PUT THIS IN YOUR PIPE AND SMOKE IT:
AN EVALUATION OF TOBACCO PIPE STEM DATING METHODS

By:

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There are currently three formula dating techniques available to archaeologists studying 17th and 18th century sites using imported English clay tobacco pipe stems based on Harrington's histogram of time periods; Binford's linear formula, Hanson's formulas and the Heighton and Deagan formula. Pipe stem bore diameter data were collected from 26 sites in Maryland, Virginia, North Carolina and South Carolina in order to test the accuracy and utility of the three formula dating methods. Of the formulas, the Heighton and Deagan proved to be the most accurate, producing formula mean dates closest to the dates assigned to the sites using other dating techniques. It was also determined that all three formula dating methods work better in Maryland and Virginia than in North and South Carolina. Other aspects of pipe stem dating were explored in this paper including regional consumption patterns and the influences Dutch pipes have on formula dating. These questions were addressed specifically on sites from the Chesapeake. This analysis supports recent assertions that the Chesapeake should be split into two sub-regions, the Upper and Lower Chesapeake.

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CHAPTER 1: INTRODUCTION

When historical archaeology, or post-medieval archaeology as it is called in Europe, began to increase in popularity in the second half of the 20th century, there was also an increased interest in dating categories or types of artifacts. Few temporally diagnostic artifacts appear in the archaeological record before the mid-18th century, when ceramic production and consumption rapidly increased and changed. However, the one artifact type that was immensely popular and modified constantly throughout the colonial period was the tobacco pipe. Pipes are ideal artifacts for site dating. Pipe styles changed rapidly, there are historical documents relating to the pipe industry and the pipe makers, and clay tobacco pipes are extremely fragile, and thus represent a large portion of the archaeological record throughout the 17th and 18th centuries (Harrington 1951:2). Pipe stem fragments are the cigarette butts of the colonial period; cheap and disposable. The history of pipes and pipe manufacturing will be discussed in Chapter 2.

Also included in Chapter 2 is a review of non-formula pipe dating methods, of which the most important for this study is the Harrington Theory. In 1954, J.C. Harrington developed a dating technique that revolutionized archaeologists’ opinions of tobacco pipe stems. He realized that pipe stem bore diameters decreased over time in measurable increments, and created a histogram of bore size averages for five time periods between 1620 and 1800. Previously, it has been pipe bowls that were used to date sites, but with Harrington’s new method, the importance of pipe stems increased in interpretive and temporal significance.

Many archaeologists began to use Harrington’s histogram of time periods and expand on his ideas. As one archaeologist put it, “as invariably happens, a mathematician, or nowadays a computer nerd, comes along to turn general trends into programmable numbers. In 1962, scholar Lewis Binford did just that, converting Harrington's modest progression into a mathematical formula” (Noël Hume 2003). The Binford straight-line regression formula became immensely popular, and is still widely used. However, many authors (e.g. Noël Hume 1963; Walker 1965:61-62) began to criticize Binford’s method and provide examples of his formula producing dates that were inconsistent with other dating methods. As a result, two more formula methods were developed over the next ten years. In 1968, Lee Hanson Jr. proposed ten straight line regression formulas to replace Binford’s one, but were still based on Harrington’s original study. Robert Heighton and Kathleen Deagan produced a curvilinear regression formula in 1971 based on their own bore size research. Each of these three formula dating methods is discussed in detail in Chapter 3.

The last two methods receive very little attention, likely due to their complexity, and as a result, there are few examples of their use in the archaeological literature. The Hanson and the Heighton and Deagan formulas have not been well tested and the accuracy of these methods is uncertain. Most archaeologists are willing to accept Harrington’s five time periods, because they are simple basic trends, and given such wide phases, most sites will fall into the correct time frame; and because Binford’s formula is simple and easy to understand, it is almost universally applied to most pre-1800 British colonial and federal sites.

The overarching theme of this study is to determine the true purpose of pipe stem formula dating, it’s utility in historical archaeology, and how it can be improved. There were two main goals to this research project, and many questions within each of those goals. The first goal is to determine which of the three formula dating methods, the Binford, the Hanson or the Heighton and Deagan, is the most accurate and useful. The secondary goal is to discuss regional variation of pipe use, trade, consumption and disposal through the lens of formula dating by comparing the differences in formula results.

In order to address the first goal, pipe stem bore diameter counts were collected and recorded from 64 individual features that had been assigned use dates with dating methods other than pipes. Each of these features is discussed in the site summaries in Chapter 4. All three formulas were run for each of the features. Each feature was assigned a predicted mean based on the date range assigned to it by the excavator or site report author. For example, if a feature, say a trash pit, was used from 1620 to 1640, the predicted mean would be 1630. This predicted mean was then compared to each of the three formula means in order to determine the average number of years away from the predicted mean the formula dates were. The second comparison done was to determine how often the formula date fell within the date range assigned by the excavator, by calculating simple percentages.

The last step in determining which formula dating method is the most accurate was to evaluate the strength of the formulae. This was done by plotting the formula results against the predicted means into a scatter plot and then running a straight line regression. The X-values of the scatter plots are the predicted means, while the formula means are the Y-values. Each formula group was done separately. In other words, all of the Binford means were plotted against all of the predicted means, followed by all of the Hanson means to all of the predicted means and lastly all of the Heighton and Deagan means against all of the predicted means. The r^2 of each resulting linear regression formula were then reported and compared. The r^2 values show how good a fit the formula dates are to the predicted dates. If perfect, the linear regression would follow the plotted points exactly, with no scatter and produce an r^2 value of 1; if null, the line would be horizontal and the r^2 value would be 0. The r^2 value can be understood as the proportion of variation in Y (the formula means) explained by the regression. If the r^2 value produced is 0, it means that knowing the predicted date does not help predict the formula date; in other words, the dating formula does not predict the correct means. The stronger the formula, the closer to 1 the r^2 is (Drennan 1996:215).

The second goal, to determine if there is any regional variation in the usefulness and accuracy of pipe stem dating, was addressed similarly to the first goal. All three of the same comparisons were conducted for each individual state plus one additional test. The differences found in the first test were analyzed not only to determine the average number of years away from the predicted mean the formula means were, but also how often the mean produced by the dating method was less than or greater than the given mean. All of these results were then evaluated for regional patterns and differences. The results of all tests are reported in Chapter 5, with discussions in Chapter 6.

CHAPTER 2: HISTORY OF TOBACCO, PIPES AND NON-FORMULA DATING

The Introduction of Tobacco and Tobacco Pipes to Europe

Tobacco is a New World plant, and before Columbus and his explorations, Europeans had no concept of smoking; in fact, early accounts of Native Americans inhaling tobacco was called “drinking” (Ayto 1979:4; Vince and Peacey 2006:12). When tobacco was introduced to Europe, first to France in 1557, then Portugal, Spain and Italy, it was ingested in snuff form and used for medicinal purposes (Oswald 1975:3). The first Europeans to adopt smoking were likely sailors and explorers who had observed the Native American practice in the early years of discovery. Smoking did not become popular with the rest of European society until the English began producing pipes in the 1570s, likely fashioned after those described in 1565 by the English explorer Hawkins. The pipes described were from Florida, and were made of an earthen bowl with a cane stem (Hakluyt 1589:47).

It was not until Sir Walter Raleigh’s 1585 expedition to Virginia that the clay pipe was introduced to England. Thomas Hariot, a member of Raleigh’s expedition, wrote in 1588 “…they use to take the fume or smoke thereof by sucking it through pipes of claie into their stomachs…we ourselves during the time we were there used to suck it after their manner as also since our returne” (Hariot 1588). Written references to tobacco and smoking increased greatly at the end of the 16th century, suggesting to Oswald (1975:5) that pipe smoking was widespread and fashionable. By 1590, the production of the ubiquitous molded white clay pipe was firmly established in England; this is supported by both the historical and archaeological records (Oswald 1975:5) This two piece molded pipe style remained popular into the early 20th century (Vince and Peacey 2006:13).

The basic shape of the white clay pipe stayed the same throughout 17th and 18th centuries, with slight variations in size, shape and surface treatment. The earliest pipes, sometimes called “little ladells” or “fairy pipes,” had very short stems, as small as 1 ¾ inches, but averaged 3 ½ inches. The bowl was often flattened on the bottom, called a heel, with an interior diameter of about a quarter of an inch. By last half of the 17th century, the size of the stem and bowl had increased, and the heel was replaced by a spur. The average stem was between 11 and 12 inches long with an interior bowl diameter of half an inch, and by the first half of the 18th century the stem had increased in length to 13 ½ inches on average. In the second half of the 18th century, pipes with two foot long stems were not uncommon and were referred to as “churchwardens.” However, these large pipes were not the only variety available in the late 18th century; the majority of pipe makers began to decrease the length of their pipes to around nine inches from bowl to mouthpiece (Noël Hume 1969:296; Ayto 1979:4). Surface treatments are addressed in the “Non-Formula Dating Methods” section of this chapter.

Tobacco Pipe Production

Europe

The English were in forefront of pipe production throughout the colonial era. While clay pipe production was well underway at the end of the 16th century, it was not until 1619 that pipe makers became an organized body in London. After this, many companies quickly organized throughout England, and production spread beyond the English borders to other European countries, mainly Holland (Oswald 1975:7). While there is some evidence of a French pipe industry, it does not become large scale until the mid-19th century, and there is little to no evidence of French pipes in the American Colonies (Oswald 1975:11, 115; Bradley 2000:118). This is also true of pipe makers in Scotland (Oswald 1975:43; Bradley 2000:117). Both British and Dutch pipes were made from locally dug white ball clay; these same deposits had been, and continued to be, used in the production of ceramics, specifically the slip decoration on finer pieces (Oswald 1975:11; Beaman 2005:54). While there have been attempts at identifying clay chemically from specific regions in order to identify the production location of specific pipes in England, this has proven difficult due to the overwhelming amount of trade between regions. The historical record indicates, and the chemical analysis supports, that manufacturers would often import clay from other areas instead of using their own local deposits (Vince and Peacey 2006). There are no similar studies comparing English and Dutch clay deposits.

The basic production techniques were similar in England and Holland. First, the white clay was dug out and cleaned to remove any dirt and stones and then allowed to dry. Once the clean clay was dry, it was then ground with a stone or beaten with an iron bar into a powder and mixed with water to the right consistency for shaping. After this preparation, balls of clay were hand rolled into the basic shape of a pipe, including stem and bowl; these blanks were called “rolls.” Next, a long piece of wire, or piercing rod, was passed through the center of the stem to create the bore; the wire was often lubricated with oil before insertion. The blank, with the wire still inside of the stem, was placed into a two-piece mold (Oswald 1975:13-17; Ayto 1979:12).

These molds were often unique to the pipe-maker, and could be carved or cast to create a decorative surface on the bowl and/or stem, including maker’s marks. Next, the assembled mold was placed into a machine that had been invented sometime in the 17th century, and was first described in 1688 as a “screw,” but was also referred to as a “Gin Press,” or a “Chest.” This machine held the mold in position while a lever was pressed into clay to form the hollow of the bowl. After the bowl was shaped, the piercing rod was removed from the stem and the shaped pipe removed from the mold. At this point, additional decoration could be applied to the pipe, including rouletting, also called milling, along the edge of the bowl using a small knife. The edges of the pipe were trimmed to remove any rough surfaces, and then the pipe was fired in a kiln at around 950ºC, or 1742ºF (Oswald 1975:16-19; Ayto 1979:12). A skilled pipe maker could produce up to 20 gross, or 3,000, undecorated pipes a week (Walker 1977:85). Noël Hume, (1969:296) citing a 1709 source, states that one gross sold for as little as two shillings.

There are a few differences in how pipes were made in England and Holland. Overall, Dutch pipes are shorter, smaller and thinner than their English counterparts (Harrington 1954:64; Noël Hume 1969:307; Oswald 1975:115; Bradley 2000:116). Oswald states that the thinness of Dutch pipes “is not approached by the English makers until the end of the 18th century.” The bowls of Dutch pipes were almost always rouletted throughout the 17th and 18th centuries, whereas, this treatment fell out of favor with the English in the early 18th century, and is rarely seen after. Similarly, Dutch pipes were usually polished to a glossy finish after 1700, while this is almost never seen on English pipes. Few early English pipes were decorated, and were never

Figure 2.1: Decorated Dutch Pipe with Minerva Motif (1670-1700) from Compton (18CV279). Courtesy Maryland Archaeological Conservation Laboratory.

as detailed as the Dutch pipes, which were decorated from the start of the industry (Figure 2.1). Dutch pipes found archaeologically are usually softer than English pipes; this is especially true of 17th century pipes that can be scratched easily with a pen knife; this is much more difficult to do on English pipes (Noël Hume 1969:307; Oswald 1975:115; Bradley 2000:116). Lastly, the method of creating the interior of the bowl differed slightly. While both used a chest to hold the pipe and mold in place, the actual act of hollowing the bowl out differed. The English would press a stopper into the bowl, leaving vertical striation on the interior of the bowl, whereas, the Dutch would screw the stopper into the bowl, creating circular striations in the bowl (Oswald 1975:16-18).

North America

Locally made pipes appear in the archaeological record in the New World, and while many of the early pipes are European copies, they are distinctly different than the imports. Pipes made in the New World were of locally dug, red clay, and range in color from orange to brown. There were no guilds or rules governing pipe makers in the Americas, and as a result, pipes manufactured outside of Europe have a variety of surface treatments, decorations and styles. Some were made of blended clays, producing an “agate” effect, while others were glazed. Probably the most well known tobacco pipe style manufactured in the United States is the two part pipe, in which a reed stem was inserted into a clay bowl; however, this does not become prevalent until the end of the 18th century, and then, almost completely replaces the one piece molded clay pipe in the 19th century. There are three well established areas of this type of pipe production known: Pamplin, Virginia; Point Pleasant, Ohio and the Moravian settlement of Bethabara, North Carolina (Noël Hume 1969:307-308; Sudbury 1977; Bradley 2000:118). Binford (1962:66) has stated that there was an influx of Canadian, more specifically Montreal manufactured, pipes to the eastern United States at the end of the 18th century. However, there is little evidence to support an exported Canadian pipe industry until the 1840's (Bradley 2000:117). None of the dating methods used on European pipes can be applied to these pipes.

Locally made historic pipes do appear in the archaeological record all along the East Coast, from Maine to Florida. However, the heaviest concentration of these red clay pipes is found on 17th century Chesapeake sites. These pipes have been referred to in a variety of ways, including terra-cotta pipes, Virginia pipes, Colono-pipes or Indian pipes. However, this variety is now usually called the Chesapeake pipe, in order to distinguish area and to not assign a single group as the producers of these pipes (Emerson 1999:47). Matthew Emerson, in his 1988 dissertation coined this term, but, it has since been questioned; particularly by Dane Magoon (1999), who suggested that this pipe tradition was also present in northeastern North Carolina. These pipes have been used to discuss a variety topics, including, but not limited to, who was making them, why they disappeared at the end of the 17th century, and what did they mean? (Agbe-Davies 2006:15-16) The majority of these studies have revolved around the unique decorations, often of abstract designs and animal motifs, found on the pipes (Figure 2.2). Emerson (1999:47) believes, and many agree, that the majority of these pipes were likely manufactured by enslaved African-Americans, while others believe these pipes represent Native American pipe traditions (Magoon 1999; Mouer et al. 1999). While this particular debate is not pertinent to this discussion, it is important to note that these locally made pipes cannot be subjected to the same formula dating methods as their European counterparts. In response to this, researchers from the *Jamestown Rediscovery* project (Monroe et al 2004) produced a formula for what they term Colono-pipes. The formula is: $Y=2073.98-50.57X$. It is solved the same way as the Binford formula (discussed in Chapter 3), where X is the mean bore diameter of the data set.

Figure 2.2: Chesapeake Pipes from Old Chapel Field (18ST233). Courtesy Maryland Archaeological Conservation Laboratory.

Alternative Uses

Clay tobacco pipes had relatively short life spans, one to two years from production to discarding (Noël Hume 1969:296); at least for their original purpose. However, archaeological and historical evidence points to alternative uses of pipes, and specifically pipe stems, after they were no longer useful for the consumption of tobacco throughout the 17th and 18th centuries. There is evidence of post-smoking uses of pipes from anywhere people were consuming tobacco, including Europe, Africa and the New World. The reuse that would require little to no modification of the pipe would be to adorn oneself with stem fragment beads (Huey 1974:107; Cressford 2001).

Figure 2.3: Pipe Stem Whistle From Kings Reach (18CV83-85). Courtesy Maryland Archaeological Conservation Laboratory.

The most commonly found reuse of a pipe stem fragment is as a whistle (Figure 2.3). This modification has appeared in the archaeological record numerous times, mainly in the Middle Atlantic region of the United States (Huey 1974:107; Heath et al. 2009:102; MAAC Lab 2009), but has also been found in Europe (Walker 1979:124) and European settlements in Africa (Graf 1997; Cressford 2001). This appears to be more common among the Dutch and Dutch colonists than the British (Huey 1974:107; Walker 1976:124).

There is archaeological evidence pointing to other uses of pipes. An 18th century walkway was excavated in Colonial Williamsburg, revealing the use of over 15,000 pipe stems as paving material (Noël Hume 1974). Jones (1979) has suggested that 289 pipe fragments found with 320 ceramics sherds off the coast of Fernandina Beach, Florida represent the dumping of ballast; ballast being any objects placed in the hull of a ship to keep it from capsizing. This use seems highly unlikely given how light clay pipes are, and probably represents refuse from the bilge.

Lastly, the most gruesome alternative use of tobacco pipes comes from the historical record. There are at least two recorded cases of men using pipe stems as weapons. The earliest example comes from London in which one pipe maker stabbed a fellow pipe maker in the eye, killing him in 1615. The first pipe maker was convicted of manslaughter (Oswald 1975:133; Walker 1976:124). In 1666, a similar incident occurred during a quarrel between two men, again resulting in death by pipe stem (Walker 1976:125).

With the exception of the last utilization mentioned, these alternative uses do appear in the archaeological record, and could affect dating, due to the curation effect. In other words, the extended use of artifacts, in this case pipe stems, past the original production and normal discard time, could ultimately effect the date produced by dating methods.

Non-Formula Dating Techniques

The earliest method of pipe dating, before pipe stem formulae, was to date the bowl by its morphology; some claim that this is still the better method (Noël Hume 1969:302; Oswald 1975:126). The earliest study of tobacco pipe bowls was published by Adrian Oswald in 1951 and all successive studies have been based on this work. He showed that pipe bowls change in shape over time, not only increasing in bowl capacity, but also the angle at which the bowl is attached to the stem. Oswald (1975:29-41), expanded on his original analysis to provide detailed drawings of English bowl shapes throughout the 17th and 18th centuries. He dated these bowl shapes using pipes in England from dated archaeological contexts, primary source paintings and drawings, pipes with dates molded onto them and pipes with makers' marks (Oswald 1975:29). Noël Hume (1969:303) produced a simplified version of Oswald's bowl typology, as seen in Figure 2.5.

The most accurate of the non-formula dating methods is to use maker's marks; again, most of the work done in regards to identifying pipe makers was conducted by Adrian Oswald in 1951 and 1975 in England. Oswald (1975:128-204) has compiled an extensive list of pipe makers, their marks and their active dates in Great Britain. These marks can be found anywhere on the pipe, but their location is often temporally dependent. Marks were usually placed on the bottom of the bowl, on the heel, in the early 17th century. By the end of the century, makers began placing their marks on either side of the spur or heel. Marks continued to be placed on either side of the spur or heel into the 18th century, with the additional popularity of stamps on the back of the bowl. Maker's marks were sometimes placed on stems throughout the 18th century, but this was less common than bowl stamps (Noël Hume 1969:304-305).

Another way to date pipes is with the decoration. This method will not produce exact dates, but provides a general date range the pipe could fall into. For example, in the mid-17th century, it was popular to decorate the stem with fleur-de-lis stamps, whereas, in the late 17th and early 18th century, it was more popular to decorate a stem with spiral fluting (Noël Hume 1969:305). Bowls with faces or decorative raised dots in the shape of trees have been found on 17th century pipes. The practice of molding the reigning monarch's coat of arms onto the bowl became popular in the 18th century; this of course would date a pipe to the time of the particular monarch the arms dates to (Noël Hume 1969:305-306).

The techniques used for the three non-formula dating methods can also be used to identify Dutch pipes. Dutch pipe bowls, and pipes overall, were smaller than the English; particularly notable is the "egg" like, or bulbous, shape of Dutch bowls. Makers' marks are not as common on Dutch pipes, and those that are present are very small, and are usually found on the base or back of the bowl (Noël Hume 1969:307; Atkinson and Oswald 1972:177, 181). Dutch pipe makers' marks were registered and controlled by guilds, and over 100 have been collected and listed by the Dutch archaeologist F.W.H. Friederich (1970), and partially reprinted in English by Atkinson and Oswald (1972). Dutch bowls are often noted for their elaborate decorations, particularly rouletted edges, and molded motifs (Noël Hume 1969:307). Dutch pipe stems were often decorated with heavy Baroque designs, including milling, geometric patterns, and fleur-de-lis (Noël Hume 1969:307; Atkinson and Oswald 1972:179). For a guide to identifying Dutch pipes that includes many drawings of pipe shapes, sizes and decorative patterns, see Atkinson and Oswald 1972.

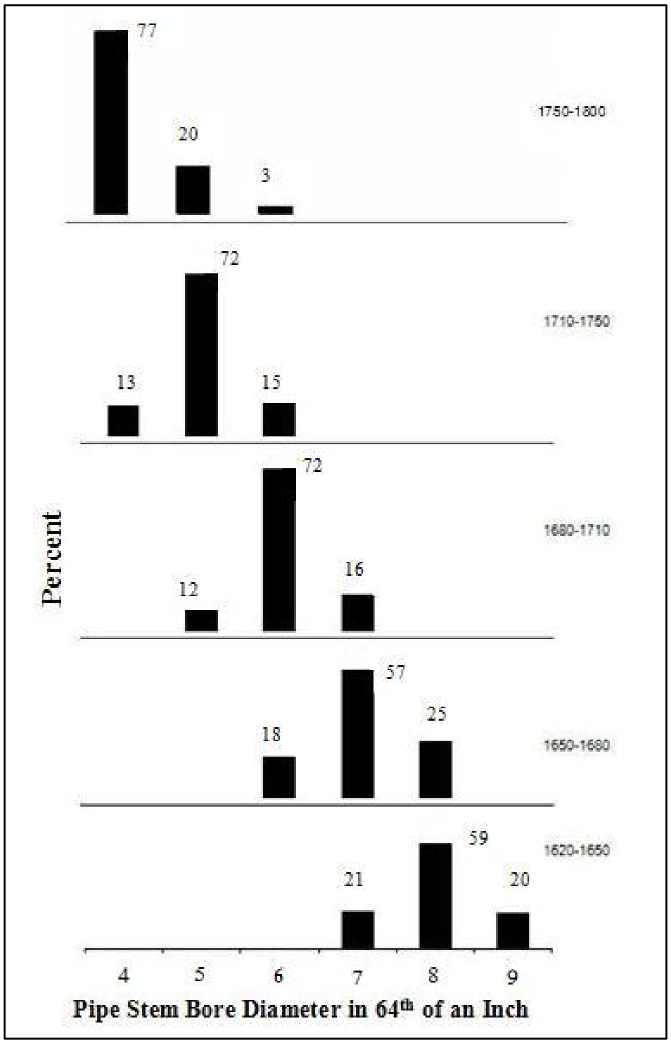

Figure 2.4: Histogram of Time Periods. Based on Harrington 1954:64

J.C. Harrington was the first archaeologist to consider using pipe stems as dating tools, and in 1954 wrote his influential article “Dating Stem Fragments of Seventeenth and Eighteenth Century Clay Tobacco Pipes.” In this article Harrington observes that imported English white clay tobacco pipe stem fragments from sites in Virginia change over time in a predictable manner, following the basic trend of decreasing bore diameter from the 17th century into the late 18th century. He tested this idea by measuring 330 stem fragments from 17th century Jamestown sites and 18th century Colonial Williamsburg sites using drill bits in 1/64th inch increments, from 9/64$^{th”}$ to 4/64$^{th”}$. Harrington states that he only used English pipe stem fragments, but does not say how he determined this. There is no mention if he used only decorated stems or stems still attached to bowls. Based on the results, Harrington defines five time periods over which relative percentages of bore diameter decreased (Figure 2.4). These time periods are 1620-1650 with the majority of the bore diameters measuring 8/64”, 1650-1680 with the majority at 7/64”, 1680-1710 at 6/64”, 1710-1750 at 5/64” and 1750-1800 at 4/64.” He states that a sample size of ten or more fragments is necessary to use this method and that the accuracy begins to break down at the end of the 18th century (Harrington 1954:64).

There have been some criticisms of the “Harrington Theory,” as it has become known (Noël Hume 1969:298). The main argument against this method is the accuracy of bore measurements. Alexander (1979:83) discusses how the piercer could wear down over time, resulting in smaller stem holes produced by the same maker using the same wire piercer within one year. It has also been noted that the end of a stem may become enlarged when the wire to form the hole is taken out. These end fragments can produce two measurement sizes, and thus an erroneous mean bore size (Harrington 1954:65; Alexander 1979:83). Walker (1965:61) suggests that the blunt end of the drill bit should be used, and not the spiral end to try and avoid distorted results. Alexander (1979:85) suggests the use of a step gauge measuring bit to help determine if the stem’s bore is two different sizes.

Garry Wheeler Stone, formally of Historic St. Mary’s City, proposed an alternative to the Harrington method in 1977. His goal was to produce tighter mean bore sizes by measuring pipe stems in smaller increments. The suggested size was 1/128”, but since drill bits are not made in that size, he used drills in 0.2mm increments. He states that the metric drill bits are close enough to his goal because 1/128” = 0.0078” and 0.2mm = 0.0079”. His recommendation was to create a new, non-mathematical method of dating based on these measurements in smaller sizes. Stone’s suggested method was never produced, but it is an interesting idea that may one day be developed, since the archaeologists at Historic St. Mary’s still measure in metric.

CHAPTER 3: METHODS

Formula Dating Methods

Binford

In 1962, about ten years after Harrington wrote his paper about the use of pipe stem bore diameter as a dating technique, Lewis Binford expanded on Harrington's histogram of time periods and applied a linear regression formula to the relative percentages. The Binford regression formula, Y=1931.85-38.26X, is a fairly simple idea. He calculated the theoretical expected date at which the bore diameter would reach zero, 1931.85, and the interval between the means of the Harrington time periods, 38.26. With these numbers, given X, the mean diameter for the sample being used, archaeologists can calculate Y, the mean date of the data sample. Binford cautions that four conditions must be met for this formula to work: 1) the sample must be from before 1780; 2) the sample must be random; 3) the sample must be representative of the site and 4) there must be a constant rate of deposition at the site. He explains that the sample must date to before 1780 because that is the point in which white clay pipe production begins in Montreal and other places in North America. These New World pipe makers were using earlier styles, which would in turn produce earlier dates. Lastly, Binford states that the estimated length of accumulation can be determined by calculating the standard deviation of the sample mean (Binford 1962:66-67).

Hanson

In 1968 archaeologist Lee Hanson Jr. developed a new method using pipe stems to date historic sites. Hanson's goal was to combine Harrington's set time periods and Binford's mean date and add standard deviation. He developed ten straight-line regression formulas (Table 3.1) based on the means of each of Harrington's time periods. Each formula has its own time bracket, and researchers must select the appropriate bracket based on their hypotheses regarding the dates of their site. These formulas are similar to Binford's, in that X is still the mean bore diameter of the sample being used and still produces a mean date. Hanson claims that his formulas are more accurate than Binford's because he uses shorter time periods, and does not assume each period is equally divided. The additional use of two standard deviations provides a date range for the mean date (Hanson 1968:1-5).

	Time Range	**Formula**
1	1620-1680	Y= 1891.64 - 32.09X ± (2SD) (15.00)
2	1620-1710	Y= 1880.92 - 30.70X ± (2SD) (15.00)
3	1650-1710	Y= 1869.31 - 28.88X ± (2SD) (15.00)
4	1620-1750	Y= 1887.99 - 31.66X ± (2SD) (16.25)
5	1650-1750	Y= 1888.06 - 31.67X ± (2SD) (16.67)
6	1680-1750	Y= 1894.88 - 32.98X ± (2SD) (17.50)
7	1620-1800	Y= 1919.10 - 36.06X ± (2SD) (18.00)
8	1650-1800	Y= 1930.24 - 38.23X ± (2SD) (18.75)
9	1680-1800	Y= 1959.66 - 44.32X ± (2SD) (20.00)
10	1710-1800	Y= 2026.12 - 58.97X ± (2SD) (22.50)

Table 3.1: Hanson's ten regression formulas
Adapted from Hanson 1968:5

However, in 1971 Hanson recanted his 1968 article, and claimed that Binford had shown him evidence that his formulas were "based on an unwarranted assumption and can therefore be dismissed" (Hanson 1971:254). This was a response to Binford's 1971 article which claims, among other things, that Hanson's work was based on a misunderstanding of statistics and that decreasing bore diameter is patterned and thus observable in his linear formula.

Heighton and Deagan

Another formula was introduced in 1971 by Robert Heighton and Kathleen Deagan who agreed with Hanson's argument that pipe stem bore diameters do not follow Binford's single line regression. In order to address this, they measured a total of 26 stems from 14 sites dating from 1635 to 1775. A mean date was computed for each individual stem, and then they produced a formula based on these results (Heighton and Deagan 1971:221). The authors suggested that bore diameters should be applied to a curvilinear line and proposed a two part equation: a logarithmic formula ($X= (-\log Y + 1.04435)/ 0.05324$) and a point of origin formula ($\text{date}= 1600+ 22X$).

To solve for this curve and obtain a mean date, one must follow a three step process. First determine Y, the mean bore diameter; this is similar to the X that is solved for both the Binford and Hanson formulas. The Y value (mean bore diameter) is then converted it to its logarithmic form. Secondly, solve the first equation ($X= (-\log Y + 1.04435)/ 0.05324$) using the logarithmic form of Y that was determined in the first step. The last step is to use X, which is determined by the first equation, to solve the second equation. In this formula, 1600 is the point of origin, or the theoretical start of stem bore size, and 22 is the estimated years between each decrease in bore diameter.

Formula Dating Critiques and Discussion

The Hanson and the Heighton and Deagan methods are used infrequently, and there are few examples of their use in the archaeological literature, while the Binford formula is universally applied to all pre-1800 British colonial sites, usually in conjunction with Harrington's histogram of time periods. In fact, the Binford method is one the most relied upon and frequently used dating techniques in British Colonial Archaeology despite criticism by many authors based on numerous examples of the formula producing inconsistent dates (Noël Hume 1963; Walker 1963:61-62; Alexander 1979: 82-83; Noël Hume 2003). Alexander (1979:85) writes that one possible reason for these anomalous dates is that archaeologists assume that a change in mean bore diameter reveals a temporal period, instead he says it "might reflect merely a change in the number of pipe smokers living on a site during its occupancy." Walker (1963:62) points out that the Binford method may produce these incorrect dates because the data he used from Harrington is not perfect, and could not be perfect. He states

> …had Harrington used other, but similarly dated material, his percentages would doubtless have varied slightly from those in his paper, but visually the histograms would have remained the same, while Binford's formula, by giving an appearance of exactness from figures that could not be exact, would appear to alter much more substantially if applied to another set of basically similar histograms.

However, not everything Walker discusses in his 1963 article is negative about the Binford formula. He provides data from his excavations in Louisbourg, Newfoundland that produced very accurate Binford dates from the 1750's fort's casemates. His data from the 1720's casemates produced Binford dates 20 plus years later than the known occupation dates. Walker's explanation for this is the large amount of Dutch pipes present in the earlier contexts, fifty percent or more (61). This is the usual explanation when pipe stem formulae do not match the predicted dates.

Oswald (1975:126) has suggested that pipe stem dating should be disregarded due to the many inaccuracies produced by the Binford and Hanson formulas (he did not discuss the

Heighton and Deagan method). He points out that any statistical method has a standard deviation of ±10-15 years, which he finds unacceptable, stating "there is little point in a tedious measurement of quantities of stems if bowls are available." Audrey Noël Hume (1979:6) expressed similar concern when she said that a formula date inaccurate by more than 15 years is less than adequate.

Others have approached the subject of pipe stem dating from a statistical point of view. Thomas (1978:232) praises Binford, stating that his formula is an "excellent example of how statistical methods directly benefit archaeologists." Thomas (1978:233) goes on to explain that the Binford formula is great because it is simple to use and easy for archaeologists to understand and that "nobody can question the effectiveness of statistical methods when they provide such neat, even elegant solutions to concrete archaeological problems." Hole (1980:288) completely disagrees with Thomas saying "I would no more use the pipestem formula to date a historic site than I would average the dates on the coins in my pockets to date my pants." She criticizes stem dating because the regression is based on averages of diameters (from Harrington), not on separate individual points, and thus the "variability in the data is hidden in the averaging process" (Hole 1980:287). Although she is only discussing the Binford formula, her criticism can be applied to the other two formula dating methods.

Another concern that could affect the accuracy of these dating methods is where the original research was conducted. The 330 stems originally measured by Harrington were all from three sites in the same area of Virginia and may not be representative of assemblages from other regions. The Binford and Hanson formulas are based on Harrington's results, and while the Heighton and Deagan formula is not derived from Harrington's measurements, the majority of their data are from the same area of Virginia (Heighton and Deagan 1971:224-225). Factors that could have an effect on assemblages are: the amount of trade available to an area, where trade items are coming from, and the preferences of the individuals engaging in consumption and deposition habits. Another obvious criticism of the Heighton and Deagan formula is that it is based on a very small sample size; 26 stems.

Previous Studies

In the same article that Hanson withdrew his own formulas, he called for a study of all pipe stem dating methods. He was specifically targeting Binford's method, and argues "a review of the literature since 1962 will show how often the Binford formula has been misused and how interpretations based on it have been slanted to conform to preconceived ideas" (Hanson 1971:256). This problem has only increased over time to the point where most archaeologists only use the Binford formula, to the exclusion of the Hanson and Heighton and Deagan methods. There have been three other studies of pipe stem dating methods similar to this one (Fox 1998; Beaman 2005; Mallios 2005); one of which contradicts the results of this analysis, one that coincides with them, and one that contradicts and coincides.

Georgia Fox, in her 1998 dissertation on Port Royal, Jamaica pipes, compares the Binford and the Heighton and Deagan formulas using the known beginning occupation date of 1655 and the end date of 1692 provided by the earthquake that destroyed the harbor city. There was evidence of 18th century occupation on the site; however, Fox only used the 18,537 pipes that were sealed in the mid to late 17th century contexts. Of those 18,537 pipes all but nine were likely manufactured in Bristol, England; this was determined by decoration and maker's marks. One was made in Broseley, England, two were from London and six were from the Netherlands; she excluded the Dutch pipes from her study (Fox 1998:23-24). Fox concludes that the Binford formula compares more favorably than the Heighton and Deagan, which she found to be consistently off by 20 years, while the Binford formula results were often different from the given dates by less than 10 years (113). Fox's results differ from those found during this investigation, which will be discussed in Chapter 6. These differences are likely because she was using one, fairly early, site compared to the multiple sites from a 200 year time period used in this study of pipe stem dating.

Thomas Beaman's 2005 study of pipe stem dating in North Carolina supports the results of Heighton and Deagan being the most reliable of the three formulas. Beaman used pipe stem data from eight house sites in Brunswick Town, North Carolina; he recounted and remeasured all of the pipe stems used in his study. He found the Heighton and Deagan results closest to the predicted means, followed by the Binford formula and then the Hanson method. His analysis also supported the generally accepted rule that formula dating tends to fall apart at the end of the 18th century. The biggest difference between Beaman's study and this one is that he used entire house site assemblages, not just isolated features. While this study does include some of the same sites that Beaman used (see Chapter 4), the pipe stem counts are not the same for two reasons; individual features were separated out for a tighter analysis and counts for this study were obtained from the original artifact catalog, not from Beaman's reanalysis. Beaman attributed these differences to the loss of artifacts during storage and display of items.

Seth Mallios conducted a study in 2005 on pipe dating. The purpose of his analysis was to compare his newly formed pipe bowl formula to the three pipe stem formula dating methods and known feature mean dates to determine which of the four methods was the most useful. The features used dated between 1607 and 1660. Mallios' formula is very similar to South's Mean

Ceramic Date formula, which, is based on Binford's pipe stem formula. The new pipe bowl formula goes like this (Mallios 2005:93):

1. Identify and note each pipebowl form within the given bowl typology, based on Atkinson and Oswald (1969).
2. Count the number of bowls represented by each form
3. Multiply the number of bowls in each type by the midpoint year of each typological date range
4. Sum these midpoint and divide by the total number of measurable bowls in the sample.

Mallios found the Hanson formula to have the smallest difference between the known mean date and the formula date at 7 years on average, and it fell within the established date range 87.5% of the time. This was followed by the Binford at 12 years on average and 37.5%, and Heighton and Deagan at 21 years and 12.5%. The results of Mallios' analysis initially would seem to contradict the results of this analysis, in that he found the Heighton and Deagan to be the least accurate. However, as will be discussed in Chapter 6, it does in fact correlate with this study; the Heighton and Deagan formula works better in Maryland in the early 17th century than in Virginia, whereas, the Binford and Hanson formulas produce more favorable results on early Virginia sites compared with early Maryland sites. Mallios' use of features from only one site, all within thirty years of one another, obviously restricts the utility of the study to archaeologists working outside of this immediate area.

Analytical Methods

The overarching theme of this analysis is: what is the purpose of tobacco pipe stem dating and how useful is it? There were two main goals to this research project, and many questions within each of those goals. The first goal was to establish which of the three formula dating methods, the Binford, the Hanson or the Heighton and Deagan, is the most accurate and consistent. The second goal was to determine if there was any regional variation in the formula results and what factors may be affecting them. In order to address these questions, pipe stem bore diameter counts were collected and recorded from 64 individual features from 26 sites in Maryland, Virginia, North Carolina and South Carolina. Each of the 26 sites and 64 features are discussed in Chapter 4. All three formulas were calculated for each of the features.

In order to address the first goal, the formula means calculated were compared to the means assigned by the excavator in order to determine the average number of years away from the predicted mean the formula dates were. Secondly, simple percentages were calculated to determine how often the formula date fell within the date range assigned by the excavator. Lastly, the strengths of the formulas were determined by plotting the formula results against the predicted means into a scatter plot with a straight line regression. The r^2 value of each formula was then calculated.

The same three tests were conducted for each of the four states to address the second question of regional variation, with one additional comparison. The differences found in the first test were analyzed not only to determine the average number of years away from the predicted mean the formula means were, but also how often the formula's results produced was less than or greater than the given mean. All of these results were then evaluated for regional patterns and differences.

CHAPTER 4: SITE DESCRIPTIONS

Project Parameters

In order to test the utility of these three formula dating methods pipe stem bore diameter data were collected from 64 sealed features from 26 sites in Maryland, Virginia, North Carolina and South Carolina. There were 11 sites from Maryland, 5 from Virginia, 7 from North Carolina and 3 from South Carolina. Of the 64 features used, 23 are from Maryland, 22 are from Virginia, 12 are from North Carolina and 7 from South Carolina. The sites and features are discussed in Chapter 4. This information was collected from site reports and artifact catalogs. Only raw counts of bore diameter size were used; if only percentages or Binford mean dates were given, the data were not included. In order to manage the data and maintain similarity among sites from a wide geographic range each of the sites used had to fit certain parameters before they were included in the analysis.

First, data were drawn from sites dating from 1600 to 1800. While some authors (Noël Hume 1969:300; Higgins 1999) have argued that the Binford formula only works on sites dating from 1680 to 1760, the cut off times were chosen based on Harrington's original time periods in order to acquire a better understanding of all three methods. Only data from European settler sites were collected; no African American or Native American sites were used. Only sealed, undisturbed and tightly dated features were used. Features used for less than 25 years were preferred; however, this time restriction was not always possible to meet. The sites used had to be dated through the historical record or with other temporally diagnostic artifacts than pipes, such as ceramics. Each feature had to have at least 25 measurable pipe stems to be included. While this sample size was arbitrary and much lower than the 900 stem sample size suggested by

Audrey Noël Hume (1963:22), it is larger than the size of 10 originally proposed by Harrington (1978:64). Lastly, no locally made pipes were sampled; only white ball clay pipes were used. The following is a breakdown of information regarding each of the sites used in this study.

Maryland

Twenty-three features were used from eleven sites in Maryland. The majority of these data were collected from site reports located in the library of the Maryland Archaeological Conservation Laboratory. There were three exceptions to this: St. John's, whose data were collected from artifact catalogs, and Abell's Wharf and Harmony Hall's were collected from articles. The majority of the sites used are located in St. Mary's County, near the Potomac River; directly across the river from the Northern Neck of Virginia. The features used range in date from the 1630's to the 1750's, with the majority dating to the late 17th/ early 18th century. Table 4.1 shows the breakdown of sites within each of Harrington's time periods.

Harrington Time period	Number of Features
1620-1650	2
1650-1680	3
1680-1710	8
1710-1750	10
1750-1800	0
Total	23

Table 4.1: Breakdown of Features in Maryland by Time Period

St. John's (18ST1-23)

The earliest dated contexts used from Maryland are from the St. John's site in St. Mary's City, St. Mary's County. St. Mary's City, established in 1634, was this first colonial capital of Maryland, and the 1638 St. John's house was one of the earliest permanent buildings built in the colony. The building was used as a private home until approximately 1667, when it was converted to a public ordinary and then into a probate office in 1693. St. John's disappears from the historical record after this final change in use; however, archaeological evidence suggests that it was occupied into the first decade of the 18th century (Hurry and Keeler 1991:37).

The site number for all of Historic St. Mary's City is 18ST1, with each individual location receiving an additional number, so that St. John's site number is 18ST1-23. The data from this site were collected from the artifact catalog located in the Historic St. Mary's City archaeological lab; this information is not published, but is on file (2009). The site's features were split into three occupational periods (1638-1665, 1665-1685 and 1685-1715), based on both the historical record and archaeological data. Five features used in the analysis are from St. John's (Table 4.2) One feature, Circular Pit, was split into two data sets, "Phase 1" and "Total," which includes two deposition periods, because the Phase II deposition did not have enough pipe stems to be included alone.

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Dairy	1638-1665	12	23	1				36
Circular Pit Phase I	1638-1665	27	18	2				47
Circular Pit total	1638-1685	28	28	4				60
Ditch	1665-1685	2	12	14				28
Potatoe Pit	1685-1715	1	6	8	31	5		51
Trash Pit	1685-1715		69	52	24			145

Table 4.2: St. John's (18ST1-23) Pipe Stem Counts by Bore Diameter

Tudor Hall (18ST677)

The Tudor site is located in St. Mary's County, near Leonardtown. The tract of land on which the site is located first shows up in the historical record in 1649, when it was given to settlers for immigrating to the colony. There is no historical evidence that the owners ever lived on the property, instead it was likely occupied by tenants. The site was dated using temporally diagnostic ceramics and marked pipe bowls (not pipe stem formulae). One feature (4.3) from Tudor Hall was used in this analysis, a cellar. The pipe stem data were collected from the Phase II site report (Child et al. 1998).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Cellar	1650-1675		13	13	2			28

Table 4.3: Tudor Hall (18ST677) Pipe Stem Counts by Bore Diameter

Charles Gift (18ST704)

This late 17th century site is located in St. Mary's County along the shore of the Patuxent River. Originally given to Jesuits by the King of the Patuxent Tribe in 1637, the land went through a series of owners until it was seized by Charles Calvert, the governor of Maryland in 1655. Calvert then presented the property to his new wife, Jane Sewall, in 1668, who in turn, passed the land onto her son, Nicholas Sewall in 1684. Sewall lived at Charles Gift with his wife until his death in 1737. One feature (Table 4.4), an intact cellar called Feature 12, was used for this project. There were 366 pipe stems found in this feature, and of those, only 222 were measurable. This feature was dated using historical documents and temporally diagnostic artifacts, including ceramics. The Mean Ceramic Date of the cellar is 1709. The data from this cellar were collected from the Phase III site report (Hornum et al. 2001).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Feature12	1670-1700		36	122	61	3		222

Table 4.4: Charles Gift (18ST704) Pipe Stem Counts by Bore Diameter

Old Baltimore (18HA30)

This site, now in Harford County, is the location of the original Baltimore County seat, established in 1674. By the end of the late 17th century, the county courthouse had been built and many public ordinaries had been established in the town. The county government abandoned Baltimore Town by 1712. The remains of an ordinary belonging to James Phillips were discovered during a Phase II archaeological investigation. Three contexts (Table 4.5) from the Phase II report provided pipe stem data used in this analysis. Two were associated with the kitchen; one, the fill located inside of the building, and the other a waste midden outside of the kitchen. The well was also included. All three were dated using diagnostic artifacts (Davis et al. 1999).

Context	**Date**	**9/64"**	**8/64"**	**7/64"**	**6/64"**	**5/64"**	**4/64"**	**Sum**
Kitchen fill	1675-1700		32	46	45	9		132
Well	1680-1710		9	23	58	3		93
Kitchen waste	1680-1710		12	48	25			85

Table 4.5: Old Baltimore (18HA30) Pipe Stem Counts by Bore Diameter

Main Street (18AP76)

The remains of an early 18th century post in ground building were uncovered during a cultural resource recovery project conducted in preparation for new construction on Main Street, in Annapolis, Maryland. Two of the features (Table 4.6) discovered, both trash pits, provided enough pipe stems for the analysis. No date ranges were assigned to the features in the site report, however, Mean Ceramic Dates were provided. These mean dates were used for comparison with the pipe stem formula results (Fefr et al. 1997).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
F4-05 Trash Pit	MCD: 1695		23	28	49	18		118
F4-04 Trash Pit	MCD: 1718		20	46	46	41	1	154

Table 4.6: Main Street (18AP76) Pipe Stem Counts by Bore Diameter

Abell’s Wharf (18ST53)

The Abell’s Wharf site is located in St. Mary’s County along the Potomac River near Leonardtown, Maryland. The majority of the property’s components are prehistoric, however, there was a late 17th/early 18th century occupation site located in the 1975/1976 field season. One feature from the historical component of the site fit the parameters to be included in this study, a trash pit (Table 4.7). The data for this site were collected from a journal article (Humphries 1991).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Trash Pit	1690-1710	5	92	188	105	55	1	446

Table 4.7: Abell's Wharf (18ST53) Pipe Stem Counts by Bore Diameter

Garrett’s Chance (18PR703)

The Garrett’s Chance site is located in Prince George’s County, near the Patuxent River. The late 17th/early 18th century earthfast house site was assigned the number 18PR703. It is known through the historical record that Bernard Johnson purchased this land is 1679 and lived there until his death in 1702, at which point it went to his daughters and then to William Wilkerson in 1711. The house that was discovered was likely built by Johnson, and occupied by him or one of his tenants, based on the archaeological record. The building appears to have burnt down sometime in the second quarter of the 18th century, at which point the debris was pushed into the large root cellar in the middle of the house. This cellar, and a clay borrow pit that was used as a trash pit, were both included in this pipe stem analysis (Table 4.8). These two features were dated using ceramics. Feature 1 was not included in the study because it was dated using the Binford and Hanson pipe stem formulae. This information was obtained from the Phase I and Phase II site report (Gibb 2006).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Root Cellar	1690-1730			5	22	6		33
Feature 21: Trash Pit	1720's			2	14	18		34

Table 4.8: Garrett's Chance (18PR703) Pipe Stem Counts by Bore Diameter

<u>Harmony Hall</u>

The Harmony Hall site is located in Fort Washington, Maryland along the upper Potomac River. The property's name is derived from the 1723 Georgian mansion still standing. The three features used in this study predate the construction on the great house (Table 4.9). The pipe stem data were collected from an article on pipe dating in Maryland (Humphries 1991).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
F17	1692-1720		6		18	113	106	33
F63	1692-1720			1	20	15	2	34
F22	1720's			7	10	18	1	

Table 4.9: Harmony Hall Pipe Stem Counts by Bore Diameter

Fly (18ST329)

The land on which the Fly site is located on was originally purchased by Jesuit missionaries in 1637, in addition to the nearby Inigoes Manor (18ST330) and Old Chapel Field (18ST233). All three locations were settled by the Jesuits, who grew tobacco and other crops to support the mission church. The Fly site is distinguished from the other two by an early 18th century timber framed, sill-set house with a brick floor. The floor context and the rubble located on top of the brick floor were used for this analysis (Table 4.10). Ceramics were used to date this site. Jesuit ownership of the property continued into the 20th century, when the land was sold to the Department of the Navy in 1942. The pipe stem data were collected from the Phase II site report (Sperling and Galke 2001).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Fly: floor	1700-1720's	3	10	40	71	54	14	192
Fly: rubble	1700-1720's	2	4	12	16	26	6	66

Table 4.10: Fly (18ST329) Pipe Stem Counts by Bore Diameter

Oxon Hill Manor (18PR175)

The site known as Oxon Hill Manor, or the Addison Plantation, is located in Prince George’s County. The property was continually occupied from the 17th century into the 20th century. The land was originally purchased in 1687 by John Addison, whose descendants maintained control over the estate until 1810. The original Addison manor house was built sometime around 1711 and stood until a fire destroyed it in 1895. The Area 1 well (Table 4.11) that was used in this paper likely dates to the early 18th century occupation. Sections B, C and D (the bottom three layers) were combined for the purpose of this study. Section A was not used because it contained modern intrusive artifacts. The three layers used were dated with the numerous ceramics found, many of which cross-mended within layers, and other artifacts, such as the many wine bottles discovered. Fifty-six of these bottles or bottle fragments were scratched with the letter “A” or “A 1726,” standing for Addison. The data used were collected from the final site report (Garrow and Wheaton 1986).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Area I Well	1720-1750		1	2	53	700	176	932

Table 4.11: Oxon Hill Manor (18PR175) Pipe Stem Counts by Bore Diameter

<u>Robert’s (18CV350)</u>

The Robert’s site is located along the Chesapeake Bay in Calvert County, Maryland. This low density site was excavated during a Phase II impact survey. One large feature, feature 40 (Table 4.12) was discovered during the course of the investigation. Feature 40 was dated to the mid-18th century based on the presence of white saltglazed stoneware, and lack of refined earthenwares. The pipe stem data were collected from the Phase II report (Gibb 2005).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Feature 40	1720's-1750's				1	21	24	46

Table 4.12: Robert's (18CV350) Pipe Stem Counts by Bore Diameter

Virginia

Twenty-two features from five sites in Virginia were sampled for this analysis. The majority of the information gathered is from the Northern Neck of Virginia along the Potomac River across the river from Historic St. Mary's City, Maryland. One site, Ferry Farm is located on the Fall Line between the Northern Neck and the Tidewater of Virginia, while the other two, Sandys and Gloucester are in the Williamsburg area. The sites from Virginia range in date from the 1620's to the 1740's. Most of the sites used are from the early 18th century. Table 4.13 shows the breakdown of sites within each of Harrington's time periods.

Harrington Time period	Number of Features
1620-1650	2
1650-1680	3
1680-1710	7
1710-1750	10
1750-1800	0
Total	22

Table 4.13: Breakdown of Features in Virginia by Time Period

Sandys (44JC802)

This site is located in James City County near the James River, and five miles from Jamestown Island, the location of the 1607 settlement. Three post-in-ground buildings and twenty-two other features were discovered archaeologically on the tract of land that was originally purchased by George Sandys in 1624. The historical record shows that Sandys never lived on the property; instead, it went through a series of owners and tenants throughout the 17th century. Two features from Sandy's were used in this project, a storage pit and a daub pit (Table 4.14). This site and the individual features were dated using ceramic mean dates and chronology, pipe bowl shape and marks and what the author terms copper quotients (CQ). CQ is a mean date derived from the percentage of copper within a sealed feature; researchers at *Jamestown Rediscovery* have shown that on 17th century sites in this area, the later a site and/or feature is, the higher the percentage of copper found is. This dating technique has additionally been used at other nearby Jamestown sites successfully. All of this information was gathered from the final site report (Mallios 2000).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Pit 1	1620's	12	110	16	1			139
Daub Pit	1630-1640's	6	81	43				130

Table 4.14: Sandy's (44JC80) Pipe Stem Counts by Bore Diameter

Gloucester (44GL407)

The area of land in Gloucester County that this site is on was originally patented in 1643 by Thomas Williams, and is located near Williamsburg. It is unclear if the mid-18th century component of the site used in this study represents Williams' occupation, or that of a tenant. One feature, Feature 1, contained enough pipe stems to be included in this analysis (Table 4.15). Feature 1 was interpreted as a clay borrow pit that was quickly filled in after its original excavation in the mid-17th century. The feature was assigned this date range based on site feature chronology based on pipe bowl dating. All information was gathered from the Phase II site report (Brown and Harpole 1997).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Feature 1	1650-1675		17	22	26			65

Table 4.15: Gloucester (44GL407) Pipe Stem Counts by Bore Diameter

Clifts Plantation (44WM33)

Clifts Plantation is located in Westmoreland County, Virginia along the Potomac River; it is across the river from Historic St. Mary's City, Maryland. This tract of land was patented in 1651 by Nathaniel Pope, and was likely inhabited by tenants from the late 17th century into the early 18th century. In the early part of the 60 to 70 year occupation time, a large earthfast house was built, and then palisaded. The property was purchased by the Lees in 1716, and the buildings at Clifts were demolished after 1729 for the new road leading from the river to the construction site of the 1738 Lee mansion, Stratford Hall.

Fourteen features (Table 4.16) from this site were used in the pipe stem analysis; all data were collected from the final site report. There were four phases assigned to the features at Clifts Plantation by the excavator: Phase I: 1670-1685, Phase II: 1685-1705, Phase III: 1705-1715 and Phase IV: 1720-1730. These phases were established using historical documents and ceramic chronology; features from all four phases were used in this analysis. Phase I was determined by domestic lead-glazed coarse earthenware, Phase II by Staffordshire slipware, Phase III by British stoneware and Phase IV by slip-dipped white salt glaze (Neiman 1980).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Pit 289	1670-1685	6	22	100	12	2		142
Pit 305	1670-1685	1	15	20	5			41
Palisade	1685-1705	1	14	21	5			41
Feature 262AB	1705-1715		2	6	10	13		31
Fence	1705-1715		24	28	45	59		156
Feature 255 A-E	1705-1715		4	5	114	552	2	677
Feature 255 F-Y	1705-1715		1	3	34	38		76
Feature 288S-AD	1705-1715		3	13	25	22		63
Feature 269A-F	1720-1730	1	3	18	37	60	2	121
Feature 277A-C	1720-1730				8	19		27
Feature 280	1720-1730			4	40	90	1	135
Privy	1720-1730		2	1	9	21	1	34
S16 Cellar	1720-1730		1		53	195	1	250
S3 Cellar	1720-1730		11	31	298	927	55	1322

Table 4.16: Clifts Plantation (44WM33) Pipe Stem Counts by Bore Diameter

Newman’s Neck (44NB180)

This area in Northumberland County, Virginia along the Potomac River first saw an influx of British colonists in the early 17th century, who were trading with local Native American populations. It was not until 1640 that more permanent settlements were established. Robert Newman was given a land grant in 1651, and moved his family there shortly after. The property then changed ownership five more times until the end of occupation in 1762. Despite Newman supplying his name to the site, it is unlikely that he built and occupied the dwelling and dependencies that were excavated and reported on. Instead, this is attributed to the 1670’s owners, Elizabeth Neale and her husband, and their descendants.

The site’s features were assigned to two phases, Phase I: 1670’s-1725, and Phase II: 1725-1740’s. These phases were determined using historical documents, diagnostic artifacts and features’ relationships and chronology. Two features (Table 4.17) from Newman’s Neck fit the requirements to be included in this study; a well (Feature 248A) and a cellar (Feature 247). The well dates to the first phase and the cellar to the second phase. Site history and feature chronology was collected from a report on the reanalysis of the site (Heath et al. 2009) and the pipe stem counts were collected from a senior honors thesis on the pipes from this site (Lawson 2009).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Well (248A)	1670-1725		10	10	5			25
Cellar (247)	1725-1740's	1	18	33	15	4	1	72

Table 4.17: Newman's Neck (44NB180) Pipe Stem Counts by Bore Diameter

Ferry Farm (44ST174)

Ferry Farm is located in Fredericksburg, Virginia on the banks of the Rappahannock River. The earliest known occupation of this land is by a freed indentured servant, Maurice Clark, who purchased the land in 1710. Clark built an earthfast house on the property and died one year later in 1711. The property was then occupied by a series of tenants until it was purchased by William Strother in 1727, who demolished the Clark house soon after, and built a new larger house to the south. The Washingtons purchased this house and its land in 1738. This is the house that George Washington grew up in. After the Washingtons left the property in 1774, it was occupied by tenants until its abandonment and demolition by neglect in the 1830's. Three features (Table 4.18) dating to the Clark occupation were used in this paper. The data from these features were collected from the Ferry Farm artifact catalog. This information is not published, but is on file (The George Washington Foundation 2008).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
West Pit	1710-1720's			2	8	199	69	278
Original Root Cellar	1720's			1	3	42	7	53
Replacement Root Cellar	1720's					18	8	26

Table 4.18: Ferry Farm (44ST174) Pipe Stem Counts by Bore Diameter

North Carolina

Twelve features from seven sites in North Carolina were used in this analysis. Three of these sites, the Eden House, United Carolina Bank and Cornell House, were Phase III data recovery projects conducted by Coastal Carolina Research Inc. The remaining four were excavated by Stanley South in the 1950's and 1960's; the Leach-Jobson House, the Epsy House and Russellborough, are all located in Brunswick Town, and the Coutanche cellar is located in Historic Bath. The features used range in date from 1680 to 1814, with the majority dating to the mid-18th century. Table 4.19 shows the breakdown of sites within each of Harrington's time periods.

Harrington Time period	Number of Features
1620-1650	0
1650-1680	0
1680-1710	0
1710-1750	7
1750-1800	5
Total	12

Figure 4.19: Breakdown of Features in North Carolina by Time Period

The Eden House (31BR52)

The Eden House site is located in Bertie County, along the Chowan River in the Albemarle Region of North Carolina. The site excavated represents one of the earliest English settlements in the Albemarle, and predates Governor Eden's house, which is likely located to the north of the project area. The site's occupation dates were based on both historical and archaeological evidence. The three features used (Table 4.20) are associated with Structure 2, an earthfast building that was interpreted as the original dwelling. Feature 2 and 3 were root cellars and Feature 311 was a well. All of the data and site history was collected from the Phase III site report (Lautzenheiser et al. 1998).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Feature 2	1680-1740				4	26	36	66
Feature 311	1680-1740			1	13	80	21	115
Feature 3	1720-1740			1	19	40	2	62

Table 4.20: The Eden House (31BR52) Pipe Stem Counts by Bore Diameter

Leach-Jobson (31BW376-30-1)

This house site is located in Historic Brunswick Town along the Cape Fear River in southeastern North Carolina. The Leach-Jobson house is one of the earliest dwellings built in Brunswick Town; construction began the same year the town was established in 1726. The house was occupied throughout the mid-18th century, until the entire town was burned during the American Revolution. Two contexts were used in this analysis, the Builder's Trench and the interior of the house foundation (Figure 4.21). The pipe stem data were collected from the site's artifact catalog (Brunswick Town n.d.) and the site history was gathered from Beaman's 2005 article on tobacco pipes from Brunswick Town.

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Builder's Trench	1726-1728				21	138	75	234
House	1728-1776				240	2628	1883	4751

Table 4.21: Leach-Jobson (31BW376-30-1) Pipe Stem Counts by Bore Diameter

Epsy (31BW376-31-2)

The James Epsy house was located next to the Leach-Jobson house in Brunswick Town. The house was built in 1731 and was occupied until the town's destruction in 1776 during the Revolutionary War. The contexts from the interior of the house were used for this analysis (Figure 4.22). The pipe stem data were collected from the site's artifact catalog (Brunswick Town n.d.) and the site history was gathered from Beaman's 2005 article on tobacco pipes from Brunswick Town.

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
House	1731-1776		1	1	134	1436	1724	3296

Table 4.22: Epsy (31BW376-31-2) Pipe Stem Counts by Bore Diameter

Coutanche

The remains of the Michael Coutanche house are located in Historic Bath, in northeastern North Carolina. The town of Bath is situated along Bath Creek, a tributary of the Pamlico Sound, and was established as North Carolina's first town and port in 1705. The ballast stone foundation and cellar of this mid-18th century building were excavated in 1960. The pipe stem counts from the cellar were used in this analysis (Table 4.23). This building was likely built in the 1730's and stood until Cotanche built a new, larger house nearby in 1751; this 1751 building is now known as the Palmer-Marsh house. The pipe stem data were collected from the artifact catalog (South n.d.), and the site history was obtained from a book on the history of Bath (Watson et al. 2005).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Cellar	1730-1750			2	0	16	18	36

Table 4.23: Coutanche Pipe Stem Count by Bore Diameter

United Carolina Bank (31CV183)

This site is located in New Bern along the Trent River in northeastern North Carolina. The site contained many 18th century components, one of which was Feature 102, a large stratified trash pit. For the purpose of this study, the pit was split into two contexts, A and B (Figure 4.24). The separation of the two contexts was determined using the sand fill that was deposited all across New Bern in 1769 by flooding from a hurricane. The feature was dated using temporally diagnostic ceramics. All information was collected from the Phase III site report (Lautzenheiser et al 1994).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Feature 102 B	1750-1769					64	19	83
Feature 102A	1769-1820				1	76	14	91

Table 4.24: United Carolina Bank (31CV183) Pipe Stem Counts by Bore Diameter

Russellborough (31BW556-1)

The Russellborough house was located on a 55-acre tract of land just outside of the main part of Brunswick Town in the mid-18th century. It was built in 1751, and served as the residence of two royal governors from 1758 until 1770. The house was abandoned when the town was burned in 1776 during the Revolutionary War. The fill within the building's foundation was used in this analysis (Figure 4.25). The pipe stem data were collected from the site's artifact catalog (Brunswick Town n.d.) and the site history was gathered from Beaman's 2005 article on tobacco pipes from Brunswick Town.

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
House Fill	1751-1776					32	18	50

Table 4.25: Russellborough (31BW556-1) Pipe Stem Counts by Bore Diameter

Samuel Cornell (31CV310)

The Samuel Cornell site is located in New Bern in northeastern North Carolina. The remains of an 18th century residence and associated features were discovered in the course of the Phase III investigation. Two late 18th century features contained enough pipe stems to be included in this study (Figure 4.26). Feature 105 is a clean up context associated with the 1769 hurricane discussed in the United Carolina Bank site section. The midden use dates to the end of the occupation of the site. All information was collected from the final site report (Brady et al. 2001)

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Feature 105	1769				9	16	4	29
Midden	1782-1814				20	37	13	70

Table 4.26: Samuel Cornell (31CV310) Pipe Stem Counts by Bore Diameter

South Carolina

Seven features from three sites in South Carolina were used in this analysis. All three sites were excavated by Martha Zierden of the Charleston Museum, and all three sites are located in Charleston. All of the features used dated to the mid-18th century, the earliest of which dated to the 1730's and the latest dated to 1760. The breakdown of features within each of Harrington's time periods is seen in Figure 4.27.

Harrington Time period	Number of Features
1620-1650	0
1650-1680	0
1680-1710	0
1710-1750	4
1750-1800	3
Total	7

Table 4.27: Breakdown of Features in South Carolina by Time Period

Heyward Washington House

The Heyward-Washington House is a 1771 three story brick building located on Church St. in downtown Charleston. However, an earlier dwelling was located on this property; features from this first residence were used in this analysis. All of the features used are associated with John Milner's occupation, who owned the property from the 1730's until 1768 (Figure 4.28). These features were a part of a stable complex located on the site. The site's features were placed into a chronology based on historical documentation and archaeological evidence of the 1740 fire that swept through Charleston. Features 65, 166 and 178 were refuse pits. Zone 5 was a large sheet midden that covered a large portion of the site. The site history was collected from the final site report (Zierden and Reitz 2007) and the pipe stem data were obtained from the site's artifact catalog (Charleston Museum n.d.).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Feature 65	1730's		3	18	150	146	1	318
Feature 166	1730's		2	17	181	514	7	721
Feature 178	1740-1750			1	16	36		53
Zone 5	1740-1750				14	70	12	96

Table 4.28: Heyward Washington House Pipe Stem Counts by Bore Diameter

<u>Beef Market</u>

Charleston's 18th century city market once stood on the current location of the City Hall. Renovations to the modern building led to an investigation of the remains of the old market. Both contexts used, Zone 8 and Zone 9 (Figure 4.29), are midden layers associated with the Early Market Building that dated between 1739 and 1760, which was determined by the historical record. The site history was collected from the final site report (Zierden and Reitz 2005) and the pipe stem data were obtained from the site's artifact catalog (Charleston Museum n.d.).

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Zone 8	1739-1760		1	29	89	174	19	312
Zone 9	1739-1760		2	14	79	243	9	347

Table 4.29: Beef Market Pipe Stem Counts by Bore Diameter

Dock Street Theater

The Dock Street Theatre was built in the 1736 on what is now Church Street in downtown Charleston. The original building burnt down in 1751, and was rebuilt that same year. One feature from this site contained enough pipe stems to be included in this study, a privy (Figure 4.30). All information was obtained from the final site report (Zierden et al. 2009)

Context	Date	9/64"	8/64"	7/64"	6/64"	5/64"	4/64"	Sum
Privy	1750's					32		32

Table 4.30: Dock Street Theater Pipe Stem Counts by Bore Diameter

CHAPTER 5: RESULTS

Overall

All of the features used, their bore diameter counts, predicted means and formula results are listed in a table in Appendix A. The features are separated out by state, and then listed in chronological order by predicted mean. The predicted mean, or assigned mean, is the date derived from the date range that is assigned by the site excavator in the site report. In other words, if the excavator dated a feature from 1620 to 1640, the predicted mean date would be 1630. This 1630 date would then be compared to the three formula means. The results of the first test conducted, to determine how close the formula date was to the assigned mean, showed the Heighton and Deagan to be the most reliable of the three methods with an average of 15 years away from the predicted date, followed by the Binford at 19 years off on average and lastly Hanson at 20 years (Figure 5.1).

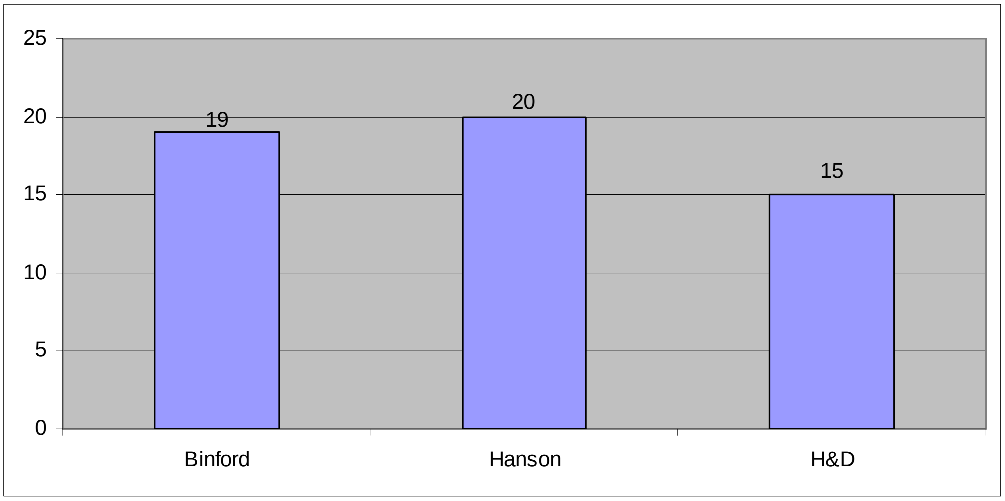

Figure 5.1: Average Years off from Predicted Mean

The second comparison done was to determine if the formula date fell within the date range assigned by the excavator. The Heighton and Deagan formula continues to compare favorably to the other two methods in this regard; Heighton and Deagan's formula date falls into the assigned date range 47% of the time, while the other two methods fall within it only 33% (Hanson) and 31% (Binford) of the time (Figure 5.2).

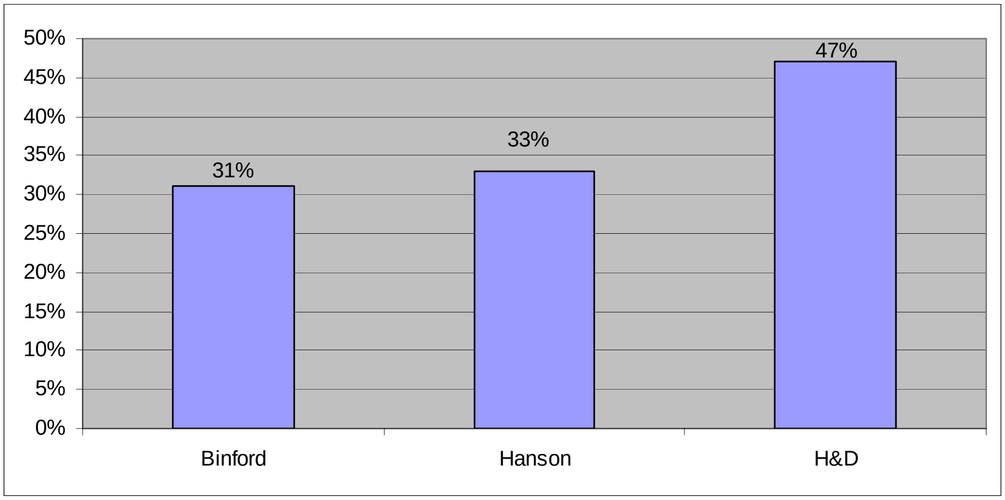

Figure 5.2: How Often the Formula Dates Fall within the Given Time Period

The final test conducted was to plot all of the formula results against the predicted means in order to create a linear regression formula to compare the r^2 produced for method strength. The closer the r^2 value is to 1, the stronger it is, meaning the date produced by the formula, the Y value, is consistently closer to the predicted mean, the X value. This test produced opposite results than the first two, showing the Heighton and Deagan formula (Figure 5.5) to be the weakest of the three with an r^2 value of 0.641. The Binford (Figure 5.3) has the highest r^2 of 0.659 and the Hanson (Figure 5.4) is in between at 0.652 R^2. However, it must be noted that all three r^2 results are fairly close to one another. All three scatter plots show a similar trend; that there is no time period in which the formula results cluster around the regression line. A logarithm regression was not done because the r^2 values produced by that equation were only different by 0.0001 than the linear regression formula. An obvious pattern can be seen on all three scatter plots; that the majority of the points before 1710 are located below the best fit line, while the majority of the points after 1710 are located above the line. This will be discussed further in the next chapter

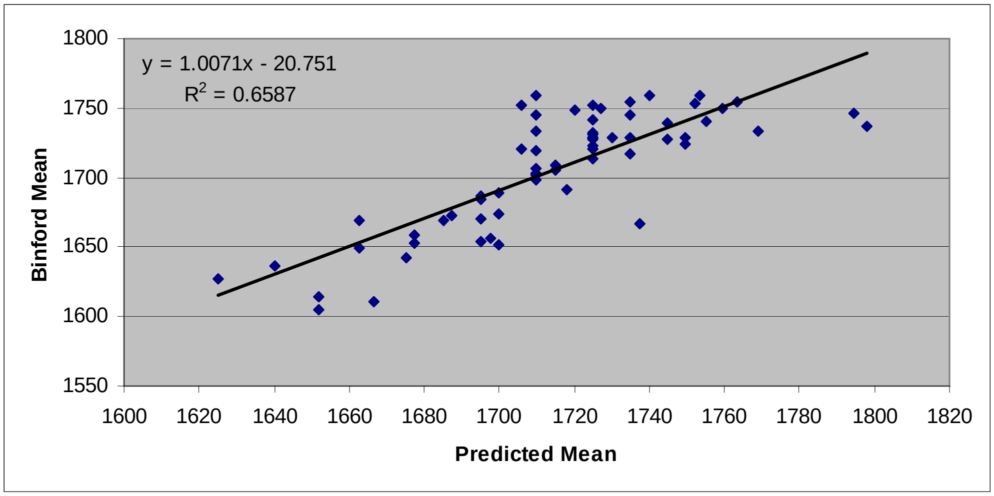

Figure 5.3: Scatter Plot and Regression Formula of All Binford Results

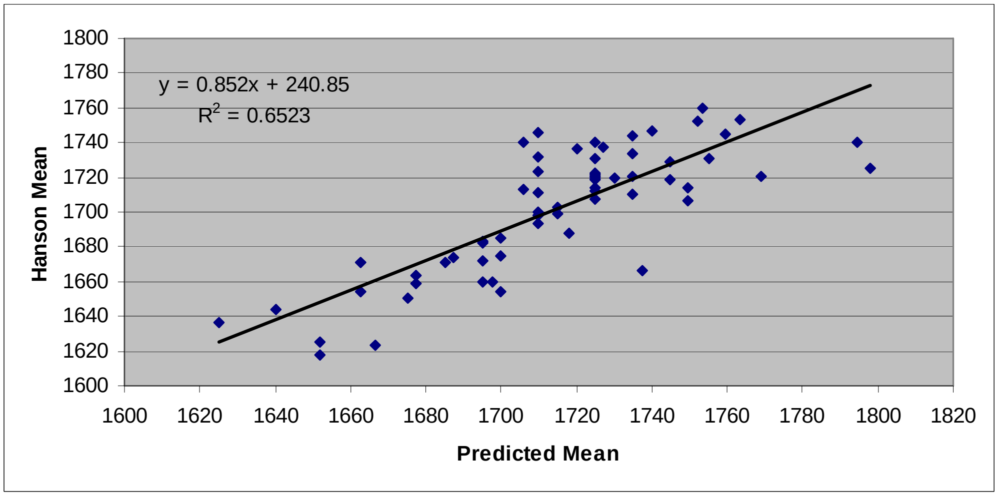

Figure 5.4: Scatter Plot and Regression Formula of All Hanson Results

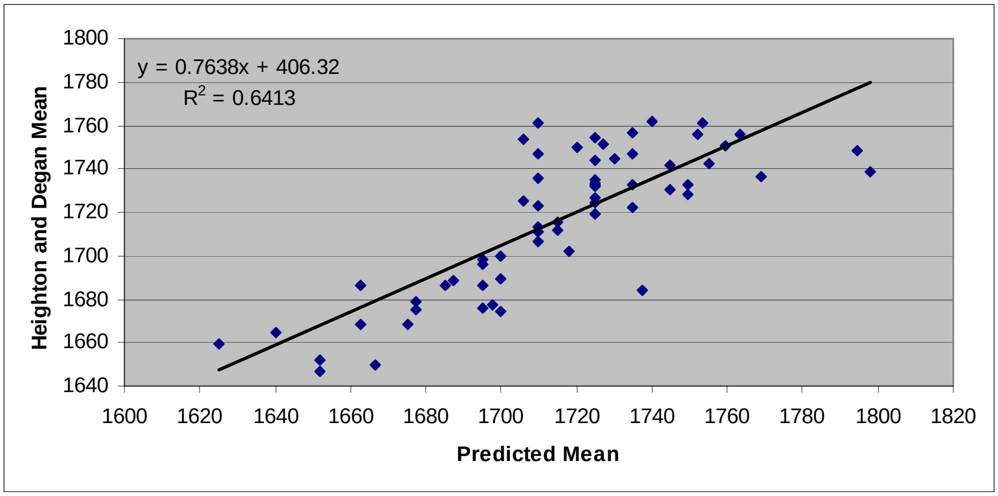

Figure 5.5: Scatter Plot and Regression Formula of All Heighton and Deagan Results

Maryland

The Heighton and Deagan formula produced the most accurate results for the first two tests; the formula means were on average 9 years different than the predicted mean and fell within the given time period 65% of the time. The Hanson method produced the second most accurate results, with the formula dates being on average 19 years different than the predicted mean and falling within the given time period 43% of the time. Lastly the Binford formula produced the least accurate results at 22 years from the predicted mean and falling within the given time period 39% of the time (Figures 5.6 and 5.7). All three r^2 values produced by the linear regression formula were close, with Binford's at 0.829, Hanson's at 0.819, and Heighton and Deagan's at 0.806 (Figures 5.8, 5.9 and 5.10). All of the data points cluster around the linear regression line, with a few exceptions from the early 18th century. The Heighton and Deagan results cluster the tightest around the regression trend line. Overall, as seen in Figure 5.11, the Heighton and Deagan formula produced the latest dates, followed by the Binford formula and lastly the Hanson method.

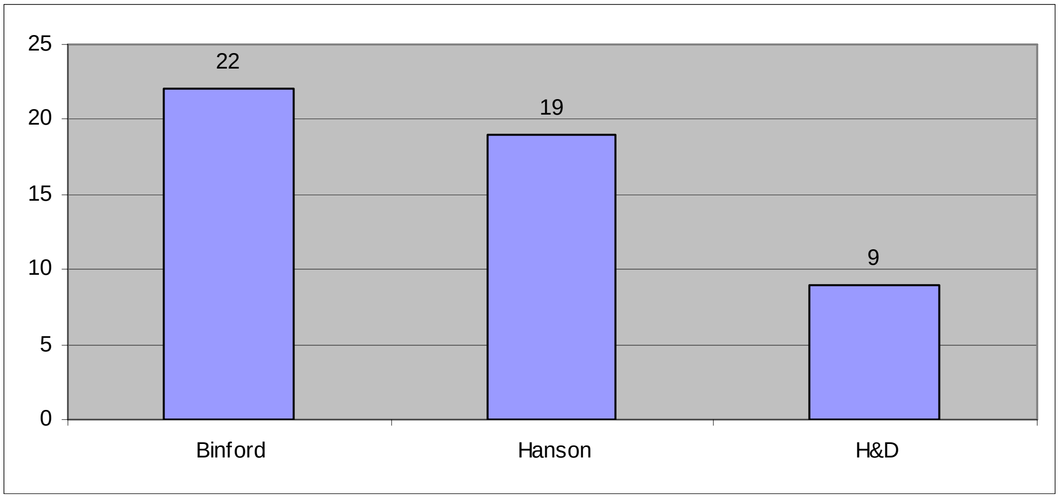

Figure 5.6: Average Number of Years the Formula Means are from the Predicted Means in Maryland

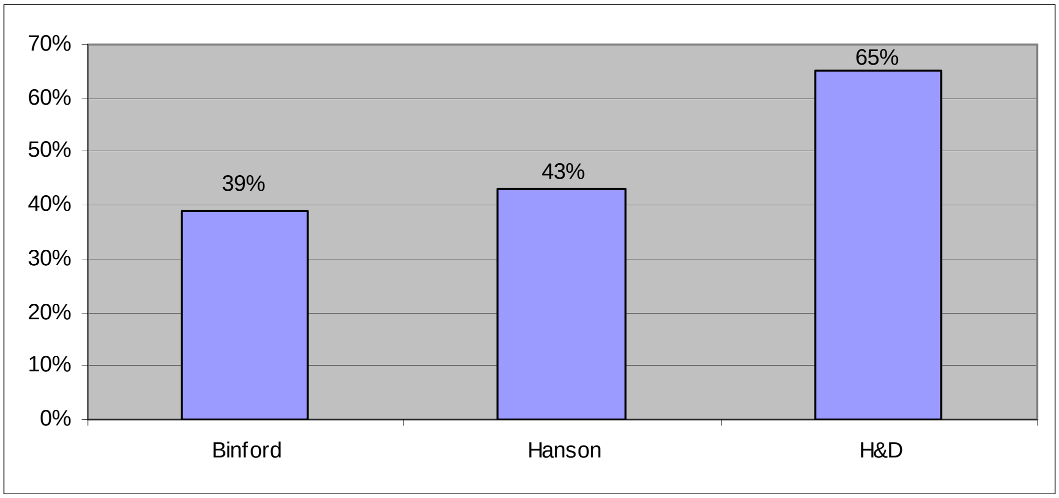

Figure 5.7: How Often the Formula Means fall within the Given Time Periods in Maryland

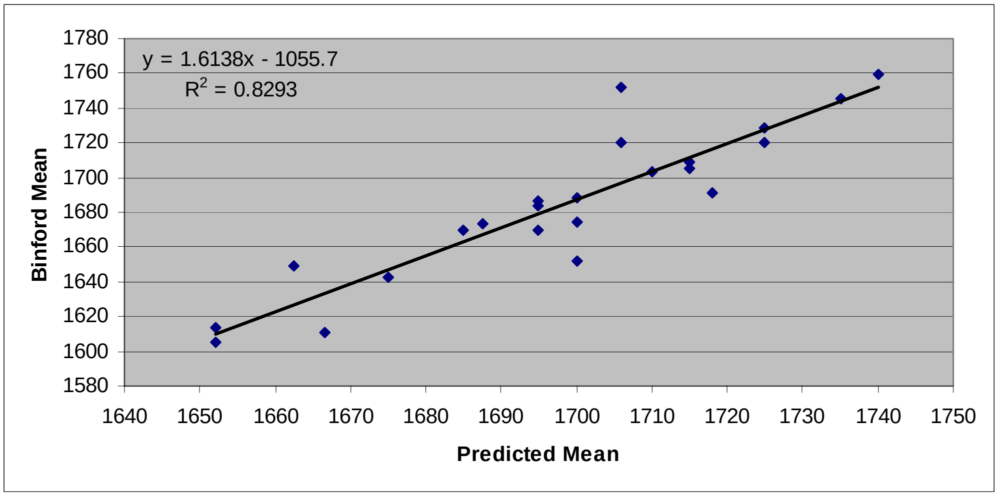

Figure 5.8: Scatter plot and Regression Formula of Binford Results in Maryland

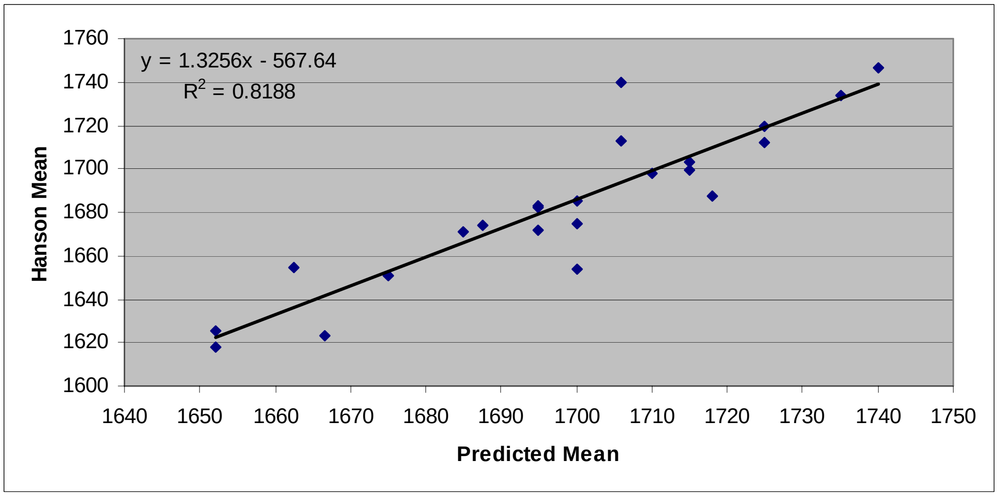

Figure 5.9: Scatter Plot and Regression Formula of Hanson Results in Maryland

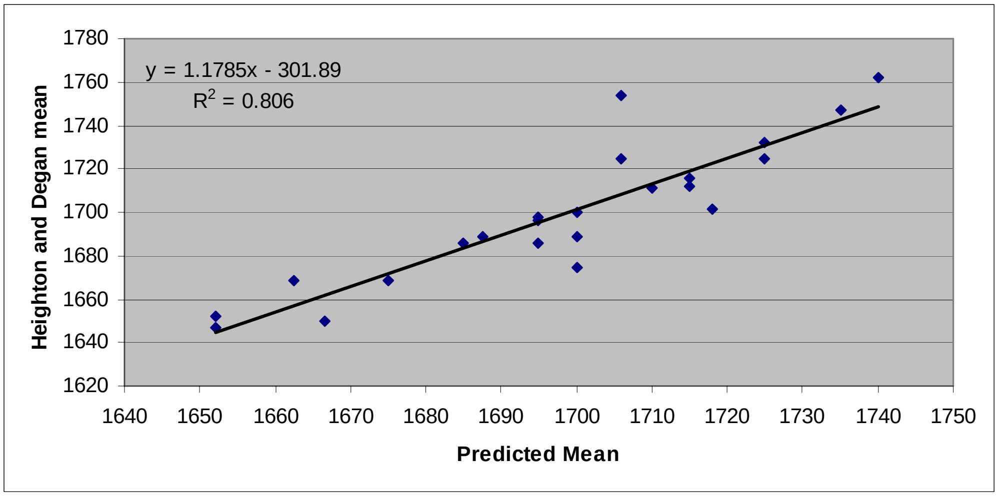

Figure 5.10: Scatter Plot and Regression Formula of Heighton and Deagan Results in Maryland

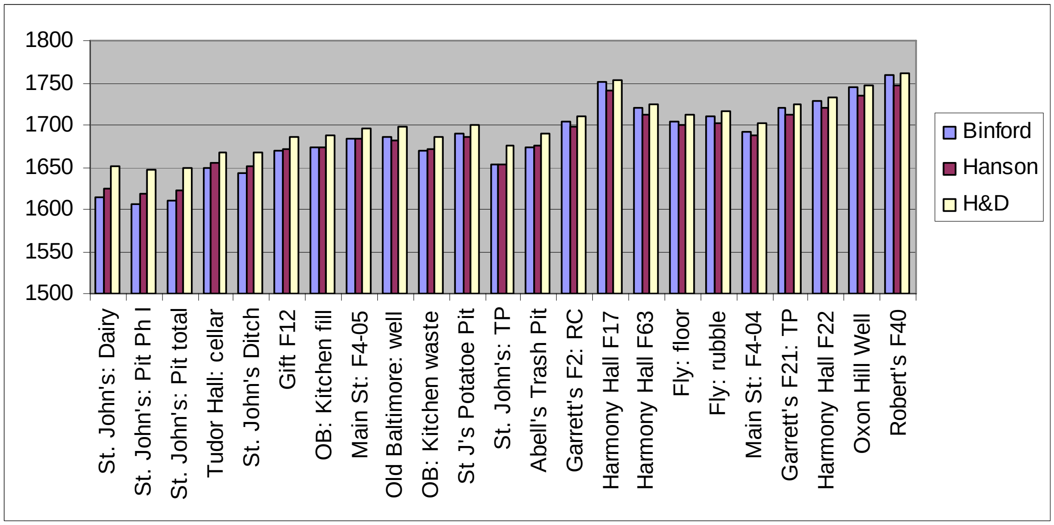

Figure 5.11: Maryland Formula Results by Feature

Virginia

All three formula methods produced similar mean dates in Virginia; the Binford formula results were on average 17 years away from the predicted mean, the Hanson method produced the lowest difference at 15 years away from the predicted mean, and the Heighton and Deagan formula's mean was on average 16 years different than the predicted mean (Figure 5.12). However, the results from the second test again show Heighton and Deagan to be the better method, with the formula means falling within the given time periods 41% of the time, followed by the Binford means at 32% of the time and the Hanson methods' results falling within the predicted time periods only 27% of the time (Figure 5.13).

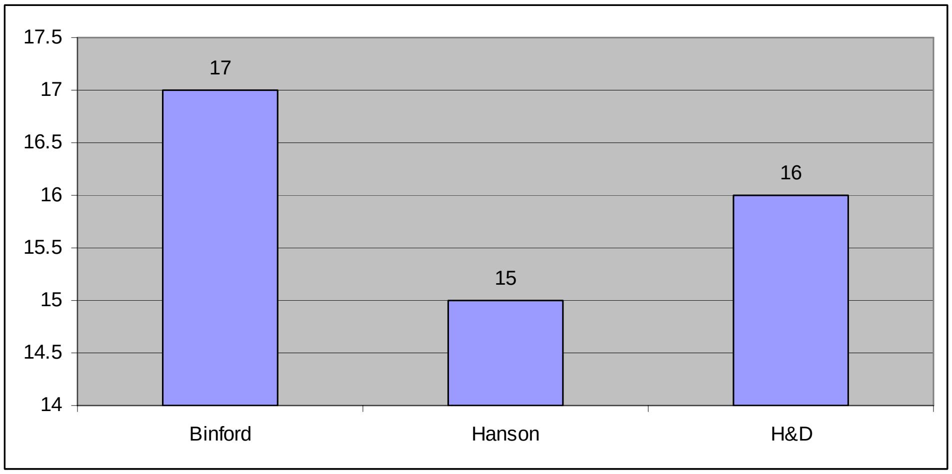

Figure 5.12: Average Number of Years the Formula Means are from the Predicted Means in Virginia

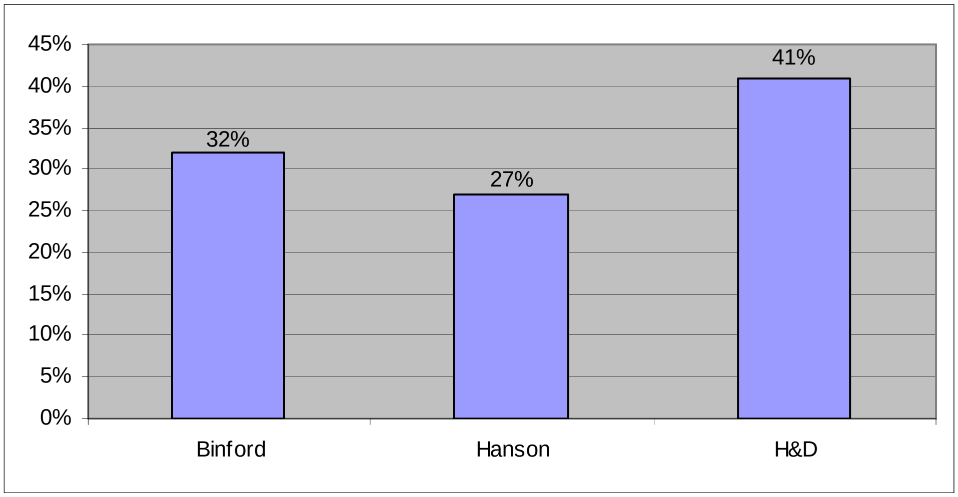

Figure 5.13: How Often the Formula Means fall within the Given Time Periods in Virginia

The means do not follow a close linear regression, especially in the 18th century. The r² produced by the linear regression trend line shows the same pattern seen in Maryland. The Heighton and Deagan (Figure 5.16) formula is the weakest with an r² of 0.589, followed by Hanson (Figure 5.15) at 0.619 and Binford (Figure 5.14) at 0.631. Again, all three r² results are close to one another. Figure 5.17 shows that the Hanson means are consistently earlier than the other two methods, with the Heighton and Deagan usually being the latest.

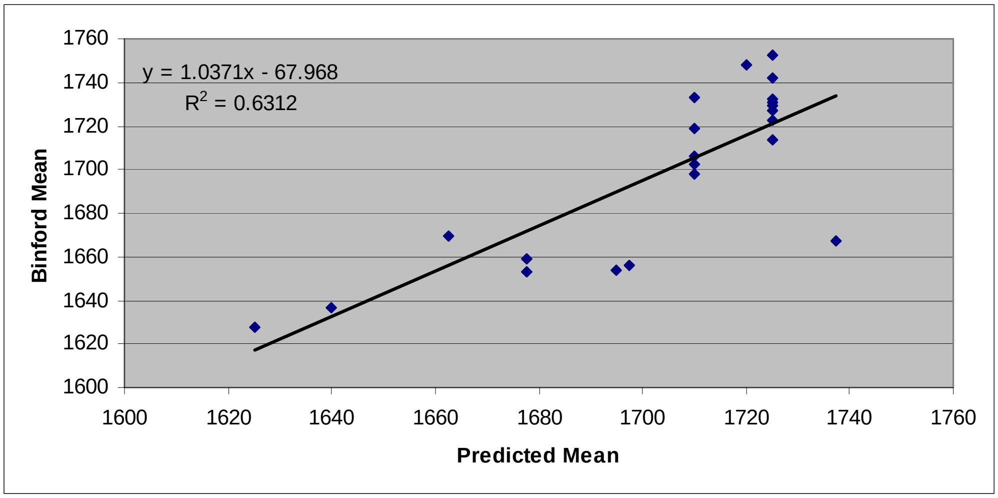

Figure 5.14: Scatter Plot and Regression Formula of Binford Results in Virginia

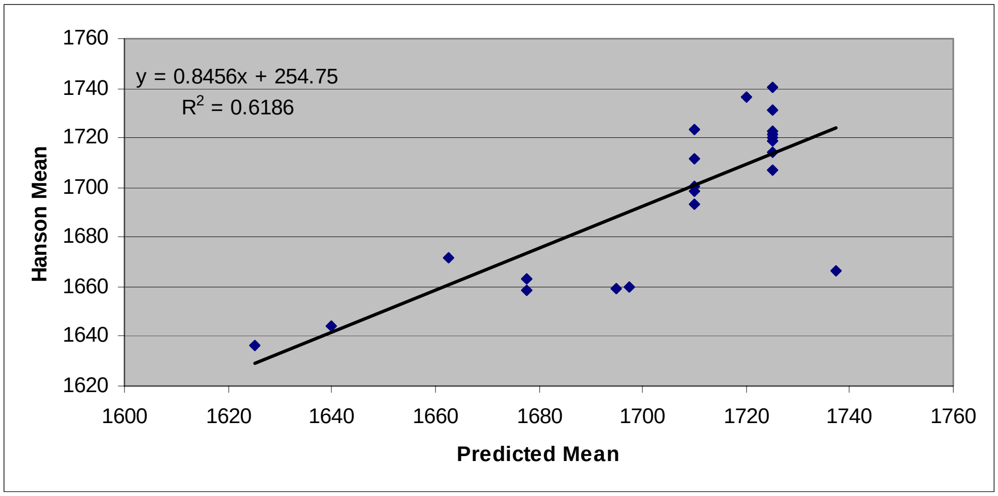

Figure 5.15: Scatter Plot and Regression Formula of Hanson Results in Virginia

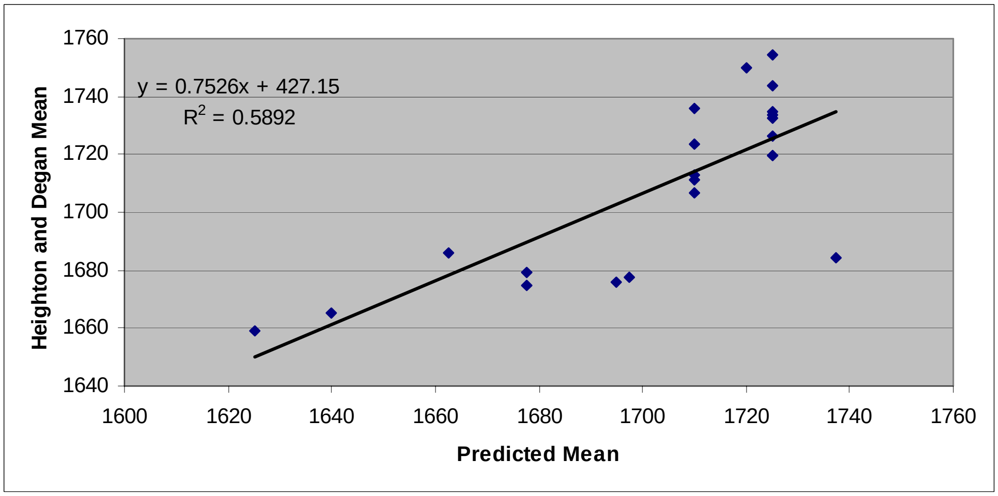

Figure 5.16: Scatter Plot and Regression Formula of Heighton and Deagan Results in Virginia

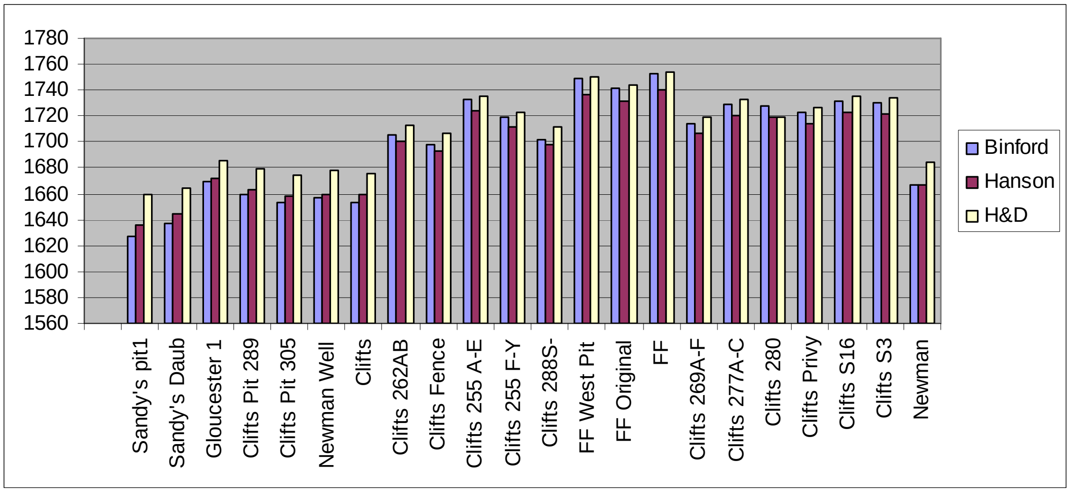

Figure 5.17: Virginia Formula Results by Site

North Carolina

The results in North Carolina are very different from those seen in the two Chesapeake states, in that there is no clear "better" method. All three formulas produced similar means and average results, with the Hanson method producing results slightly more accurate. On average, the Hanson means were 24 years different that the predicted means, followed by the Binford at 25 years and the Heighton and Deagan means were only one more year greater at 26 years (Figure 5.18). Similarly, the Binford and Heighton and Deagan formulas fell within the assigned time periods 33% and the Hanson averaged 42% (Figure 5.19).

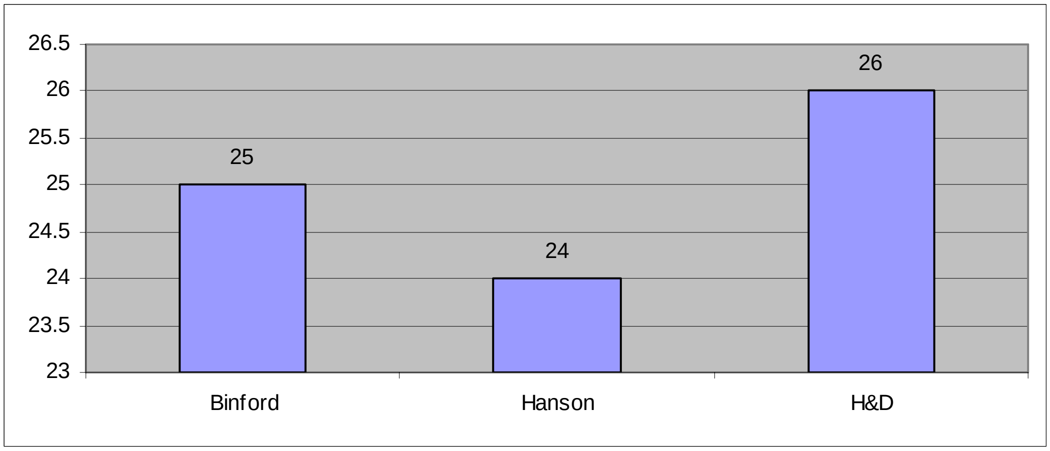

Figure 5.18: Average Number of Years the Formula Means are from the Predicted Means in North Carolina

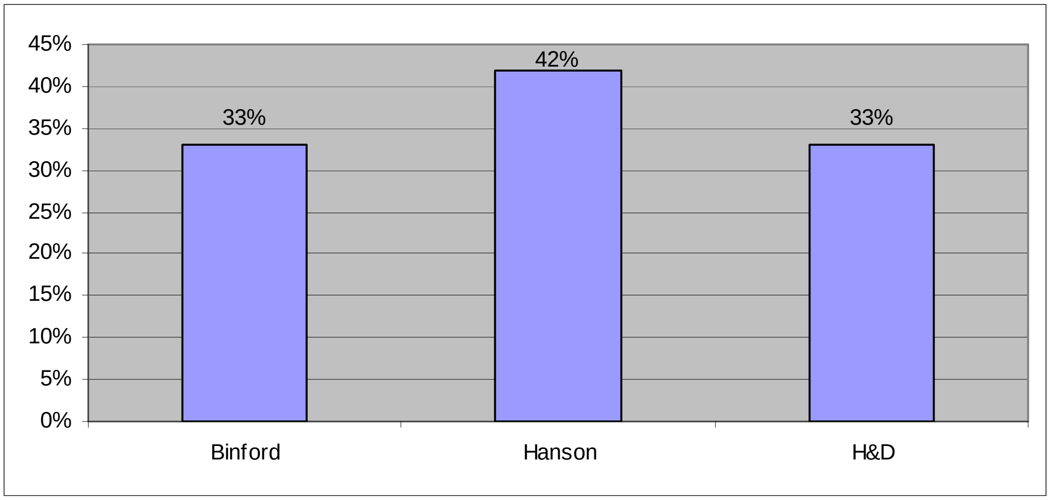

Figure 5.19: How Often the Formula Means fall within the Given Time Periods in North Carolina

However, once plotted into a scatter plot and a linear regression formula applied, the results look very different. All three linear formulas are negative, whereas, the results from the three other states used have positive linear formulas. The linear regression shows the Heighton and Deagan (Figure 5.22) formula to be the strongest of the three with an r^2 of 0.174, followed by Binford (Figure 5.20) at 0.0663 R^2, and finally Hanson (Figure 5.21) at 0.004 R^2. Unlike the results in Maryland and Virginia, all three formulas prove to be very weak and do not follow the trend lines at all. One result that is similar to what was seen in the Chesapeake states is that the Hanson means consistently date earlier than the other two methods' results, as seen in Figure 5.23.

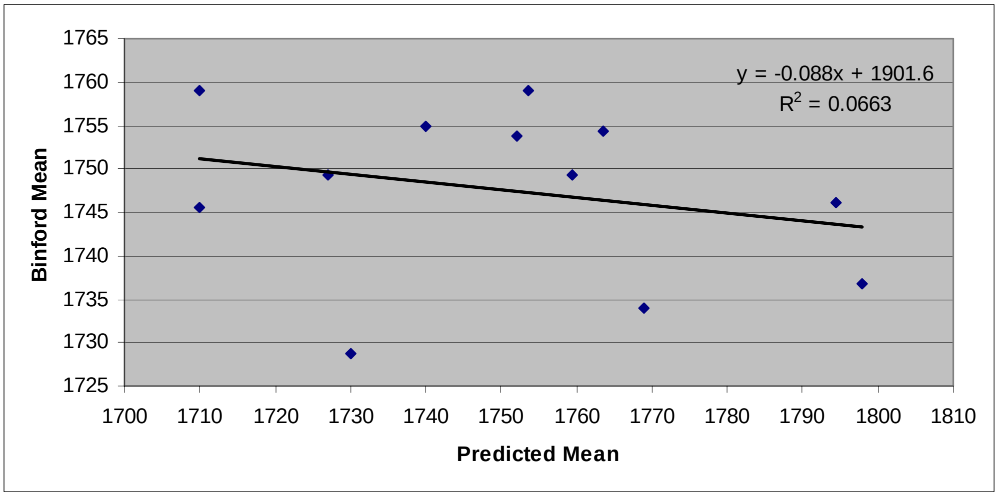

Figure 5.20: Scatter Plot and Regression Formula of Binford Results in North Carolina

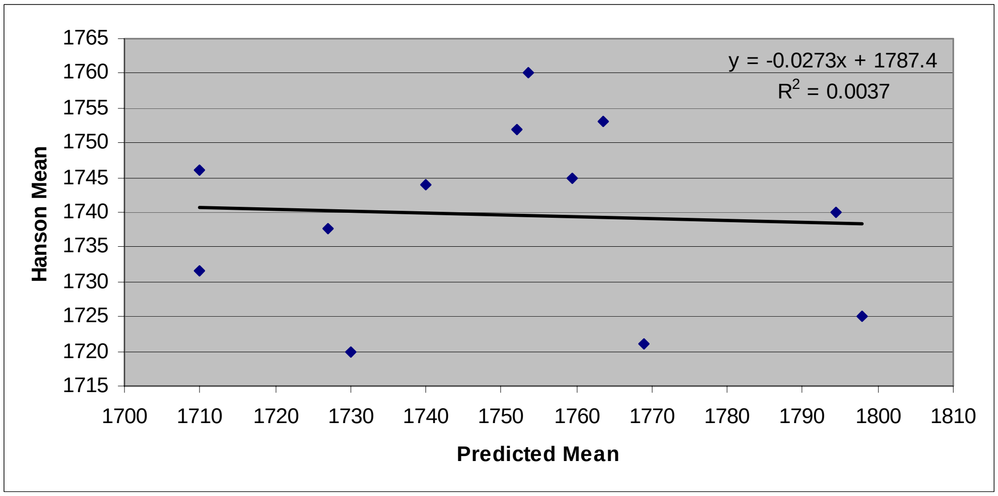

Figure 5.21: Scatter Plot and Regression Formula of Hanson Results in North Carolina

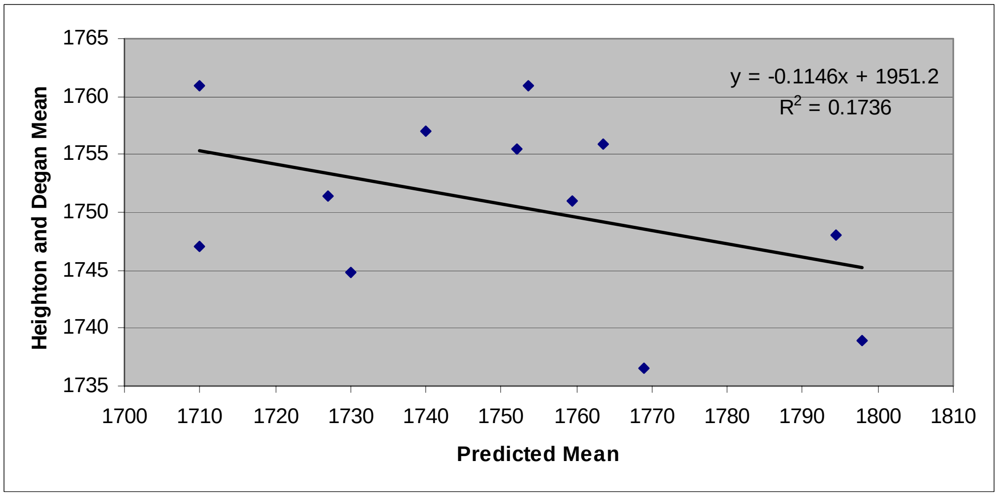

Figure 5.22: Scatter Plot and Regression Formula of Heighton and Deagan Results in North Carolina

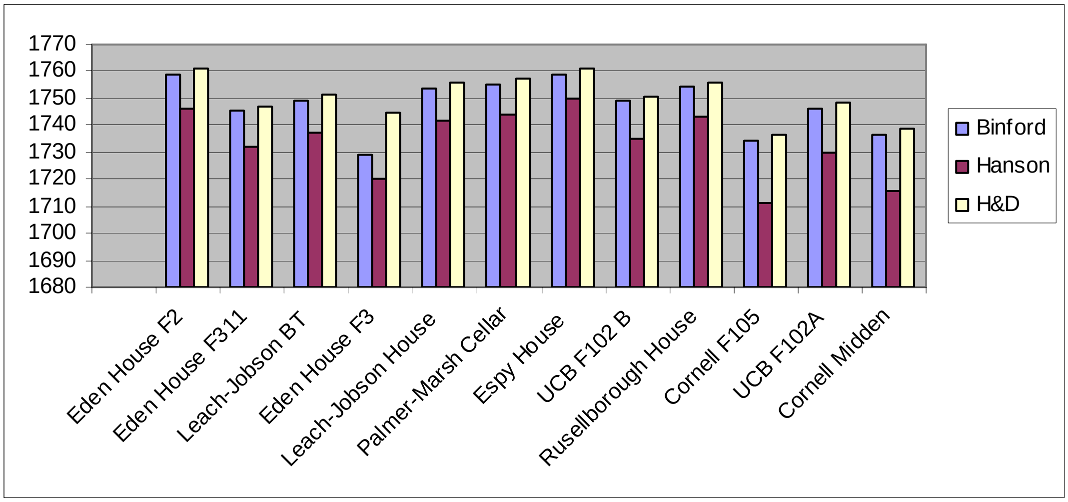

Figure 5.23: North Carolina Formula Results by Site

South Carolina

The results from South Carolina again show the Heighton and Deagan to have the smallest difference between predicted means and formula means at 12 years, followed by Binford at 15 years and lastly Hanson at 26 years (Figure 5.24). Every single formula mean date produced was earlier than the predicted mean, and only one formula mean, produced by the Heighton and Degan formula, fell within the given time period at 29%. The scatter plots show the same trend seen in the first test, that the Heighton and Deagan formula (Figure 5.27) is the strongest with a value of 0.332 R^2, followed by Binford (Figure 5.25) with 0.331R^2, and lastly Hanson (Figure 5.26) with 0.089 R^2. The Heighton and Deagan and the Binford values are very close to one another, but not very strong, while the Hanson's r^2 result is far from the other two and shows it to be very weak. Figure 5.28 shows the same trend seen in the other three states of the Hanson method producing the earliest dates.

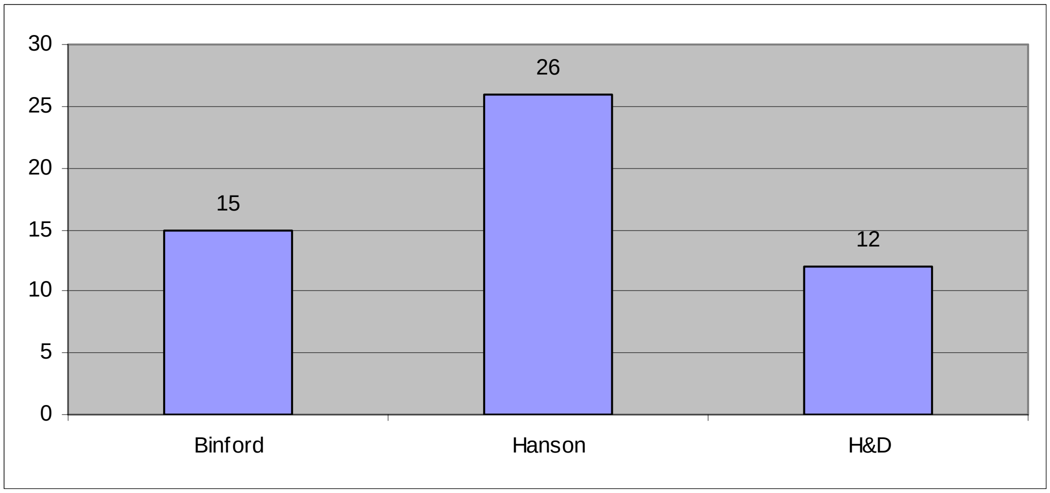

Figure 5.24: Average Number of Years the Formula Means are from the Predicted Means in South Carolina

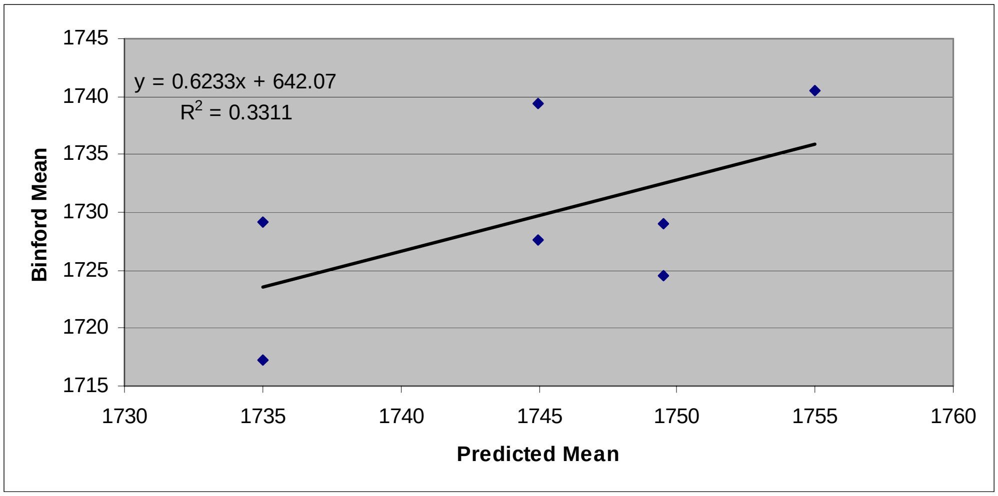

Figure 5.25: Scatter Plot and Regression Formula of Binford Results in South Carolina

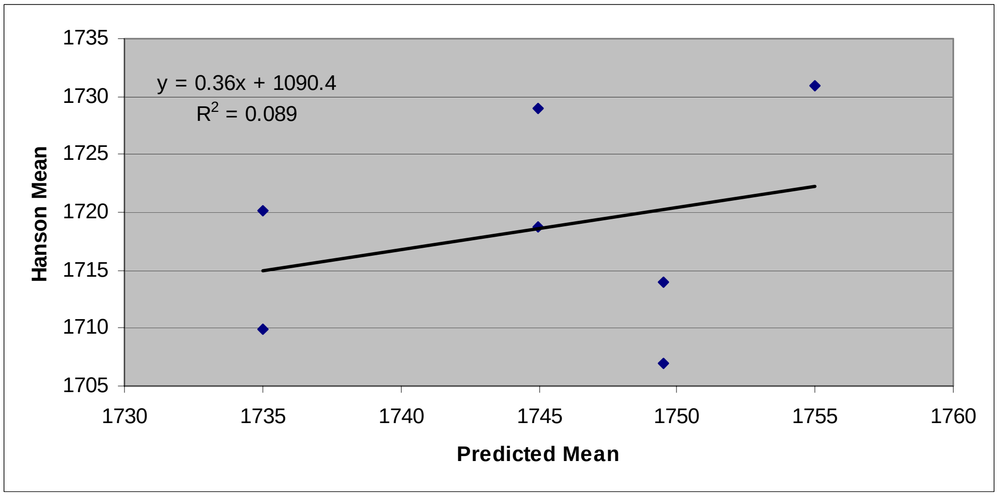

Figure 5.26: Scatter Plot and Regression Formula of Hanson Results in South Carolina

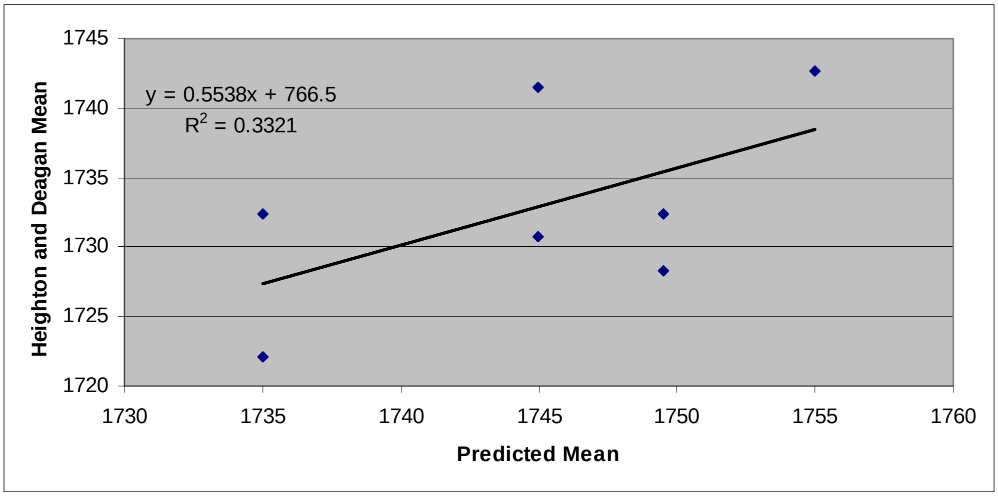

Figure 5.27: Scatter Plot and Regression Formula of Heighton and Deagan Results in South Carolina

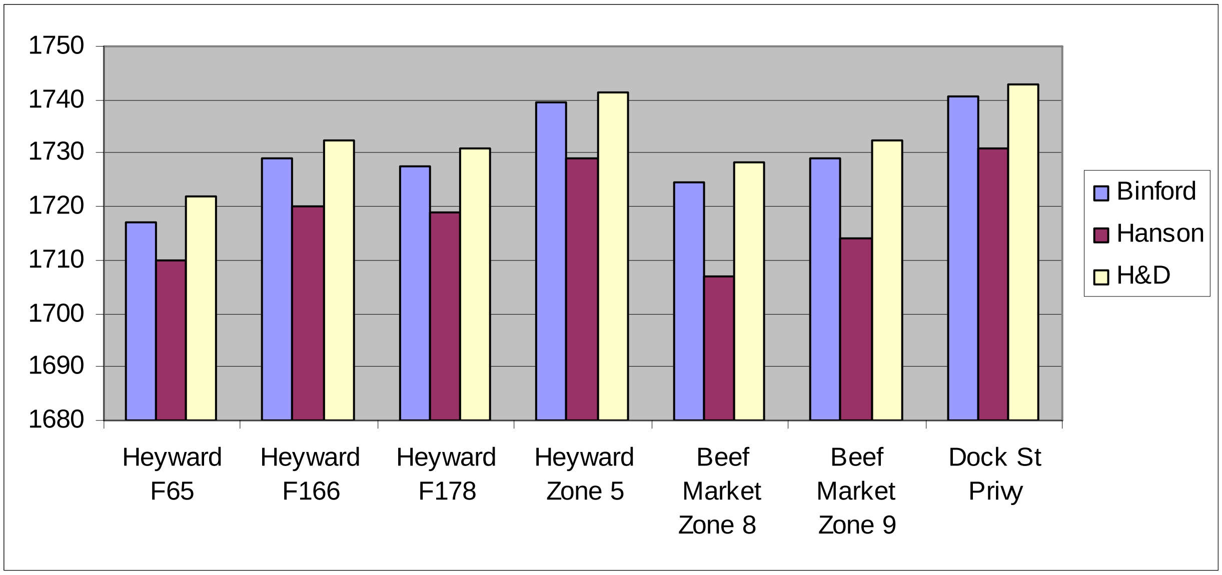

Figure 5.28: South Carolina Formula Results by Site

CHAPTER 6: DISCUSSION

General Discussion

Overall, the Heighton and Deagan formula produced the best results, particularly from the first two tests; determining the average number of years the formula means are from the predicted means and how often the formula means fall within the time period assigned to the data set. This was not only seen in the combination of all the data, but also in the individual states, which is best represented by Maryland. In Maryland, the Heighton and Deagan means were only 9 years from the predicted means, the smallest difference seen by any of the formulas in all four states, and fell within the predicted time period 65% of the time, again, the best from any state. However, outside of Maryland, the results become more ambiguous.

The small data set from South Carolina shows the Heighton and Deagan formula to be clearly stronger than the other two in all three tests. However, the fact that none of the Binford or Hanson means, and only one Heighton and Deagan mean, fell into the given time period is suspect. This is supported by the low r^2 values for all three formulas, and that there is no clear trendline produced for any of the three formulas. In both Virginia and North Carolina, the average number of years the formula means are off from the predicted means are similar; in both states, the averages are all within two years of one another: Virginia producing 15, 16 and 17 years, and North Carolina 24, 25 and 26. The results of the second test are similar; Virginia's being 27%, 32% and 41%; North Carolina's 33%, 33% and 42%. While Virginia's formula means are closer to the predicted means than North Carolina's, there is no clear "best" from either state.

The scatter plots and trendlines show that all three formulas work better in the Chesapeake than in the Carolinas. The trendlines produced in both Maryland and Virginia are strong positive linear regressions, with Maryland being the stronger of the two producing r^2 values around 0.8 while Virginia's are about 0.6 r^2. In both states, the data points follow the trendlines closely, particularly in the 17th century. Maryland's points are closer to the trend lines than Virginia's throughout all 200 years. North Carolina's results are clearly the weakest of the four states, as seen by the scatter plots. The regression formulas produced are negative, the data points do not follow the trend lines produced and the r^2 values are very weak. Similar to North Carolina, South Carolina's r^2 results are weak and the data points do not follow the trend lines produced; however, South Carolina's regression line is positive. The overall scatter plots (Figures 5.3, 5.4 and 5.5) show the pattern of all three formulas producing points below the best fit trendline before around 1710, and points above the trendline after that date. This coincides with the Chesapeake/ Carolina divide. The majority of the mean dates from Maryland and Virginia are before 1710, whereas, the Carolina's mean dates are after 1730.

Many archaeologists (e.g. Walker 1963; Oswald 1975; Alexander 1979; Noël Hume 1979; Hole 1980) have expressed concern over the reliance on a dating method that consistently produces incorrect mean dates. Particularly, Oswald (1975:126) and Noël Hume (1979:6) have stated that a formula date off by more than 15 years is less than adequate. By this measure, all three formula methods fail; and while 15 years is enough of a difference in historical archaeology to be interpretively significant, other factors must be taken into account when judging usefulness. One should not expect a formula to produce a perfect date every time. Formula mean dates can be useful in understanding the general occupation time frame of a site and as a relative dating method. Formula dating, as with all dating methods, should not stand alone in the interpretation of a site. It should be used in conjunction with other methods, and can even be used to point out previously missed factors. Anomalous pipe stem data could indicate a variety of issues, including a previously overlooked occupation, or differences in consumption patterns between sites, regions or settlement groups.

It was difficult to determine if the generally accepted rule that pipe stem dating worked best between 1680 and 1760, because the only state that had data that spanned that entire time period is North Carolina, and the majority of the formula results from there are suspect, which will be addressed in the section “Sample Biases.” However, it is obvious from the results in Maryland and Virginia that the formulas work well on features dating to before 1680. The results can be viewed in Appendix 1, but this trend is also evident on the scatter plots showing data points close to the trend lines in Chapter 5. The formula results do appear to fall apart at the end of the 18th century in the Carolinas; there are no features dating to the second half of that century from the Chesapeake. The majority of features in the Carolinas produce formula means that are within 10 to 15 years of one another, regardless of how different they are from the predicted means.

Binford states that his formula does not work past 1780 because there is an increase in European style pipes from Montreal along the East Coast (1962:66). However, later scholars have said that the Canadian pipe industry does not begin to flourish and export products until the 1840’s (Bradley 2000:117). Instead, it is more likely that the trend observed by Noël Hume (1969:296) of British pipe makers decreasing the length of their pipes, and possibly inversely increasing the bore diameters, in the second half of the 18th century is responsible for this breakdown in accuracy.

Maryland and Virginia

There is an interesting trend that is apparent in the Maryland and Virginia results. In Virginia, the three features from the two earliest sites, Sandys and Gloucester, dating between 1620 and 1685 and both in the Williamsburg area, produced Binford and Hanson results between 1 and 8 years of each other and 2 to 11 years later than the predicted means, but produce Heighton and Deagan results that are 15 to 23 years later than the next closest mean and 23 to 34 years greater than the predicted mean. This is juxtaposed to what is seen in the early Maryland sites. The three earliest features, all from St. John's in St. Mary's County, dating between 1638 and 1685, produced Heighton and Deagan results between 0 and 17 years less than the predicted mean, and Binford and Hanson results 27 to 57 years less than the predicted mean.

The question becomes, are these variations the result of differences in dates, the three Virginia sites lean closer to the early 17th century, whereas, the Maryland sites more towards the late 17th, at least in regards to assigned means; or can these differences be attributed to regional variation? The latter appears to be more likely, or a combination of the two. While there is much debate over the exact definition of "The Colonial Chesapeake," loosely, it refers to the geographic and European-settlement culture area in Maryland and Virginia; often limiting the definition to the Tidewater (King et al 2006:1). Recently, it has been suggested that the colonial Chesapeake should be split into two sub-regions, the Upper Chesapeake and the Lower Chesapeake, for research purposes.

Walsh (1999), a historian, first suggested this sub-regional split in regards to staple crops during the colonial period; specifically the type of tobacco grown, the traditional Oronoco in the Upper Chesapeake and the new sweet-scented in the Lower Chesapeake. Walsh (2001) later expands on this to discuss sub-regional differences in regards to the origins of enslaved Africans.

Samford (2007; Samford and Chaney 2010) addressed this question using archaeological evidence. Through her study of subfloor pits, she suggests that there is an Igboized enslaved culture in Southern Virginia (the Lower Chesapeake). In other words, there is a more cohesive ethnic African population in the Lower Chesapeake than the more diverse population of enslaved Africans that Walsh (2001:159) suggests there was in the Upper Chesapeake. Samford (Samford and Chaney 2010:2) defines the Upper Chesapeake as Maryland and the Potomac River Basin, and the Lower Chesapeake as the York and Upper James River Basins.

Although this split between Potomac and non-Potomac sites does not follow the exact boundaries of the Upper and Lower Chesapeake divide, it is compelling evidence that sub-regions exist within the larger framework. While not perfect, this trend of the Heighton and Deagan formula working better on sites along the Potomac River seems to continue beyond this initial example, while the other two formulas work better elsewhere and on later dated sites. This can be seen on Figures 6.1 and 6.2, where the Heighton and Deagan formula is producing dates much later than the other two in the 17th century, but then meets up with the Binford and Hanson formulas in the 18th century. This also explains why the Heighton and Deagan formula, while producing better means, has a lower r^2 value in both Maryland and Virginia; it is not as consistent as the other two, likely because it is a curvilinear regression, and not a linear like the Binford and Hanson formulas.

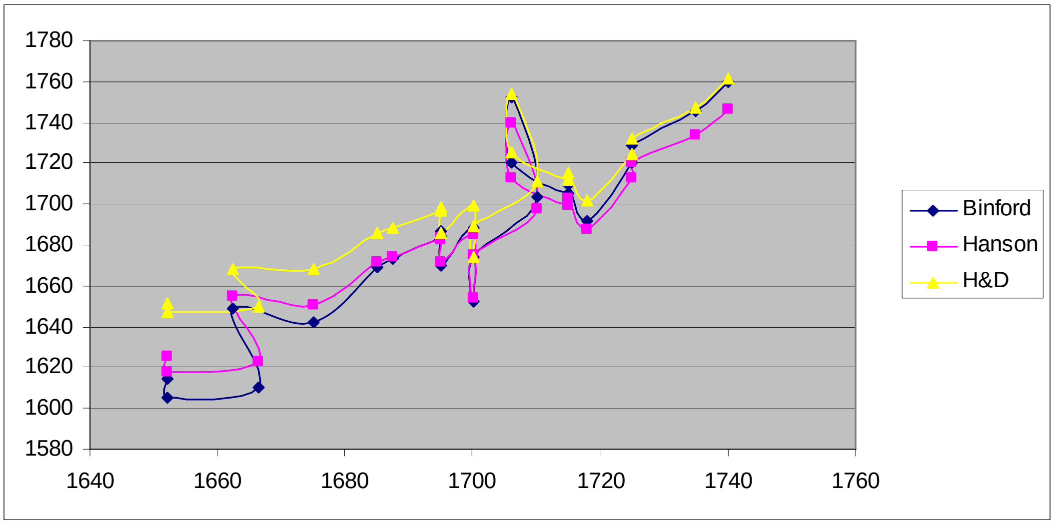

Figure 6.1: Scatter Plot of Maryland Results

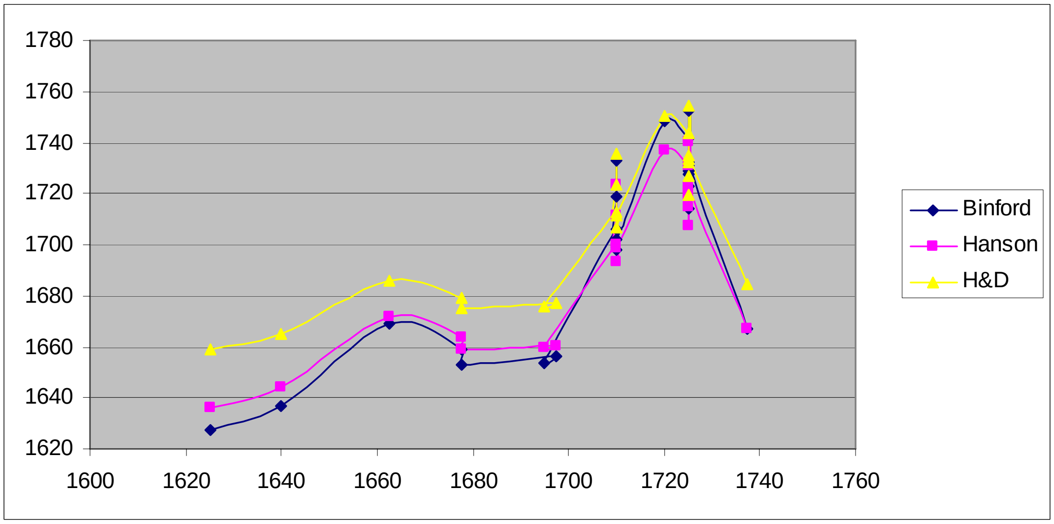

Figure 6.2: Scatter Plot of Virginia Results

In Virginia, the early Clift's site features and the Newman's Neck features, both on the Northern Neck along the Potomac, produce Heighton and Deagan results much closer to the predicted means than the other two formulas. The two features from Newman's Neck, while they are obvious outliers, producing dates 21 to 71 years earlier than the assigned means, do follow this same trend of better Heighton and Deagan means. The Clift's features dating to the early 18th century tend to produce low Hanson results and high Binford and Heighton and Deagan means; this is also seen from the three features from Ferry Farm, which is located along the Rappahannock River. The late Clifts features, dating to the second quarter of the 18th century, produce results all less than 10 years from the predicted means.

In Maryland, the five sites located in St. Mary's County, near the Potomac River, St. John's, Charles Gift, Tudor Hall, Fly and Abell's Wharf, all produce early Heighton and Deagan results that are very close to the predicted means, and late Binford and Hanson results that are often greater than 15 years, and up to 57 years, away from the predicted mean. The Main Street site and two of the features from Old Baltimore follow this trend as well. While these sites are not along the Potomac River, they are both on the Chesapeake Bay in the Upper Chesapeake. The rest of the Maryland sites follow the pattern seen in the Carolinas and the non-Potomac sites in Virginia of all three formula means being within 10-15 years of one another.

Sample Biases

Beyond the factors that may affect pipe stem dates in general, such as the wearing down of the piercer to create the bore during manufacturing, or whether one is measuring the lip or bowl end; some of this variation may be due to the biases of the samples used. The majority of the data are from the Chesapeake. Of the 64 features used, 23 are from Maryland, 22 from Virginia, 12 from North Carolina and 7 from South Carolina. Within the large samples from Maryland and Virginia, sites on the Potomac River, particularly Clifts Plantation in Virginia and sites from St. Mary's in Maryland, were heavily relied upon.

The features used do not work well for intrastate evaluation; the dates and lengths of occupation do not lend themselves to comparison. The sites from Maryland date between 1638 and the 1750’s, and are heavily weighted to the turn of the 17th century. The average number of years the features from Maryland were used is 15. Virginia’s sites date between 1620 and the 1740’s, with the majority dating to the 1720’s. The average number of years the Virginia features were used is 27 years. The most variation is seen in the North Carolina sites; two of the features, United Carolina Bank Feature 102A and Cornell’s midden, date past the cut off date of 1800 originally established in the parameters. The features used range in date from 1680 to 1814. The average occupation time for North Carolina features is 32 years; these long date ranges affect the probability of producing a formula date that represents the true mean occupation. The sites used in South Carolina date from the 1730’s to the 1750’s with an average occupation rage of 16 years.

While attempts were made to avoid many of these issues, it was nearly impossible, given the limits of this study. Some of these limits include, time and monetary restraints, only using data that have been made publicly available, and of the available data, finding samples that fit all the parameters laid out in Chapter 4. Another major issue was finding historical sites that had been excavated in at least Phase II, if not Phase III, investigations in the Carolinas; this proved very difficult. Despite the fact that there are fewer historical sites dating to the 17th and 18th centuries in the Carolinas than in the Chesapeake, there are plenty that have either not been excavated, or the data have not been analyzed, published in a useful way or been made publicly available.

Dutch Influence

The objective in data collection was to use sites with only English kaolin clay pipes, however, the likely inclusion of pipes from other European countries is high. Although the presence of French or Scottish pipes seems highly doubtful, the probability of Dutch pipe stems being present is great. Without a maker’s mark, it would be nearly impossible for authors of the site reports to tell unmarked English and Dutch pipe stems apart. As previously discussed in Chapter 1, the only way to tell the origin of an individual undecorated stem is by testing the hardness of the clay by scratching the surface; Dutch pipes are usually much softer than English and can be easily scratched using a pen knife. This is not possible on English pipes (Oswald 1975:115). Besides the ethics of purposefully damaging an artifact in this way, it is a fairly subjective test, and most people would deem this as a waste of lab time.

There have been more Dutch pipes identified on sites in the Chesapeake than in the Carolinas (Hurry and Keeler 1991; Miller 1991:73, 84; Riordan 1991:92; Cavallo 2004), and this may account for some of the differences. However, it must be noted that a “few” Dutch pipes were present among the thousands on the Brunswick Town sites (Beaman 2005:64), and two Dutch bowl fragments were uncovered from United Carolina Bank (Lautzenheiser et al. 1994:130). All three formula methods work best in the Chesapeake; these methods originated in Virginia and may be based on samples that included unknown, unmarked Dutch pipes. Although Harrington claims that he only used English pipe stem fragments (Harrington 1954:64), he does not say how he determined this. Dutch pipe stems are generally much thinner, and the bores smaller, than their English counterparts (Oswald 1975:115; Harrington 1978:64; Bradley 2000:116). If the original Harrington samples did include pipes from the Netherlands, then samples lacking Dutch pipes would produce formula results much earlier than the predicted mean they are being compared to.

While the sites from Virginia and Maryland produce results earlier and later than the predicted mean, the majority of the formula results date later than the predicted mean. From

Maryland, 9 of the 23 features, or 39%, had results that were later than the predicted mean for all of the formulas; and of the 22 features from Virginia, 6, or 27%, produced results later than the predicted mean for all three formulas. There is an increase in the percentage of the features in which all three formula results are earlier than the predicted mean the further south the site. From North Carolina, 5 of the 12 features, or 42%, produced only earlier means, and lastly, all of the formula results from the 7 features in South Carolina were earlier than their predicted means (Figure 6.3).

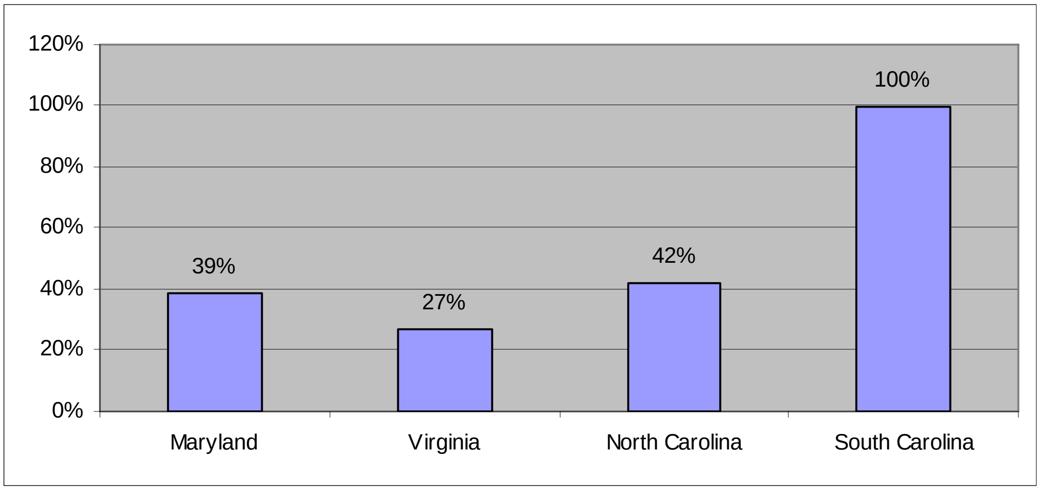

Figure 6.3: How Often all Three Formula Results are Less than the Predicted Mean

CHAPTER 7: CONCLUSIONS

This analysis has shown the Heighton and Deagan formula to overall be the most reliable and accurate of the three dating techniques tested. This method produced the mean dates closest to the predicted means more often than the other two, Binford and Hanson, formulas, and fell within the assigned date range a higher percentage of times than the others. This pattern continued once the data were broken down by state, in both Maryland and South Carolina. Neither Virginia nor North Carolina had a formula that worked best in that state; instead all three methods produced similar results. Overall, all three formulas produced the most reliable means in Maryland and Virginia, while the results from North Carolina and South Carolina were suspect. This was demonstrated not only with the first two tests, but also with the scatter plots; once a linear regression was applied to all four states, it was quite obvious that the formulas produced stronger results in the Chesapeake than in the Carolinas.

However, the Heighton and Deagan formula did not consistently produce the best results. As seen in the comparison of Maryland and Virginia sites, regional and temporal factors could be affecting the formula results, causing the Binford and Hanson formulas to sometimes work better than the Heighton and Deagan. There appears to be a difference between sites located on the Potomac River and those that are further away from the Chesapeake Bay. The Heighton and Deagan formula produced means closest to the predicted means, compared to the Binford and Hanson methods, on sites located along the Potomac. This is juxtaposed to the early Williamsburg sites that produced better Binford and Hanson results than the Heighton and Deagan formula. This study supports the suggestion that the Chesapeake should not be studied as one single region, but split into multiple sub-regions (Walsh 1999, 2001; Samford 2007).

As with any research project, there are now more questions than answers. Due to the lack of comparable sites, the one major question still remains: do these formulas work best in the Chesapeake, or were the data sets from that region simply better samples? Additional sites from the Carolinas, particularly from other colonial and federal period settlements, are needed to more fully answer this question. It would also be beneficial to use sites from the western parts of these states; only sites from the Tidewater were used in this study. There may be differences in lifestyle between Tidewater and Piedmont settlers, such as discard rates and consumption patterns, which could affect the dates produced on sites located far from major areas of trade.

As previously discussed, factors of use and discard rates could affect the tobacco pipe assemblages, and thus the formula dates produced. A possible way of more fully understanding use, availability and deposition rates of pipes would be to compare the price and availability of tobacco to the number of pipes found from a given time period. The expected results would be to see a decrease in the number of pipes in relation to the increase in price or decrease in availability of tobacco.

The question of Dutch influence could be addressed in a number of ways. Sites with known Dutch settlement or influence should be studied and compared to Mid-Atlantic and Southern sites; this would be easiest in states such as New York and Delaware, which early on, were Dutch colonies. Noël Hume (1969:307) states that Dutch pipes are more abundant on sites in Florida and along the Gulf Coast than elsewhere in the United States. It would be interesting to expand this research to include these areas as well, and note if the same patterns produced in this study are seen elsewhere. Colonial trade records could be consulted to determine the possibility of trade ships from Holland entering ports near sites being analyzed. Lastly, a better understanding of the differences between Dutch and English pipes is needed. The number of each type of pipe should be reported for each site. There are many resources available (Atkinson and Oswald 1972; McCashion 1979; Duco 1981) to aid in the identification of Dutch pipes that should be consulted more often.

In order to improve any of the three formulas, and formula dating in general, the original data must be evaluated. Harrington's data set was biased in many ways. It is all based on assemblages located in the same region, it is small, only 330 stem fragments, and is based on averages from dated features. The best way to increase the accuracy of these bore diameter averages would be to measure marked pipes with known manufacture dates from the historical record; since the time between production and discard is relatively short, approximately one year, this should produce more accurate bore averages. This may also lead to a new histogram of time periods with smaller date ranges. Pipes from multiple areas and site types should be used to decrease sample biases, and the sample number should be increased to more than 330 stems.

Site dating should not rely on a single factor, and interpretation should definitely not change to fit a single formula, instead it should be all encompassing. Just like radiocarbon dating, pipe stem dating is considered a form of absolute dating that can be unreliable and suspect. While incorrect C-14 dates are often due to contamination, anomalous pipe stem dates can be due to a variety factors, including site disturbance, sampling techniques, variables in measurements and site formation. An unexpected pipe stem date, that does not match the results of other artifacts and historical records, should be noted as a red flag. This could point to any number of issues that may have previously been overlooked, including factors that could affect interpretation, such as unknown trade relations, a longer occupation period than previously interpreted or an earlier undocumented deposition.

Formula dating has been in wide use by historical archaeologists since the 1960's, and while there is comfort in the simplicity of a date produced by a seemingly unbiased mathematical equation, archaeologists need to step back and reconsider. Noël Hume once said of formula dating, "I must admit I am often worried by the ever-increasing tendency to let statistics substitute for logic" (quoted in Alexander 1979:85). He was right to worry, and archaeologists need to evaluate what these dates are used for and how they are arrived at. The complete reliance on one method, the Binford formula, is in and of itself biased when there have been two other methods waiting to be utilized for forty years. All three pipe stem formulas, the Binford, the Hanson and the Heighton and Deagan, should be used in conjunction with one another and other dating techniques to help determine site dates, uses and anomalies.

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APPENDIX A: FORMULA RESULTS BY STATE

Maryland Formula Results

Site & Context	**Sample Size**	**Date Range**	**Mean Date**	**Binford**	(difference)	**Hanson**	(difference)	**H&D**	(difference)
St. John's: Dairy	36	1638-1665	1652	1614	-38	1625	-27	1652	0
St. John's: Pit Ph I	47	1638-1665	1652	1605	-47	1618	-34	1647	-5
St. John's: Pit total	60	1638-1685	1667	1610	-57	1623	-44	1650	-17
Tudor Hall: cellar	28	1650-1675	1663	1649	-14	1654	-9	1668	+5
St. John's Ditch	28	1665-1685	1675	1642	-33	1651	-24	1668	-7
Gift F12	222	1670-1700	1685	1669	-16	1671	-14	1686	+1
OB: Kitchen fill	132	1675-1700	1688	1673	-15	1674	-14	1689	+1
Main St: F4-05	118	MCD: 1695	1695	1684	-11	1683	-12	1696	+1
Old Baltimore: well	93	1680-1710	1695	1687	-8	1682	-13	1698	+3
OB: Kitchen waste	85	1680-1710	1695	1670	-25	1672	-23	1686	-9
St J's Potatoe Pit	51	1685-1715	1700	1689	-11	1685	-15	1700	0
St. John's: TP	145	1685-1715	1700	1652	-48	1654	-46	1675	-25
Abell's Trash Pit	446	1690-1710	1700	1674	-26	1675	-25	1689	-11
Garrett's F2: RC	33	1690-1730	1710	1703	-7	1698	-12	1711	+1
Harmony Hall F17	243	1692-1720	1706	1752	+46	1740	+34	1754	+48
Harmony Hall F63	38	1692-1720	1706	1720	+14	1713	+7	1725	+19
Fly: floor	192	1700-1720's	1715	1705	-10	1699	-16	1712	-3
Fly: rubble	66	1700-1720's	1715	1709	-6	1703	-12	1715	0
Main St: F4-04	154	MCD: 1718	1718	1692	-26	1688	-30	1702	-16
Garrett's F21: TP	34	1720's	1725	1720	-5	1713	-12	1725	0
Harmony Hall F22	36	1720's	1725	1729	+4	1720	-5	1732	+7
Oxon Hill Well	932	1720-1750	1735	1745	+10	1734	-1	1747	+12
Robert's F40	46	1720's-1750's	1740	1760	+20	1746	+6	1762	+22

Virginia Formula Results

Site & Context	**Sample Size**	**Date Range**	**Mean Date**	**Binford**	(difference)	**Hanson**	(difference)	**H&D**	(difference)
Sandy's pit1	139	1620's	1625	1627	+2	1636	+11	1659	+34
Sandy's Daub	130	1630-1640's	1640	1637	-3	1644	+4	1665	+25
Gloucester 1	65	1650-1675	1663	1669	+6	1671	+8	1686	+23
Clifts Pit 289	142	1670-1685	1678	1659	-19	1663	-16	1679	+1
Clifts Pit 305	41	1670-1685	1678	1653	-25	1659	-19	1675	-3
Newman Well	25	1670-1725	1698	1656	-42	1660	-38	1677	-21
Clifts Palisade	41	1685-1705	1695	1654	-41	1659	-36	1676	-19
Clifts 262AB	31	1705-1715	1710	1706	-4	1700	-10	1713	+3
Clifts Fence	156	1705-1715	1710	1698	-12	1693	-17	1707	-3
Clifts 255 A-E	677	1705-1715	1710	1733	+23	1723	+13	1736	+26
Clifts 255 F-Y	76	1705-1715	1710	1719	+9	1711	+1	1723	+13
Clifts 288S-AD	63	1705-1715	1710	1702	-8	1699	-11	1711	+1
FF West Pit	278	1710-1720's	1720	1748	+28	1737	+17	1750	+30
FF Original Root	53	1720's	1725	1742	+17	1731	+6	1744	+19
FF Replacement	26	1720's	1725	1752	-27	1740	+15	1754	+29
Clifts 269A-F	121	1720-1730	1725	1714	-11	1707	-18	1720	-5
Clifts 277A-C	27	1720-1730	1725	1729	+4	1720	-5	1732	+7
Clifts 280	135	1720-1730	1725	1727	+2	1718	-7	1720	-5
Clifts Privy	34	1720-1730	1725	1723	-2	1714	-11	1727	+2
Clifts S16 Cellar	250	1720-1730	1725	1732	+7	1723	-2	1735	+10
Clifts S3 Cellar	1322	1720-1730	1725	1731	+6	1722	-3	1734	+9
Newman Cellar	72	1725-1740's	1738	1667	-71	1667	-71	1684	-54

North Carolina Formula Results

Site & Context	Sample Size	Date Range	Mean Date	Binford	(difference)	Hanson	(difference)	H&D	(difference)
Eden House F2	66	1680-1740	1710	1759	+49	1746	+36	1761	+51
Eden House F311	115	1680-1740	1710	1746	+36	1732	+22	1747	+37
Leach-Jobson BT	234	1726-1728	1727	1749	+22	1738	+11	1751	+24
Eden House F3	62	1720-1740	1730	1729	-1	1720	-10	1745	+15
Leach-Jobson House	4751	1728-1776	1752	1754	+2	1752	0	1756	+4
Coutanche Cellar	36	1730-1750	1740	1755	+15	1744	+4	1757	+17
Espy House	3296	1731-1776	1754	1759	+5	1760	+6	1761	+7
UCB F102 B	83	1750-1769	1760	1749	-11	1745	-15	1751	-9
Rusellborough House	50	1751-1776	1764	1754	-10	1753	-11	1756	-8
Cornell F105	29	1769	1769	1734	-35	1721	-48	1737	-32
UCB F102A	91	1769-1820	1795	1746	-49	1740	-55	1748	-47
Cornell Midden	70	1782-1814	1798	1737	-61	1725	-73	1739	-59

South Carolina Formula Results

Site & Context	Sample Size	Date Range	Mean Date	Binford	(difference)	Hanson	(difference)	H&D	(difference)
Heyward F65	318	1730's	1735	1717	-18	1710	-25	1722	-13
Heyward F166	721	1730's	1735	1729	-6	1720	-15	1732	-3
Heyward F178	53	1740-1750	1745	1728	-17	1719	-26	1731	-14
Heyward Zone 5	96	1740-1750	1745	1739	-6	1729	-16	1741	-4
Beef Market Zone 8	312	1739-1760	1750	1724	-26	1707	-43	1728	-22
Beef Market Zone 9	347	1739-1760	1750	1729	-21	1714	-36	1732	-18
Dock St Privy	32	1750's	1755	1741	-14	1731	-24	1743	-12

APPENDIX B: DATA CITATIONS

Maryland

Site Name	Citation
St John's	Historic St. Mary’s City. 2009. St. John's Site (18ST1-23) artifact catalog. Documents on file Historic St. Mary's City, St. Mary's, Maryland.
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Charles Gift House	Hornum, Michael B., Andrew D. Madsen, Christian Davenport, John Clarke, Kathleen M. Child and Martha Williams 2001. *Phase II Archaeological Data Recovery at Site 18ST704, Naval Air Station Patuxent River, St. Mary's County, Maryland.* R. Christopher Goodwin & Associates, Inc.
Old Baltimore	Davis, Thomas W., Martha R. Williams, William Lowthert IV and Andrew Madsen 1999. *Archaeological Investigations at the Site of Old Baltimore, Aberdeen Proving Ground, Harford County, Maryland.* R. Christopher Goodwin & Associates, Inc.
Garrett's Chance	Gibb, James G. 2006. *A Phase I Intesive Archaeological Survey of the Stanwick Farm, Aquasco, Prince George's County, Maryland, Phase II Investigations of Garrett's Chance #2 (18PR703), and Phase II/III Investigations of Garrett's Chance #3 (18PR704).* Andrew Garte & Associates.
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Oxon Hill Manor	Garrow, Patrick H. and Thomas R. Wheaton Jr. (editors) 1986. *Final Report: Oxon Hill Manor, Archaeological Site Mitigation Project, I-95/MD 210/I295.* Garrow and Associates, Inc.
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Maryland cont.

Site Name	Citation
Harmony Hall	Humphries, M.E. 1991. Tobacco Pipes from the Abell's Wharf Site (18ST53), St. Mary's County, Maryland. In *The Archaeology of the Clay Tobacco Pipe XII, Chesapeake Bay*, Peter Davey and Dennis J. Pogue, editors, pp. 99-103. British Archaeological Reports International Series 56. British Archaeological Reports, Oxford.
Abell's Wharf	Humphries, M.E. 1991. Tobacco Pipes from the Abell's Wharf Site (18ST53), St. Mary's County, Maryland. In *The Archaeology of the Clay Tobacco Pipe XII, Chesapeake Bay*, Peter Davey and Dennis J. Pogue, editors, pp. 99-103. British Archaeological Reports International Series 56. British Archaeological Reports, Oxford.

Virginia

Site Name	Citation
Sandys	Mallios, Seth. 2000. *At the Edge of the Precipice: Frontier Ventures, Jamestown's Hinterland, and the Archaeology of 44JC802*. Association for the Preservation of Virginia Antiquities.
Gloucester	Brown, David A., and Thane H. Harpole 1997. The Gloucester Frontier: An Archaeological Investigation of a Mid-Seventeenth-Century Domestic Farmstead (44GL407), Gloucester County Virginia. Ms on file, Department of Anthropology, College of William and Mary, Williamsburg.
Clifts	Neiman, Fraser D. 1980. Field Archaeology of The Clifts Plantation Site, Westmoreland County, Virginia. Ms on file, The Robert E. Lee Memorial Association, Stratford, Virginia.
Ferry Farm	The George Washington Foundation. 2008. Ferry Farm Artifact Catalog. Documents on File, The George Washington Foundation, Fredericksburg, VA
Newman's Neck	Heath, Barbara J., Eleanor E. Breen, Dustin S. Lawson, and Daniel W. H. Brock 2009. Archaeological Reassessment of Newman's Neck (44NB180). Department of Anthropology, University of Tennessee, Knoxville.

North Carolina

Site Name	Citation
Eden House	Lautenheiser, Loretta E., Patricia Samford, Jaquelin Drane Nash, Mary Ann Holm and Thomas Hargrove 1998. *Data Recovery at Eden House*. Coastal Carolina Resources Inc.
United Carolina Bank	Lautenheiser, Loretta E., Patricia Samford, Annie Holm and Jane Eastman 1994. *Archaeological Data Recovery: Site 31CV183, United Carolina Bank, New Bern, NC.Coastal Carolina Resources Inc.*
Cornell	Brady, Ellen M., Patricia Samford, Susan E Bamann and Loretta E. Lautenheiser 2001. *Archaeological Data Recovery: Site 31CV310, The Samuel Cornell House Site, Craven County, NC*. Coastal Carolina Research Inc.
Russellborough	Brunswick Town Catalog sheets. Documents on file, North Carolina Department of Cultural Resources, Raleigh.
Epsy	Brunswick Town Catalog sheets. Documents on file, North Carolina Department of Cultural Resources, Raleigh.
Leach-Jobson	Brunswick Town Catalog sheets. Documents on file, North Carolina Department of Cultural Resources, Raleigh.
Coutanche	South, Stanley. N.d. Coutanche cellar artifact Catalog Sheets. Documents on file, East Carolina University, Greenville, NC

South Carolina

Site Name	Citation
Dock St. Theater	Zierden, Martha, Andrew Agha, Carol Colannino, John Jones, Eric Poplin, Elizabeth Reitz 2009. *The Dock Street Theatre: Archaeological Discovery and Exploration.* The Charleston Museum, Archaeological Contributions 42.
Heyward	Zierden, Martha and Elizabeth Reitz 2007. *Charleston through the Eighteenth Century: Archaeology at the Heyward-Washington House Stable.* The Charleston Museum, Archaeological Contributions 39.
Beef Market	Zierden, Martha and Elizabeth Reitz 2005. *Archaeology at City Hall: Charleston’s Colonial Beef Market.* The Charleston Museum, Archaeological Contributions 34.