 1545 | 95.4 | 1513 | 1532 | 68.3 | 1508 | 1550 | 95.4 |
| **Date Estimate Barnes** | 1524 | 1540 | 68.3 | 1517 | 1551 | 95.4 | 1518 | 1539 | 68.3 | 1513 | 1556 | 95.4 |
| **Boundary End Barnes** | 1529 | 1545 | 68.3 | 1523 | 1557 | 95.4 | 1524 | 1546 | 68.3 | 1519 | 1562 | 95.4 |
| **Boundary Start McNab** | 1521 | 1534 | 68.3 | 1515 | 1545 | 95.4 | 1519 | 1535 | 68.3 | 1512 | 1547 | 95.4 |
| **Date Estimate McNab** | 1526 | 1540 | 68.3 | 1520 | 1551 | 95.4 | 1523 | 1540 | 68.3 | 1517 | 1553 | 95.4 |
| **Boundary End McNab** | 1530 | 1544 | 68.3 | 1526 | 1556 | 95.4 | 1529 | 1546 | 68.3 | 1524 | 1559 | 95.4 |
| **Boundary Transition Barnes McNab/TH Atwell** | 1534 | 1551 | 68.3 | 1529 | 1564 | 95.4 | 1532 | 1553 | 68.3 | 1527 | 1567 | 95.4 |
| **Boundary Start Temperance House** | 1539 1562 | 1559 1563 | 66.0 2.2 | 1533 | 1572 | 95.4 | 1540  1560 | 1558  1566 | 54.0  14.3 | 1532 | 1574 | 95.5 |
| **Date Estimate Temperance House** | 1545 | 1568 | 68.3 | 1537 | 1580 | 95.4 | 1547 | 1571 | 68.3 | 1537 | 1582 | 95.4 |
| **Boundary End Temperance House** | 1551 | 1575 | 68.3 | 1543 | 1587 | 95.4 | 1553 | 1577 | 68.3 | 1544 | 1589 | 95.4 |
| **Boundary Start Atwell** | 1540 1561 | 1559 1562 | 65.2 3.0 | 1533 | 1572 | 95.4 | 1543 | 1566 | 68.3 | 1534 | 1577 | 95.4 |
| **Date Estimate Atwell** | 1546 | 1569 | 68.3 | 1538 | 1581 | 95.4 | 1549 | 1573 | 68.3 | 1539 | 1584 | 95.4 |
| **Boundary End Atwell** | 1551 | 1575 | 68.3 | 1543 | 1588 | 95.4 | 1556 | 1580 | 68.3 | 1546 | 1591 | 95.4 |
| **Boundary Transition TH Atwell/Chase** | 1558 1566 | 1563 1591 | 9.1 59.2 | 1550 | 1603 | 95.4 | 1567 | 1592 | 68.3 | 1553 | 1600 | 95.4 |
| **Date Estimate Chase** | 1574 | 1606 | 68.3 | 1556 | 1614 | 95.5 | 1576 | 1601 | 68.3 | 1560 | 1610 | 95.4 |
| **Boundary End Chase** | 1585 1587 | 1586 1618 | 0.9 67.4 | 1563 | 1623 | 95.4 | 1586 | 1610 | 68.3 | 1568 | 1618 | 95.4 |
| **Boundary Start Pompey Center** | 1612 | 1631 | 68.3 | 1566 1601 | 1589 1635 | 11.5 83.9 | 1599 | 1620 | 68.3 | 1581 | 1629 | 95.4 |
| **Date Estimate Pompey Center** | 1619 | 1639 | 68.3 | 1570  1608 | 1596  1647 | 11.2  84.2 | 1609 | 1633 | 68.3 | 1587 | 1642 | 95.4 |
| **Boundary End Pompey Center** | 1626 | 1647 | 68.3 | 1576 1618 | 1603 1658 | 10.9 84.6 | 1620 | 1643 | 68.3 | 1587 | 1642 | 95.4 |

**Supplemental Table 16.** The results from the model for the Onondaga Sequence in Table 2 and Supplemental Tables 13 and 15 run, as in Supplemental Table 8 (after excluding four dates as outliers – see Supplemental Discussion above and Supplemental Table 8), applying the OxCal outlier models, are compared to running an example of the same model minus the same four outliers (see Supplemental Discussion above) but with no outlier models then applied. The results obtained are almost identical. We show this comparison to illustrate that (continued) use of the outlier models does not affect date ranges calculated (after manual removal of outliers). Data will vary between runs of such models by very small amounts (typically around one year). As noted earlier, note that rounding errors mean some probabilities, when there are sub-ranges, add up to 0.1% more or less than 68.3% and 95.4%.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Onondaga (Amodel 112.2, Aoverall 120.2) with outlier models applied (as Table 2, Supplemental Table 13) compared with Onondaga (Amodel 104.6, Aoverall 113.6) with no outlier models applied. In both cases 4 outlier dates have been removed (see Supplemental Material; the 4 dates excluded are indicated in Supplemental Table 8)*** | | | | | | | | | | | | |
| **Name** | ***Modelled (AD) Outlier Models Applied***  ***(4 outliers removed)***  ***Table 2, Supplemental Table 13*** | | | | | | ***Modelled (AD) No Outlier Models Applied***  ***(4 outliers removed)*** | | | | | |
|  | **from** | **to** | **%** | **from** | **to** | **%** | **from** | **to** | **%** | **from** | **to** | **%** |
| **Boundary Start Kelso HH Schoff** | 1378 | 1406 | 68.3 | 1347 | 1418 | 95.4 | 1379 | 1406 | 68.3 | 1350 | 1417 | 95.4 |
| **Boundary Start Kelso** | 1392 | 1408 | 68.3 | 1384 | 1419 | 95.4 | 1393 | 1408 | 68.3 | 1385 | 1418 | 95.4 |
| **Date Estimate Kelso** | 1399 | 1417 | 68.3 | 1390 | 1430 | 95.4 | 1399 | 1417 | 68.3 | 1391 | 1429 | 95.4 |
| **Boundary End Kelso** | 1406 | 1424 | 68.3 | 1400 | 1439 | 95.4 | 1406 | 1423 | 68.3 | 1399 | 1437 | 95.4 |
| **Boundary Start Howlett Hill** | 1410 | 1429 | 68.3 | 1397 | 1436 | 95.4 | 1410 | 1429 | 68.3 | 1398 | 1436 | 95.4 |
| **Date Estimate Howlett Hill** | 1418 | 1437 | 68.3 | 1406 | 1444 | 95.4 | 1418 | 1436 | 68.3 | 1407 | 1444 | 95.4 |
| **Boundary Transition End Howlett Hill/Start Schoff** | 1427 | 1443 | 68.3 | 1418 | 1450 | 95.4 | 1427 | 1443 | 68.3 | 1418 | 1450 | 95.4 |
| **Date Estimate Schoff** | 1433 | 1451 | 68.3 | 1424 | 1460 | 95.4 | 1433 | 1450 | 68.3 | 1424 | 1459 | 95.4 |
| **Boundary End Schoff** | 1441 | 1458 | 68.3 | 1432 | 1468 | 95.4 | 1440 | 1457 | 68.3 | 1431 | 1467 | 95.4 |
| **Boundary Transition Kelso HH Schoff/2** | 1453 | 1475 | 68.3 | 1443 | 1486 | 95.4 | 1453 | 1475 | 68.3 | 1443 | 1485 | 95.4 |
| **Date Estimate Bloody Hill** | 1463 | 1485 | 68.3 | 1452 | 1494 | 95.4 | 1463 | 1484 | 68.3 | 1452 | 1494 | 95.4 |
| **Boundary Transition Bloody Hill/Christopher Burke** | 1474 | 1493 | 68.3 | 1464 | 1500 | 95.4 | 1474 | 1492 | 68.3 | 1464 | 1499 | 95.4 |
| **Boundary Start Christopher** | 1483 | 1500 | 68.3 | 1473 | 1507 | 95.4 | 1482 | 1500 | 68.3 | 1473 | 1507 | 95.4 |
| **Date Estimate Christopher** | 1488 | 1506 | 68.3 | 1479 | 1513 | 95.4 | 1488 | 1506 | 68.3 | 1479 | 1513 | 95.4 |
| **Boundary End Christopher** | 1495 | 1511 | 68.3 | 1486 | 1517 | 95.4 | 1495 | 1511 | 68.3 | 1486 | 1517 | 95.4 |
| **Boundary Start Burke** | 1482 | 1499 | 68.3 | 1474 | 1506 | 95.4 | 1482 | 1498 | 68.3 | 1474 | 1505 | 95.4 |
| **Date Estimate Burke** | 1487 | 1504 | 68.3 | 1479 | 1511 | 95.4 | 1488 | 1504 | 68.3 | 1479 | 1511 | 95.4 |
| **Boundary End Burke** | 1494 | 1510 | 68.3 | 1485 | 1516 | 95.4 | 1494 | 1509 | 68.3 | 1485 | 1515 | 95.4 |
| **Boundary Transition Christopher Burke/Cemetery** | 1502 | 1516 | 68.3 | 1494 | 1522 | 95.4 | 1502 | 1516 | 68.3 | 1494 | 1521 | 95.4 |
| **Date Estimate Cemetery** | 1508 | 1523 | 68.3 | 1499 | 1529 | 95.4 | 1508 | 1523 | 68.3 | 1500 | 1529 | 95.4 |
| **Boundary Transition Cemetery/Barnes McNab** | 1515 | 1528 | 68.3 | 1507 | 1535 | 95.4 | 1516 | 1528 | 68.3 | 1508 | 1535 | 95.4 |
| **Boundary Start Barnes** | 1520 | 1535 | 68.3 | 1513 | 1545 | 95.4 | 1520 | 1534 | 68.3 | 1513 | 1545 | 95.4 |
| **Date Estimate Barnes** | 1524 | 1540 | 68.3 | 1517 | 1551 | 95.4 | 1524 | 1540 | 68.3 | 1518 | 1551 | 95.4 |
| **Boundary End Barnes** | 1529 | 1545 | 68.3 | 1523 | 1557 | 95.4 | 1529 | 1545 | 68.3 | 1523 | 1557 | 95.4 |
| **Boundary Start McNab** | 1521 | 1534 | 68.3 | 1515 | 1545 | 95.4 | 1521 | 1534 | 68.3 | 1515 | 1544 | 95.4 |
| **Date Estimate McNab** | 1526 | 1540 | 68.3 | 1520 | 1551 | 95.4 | 1525 | 1540 | 68.3 | 1519 | 1551 | 95.4 |
| **Boundary End McNab** | 1530 | 1544 | 68.3 | 1526 | 1556 | 95.4 | 1530 | 1544 | 68.3 | 1525 | 1556 | 95.4 |
| **Boundary Transition Barnes McNab/TH Atwell** | 1534 | 1551 | 68.3 | 1529 | 1564 | 95.4 | 1534 | 1551 | 68.3 | 1529 | 1564 | 95.4 |
| **Boundary Start Temperance House** | 1539 1562 | 1559 1563 | 66.0 2.2 | 1533 | 1572 | 95.4 | 1539  1562 | 1558  1564 | 65.0  3.3 | 1533 | 1572 | 95.5 |
| **Date Estimate Temperance House** | 1545 | 1568 | 68.3 | 1537 | 1580 | 95.4 | 1545 | 1568 | 68.3 | 1537 | 1580 | 95.4 |
| **Boundary End Temperance House** | 1551 | 1575 | 68.3 | 1543 | 1587 | 95.4 | 1550 | 1575 | 68.3 | 1543 | 1587 | 95.4 |
| **Boundary Start Atwell** | 1540 1561 | 1559 1562 | 65.2 3.0 | 1533 | 1572 | 95.4 | 1539  1561 | 1560  1563 | 65.0  3.3 | 1533 | 1572 | 95.4 |
| **Date Estimate Atwell** | 1546 | 1569 | 68.3 | 1538 | 1581 | 95.4 | 1545 | 1569 | 68.3 | 1538 | 1580 | 95.4 |
| **Boundary End Atwell** | 1551 | 1575 | 68.3 | 1543 | 1588 | 95.4 | 1551 | 1575 | 68.3 | 1543 | 1588 | 95.4 |
| **Boundary Transition TH Atwell/Chase** | 1558 1566 | 1563 1591 | 9.1 59.2 | 1550 | 1603 | 95.4 | 1558  1565 | 1563  1591 | 9.7  58.6 | 1550 | 1602 | 95.4 |
| **Date Estimate Chase** | 1574 | 1606 | 68.3 | 1556 | 1614 | 95.5 | 1573 | 1606 | 68.3 | 1556 | 1614 | 95.4 |
| **Boundary End Chase** | 1585 1587 | 1586 1618 | 0.9 67.4 | 1563 | 1623 | 95.4 | 1587 | 1618 | 68.3 | 1563 | 1623 | 95.4 |
| **Boundary Start Pompey Center** | 1612 | 1631 | 68.3 | 1566 1601 | 1589 1635 | 11.5 83.9 | 1612 | 1631 | 68.3 | 1566  1601 | 1589  1635 | 12.2  83.3 |
| **Date Estimate Pompey Center** | 1619 | 1639 | 68.3 | 1570  1608 | 1596  1647 | 11.2  84.2 | 1619 | 1639 | 68.3 | 1570  1608 | 1596  1647 | 11.9  83.6 |
| **Boundary End Pompey Center** | 1626 | 1647 | 68.3 | 1576 1618 | 1603 1658 | 10.9 84.6 | 1625 | 1646 | 68.3 | 1576  1618 | 1603  1657 | 11.5  84.0 |

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