Pleistocene Bones and Stones in the New World

(First Entry into the New World)

Tony Baker December 11, 2007

This paper is concerned with the first entry of people into the New World and the associated Pleistocene archaeological record. For my purposes the archaeological record consists of two parts: the stuff that has been discovered and made available to the public, or at least the archaeological community, and the stuff that is still in the ground waiting to be discovered. From a different perspective, the discovered portion is a sample of the total archaeological record or the universe. I know this sounds like probability and statistics, and it is. Yet, if there is only one thing that makes archaeology a science, it is this concept of sample and universe. Consider how many samples of an apple falling to the earth did Newton observe before he conceived of the idea that the earth held the moon to it with the invisible arms of gravity?

Representative Sample

The term "representative sample" is not mathematically defined but instead it is used to add credence to one's sampling and statistical work. It basically implies the sample from the universe is very similar to the universe, or that one can expect the universe to look like the sample. To illustrate, consider a universe of 1000 square meters of barn floor and yard. One can dig ten randomly spaced test pits (one-meter square) and maybe, just maybe, produce a representative sample of the archaeology beneath the surface. Yet, one is not sure because the tests pits represent only one-hundredth of the universe. Increase the sample size and dig 100 test pits and your chances of getting a representative sample of the universe have increased 10 fold. Dig 1000 test pits and you will definitely have a representative sample because you will have dug up the entire barn floor or the universe.

The single biggest problem with the New World Pleistocene archaeological record is the universe size is unknown. In different words, we don't know what percent of the universe is represented by the discovered-archaeological-sample, which are sites such as Gault, Monte Verde, Lindenmeier, Mesa, Willamson, Adams, Blackwater Draw, etc. Additionally, we cannot increase the sample size on demand because all the found Pleistocene sites have been tested and new ones are extremely rare and, therefore, come very infrequently.

Not knowing the universe size of the archaeological record makes it impossible to state the discovered-archaeological-record is a representative sample. If it is not, how does one begin to answer a question about the peopling of the New World? One common option is to assume the discovered-archaeological-record is not a representative sample and adopt other approaches or methodologies. A second option is to convince one's self that the discovered-archaeological-record is a representative sample.

Population Dynamics

Over the years a number of independent approaches to studies of the peopling the New World, sometimes called multi-disciplinary approaches, have been proposed to ignore the discovered-archaeological-record because it was assumed to be non-representative. I say independent because they are independent of the archaeological record and each other. Some of these methods are genetics, linguistics, and population dynamics.

In this paper I have chosen to discuss population dynamics in lieu of the other independent approaches because I am most familiar with the associated math and assumptions. I acquired this knowledge via email communications with Jose Carlos Soler over the last six months. Carlos is a Ph.D. candidate at the Universidad Nacional de Educación a Distancia, Madrid. Although we often disagree, he has expanded and enhanced my understanding of all subjects touched on in this paper. Carlos can be reached at alentraia@yahoo.es .

At the heart of population dynamics is the basic exponential growth equation $P_t = P_0 * e^{rt}$ or, perhaps, in a less daunting form of $\ln(P_t/P_0)=r*t$. The variables in the equation represent the following:

P_t = the population at the end of the time period,
P_0 = the population at the beginning of the time period,
t = the number of years during the time period,
r = the annual growth rate,
e = 2.718282, and
ln( ) = natural logarithm.

For the reader with a financial background this is the same equation that is used to calculate the growth of a savings account that is compounded continuously. And, in both the anthropological and economical disciplines there is the associated concept of doubling time (DT). This is the years it takes to double the population or the value of a savings account with no subsequent contributions. For example, one can double their savings in approximately 10 years at a 7% interest rate. In the remainder of this paper, DT will be discussed instead of "r", from the growth equation, because it is easier to comprehend. DT is directly related to "r" by the equation $DT=\ln(2)/r$.

To apply this equation to the peopling of the New World, or more specifically to answer the question when was the entry date, we need only to know the population at time of entry (P_0), the population at some point later in the Pleistocene, and the DT value for the population. The population at time of entry is generally assumed to be between 50 to 100 individuals, as this is believed to be the minimum size that is required for a viable and reproducible population. In this paper a value of 70 individuals has been used. The later population (P_t) can be any point in time one chooses. I have chosen 10,000 years BP or the end of the Pleistocene. I am of the opinion that the way of life, hunting and gathering, changed very little between entry into the New World and 10,000 years. Therefore, the rate of population growth, DT, should not have varied substantially during this time. As to the number of people at 10,000 years, I can only guess. The U.S. Census Bureau estimates the world population at that time to be in the range of 5-10 million people (2007). But, again this is the total world and not the New World. For illustrative purposes I will assume the New World population at 10,000 years was 500,000 people. (***Please note, all dates in this paper are calendar year before present.)***

Again, the DT value is measured in years and it is the time it takes to double the population, e.g. from 70 people to 140 people. By using DT, I am able to avoid discussing the many assumptions generally associated with population dynamics. For example, it avoids infant mortality concerns, diseases from unsanitary conditions, deaths from mammoth maulings, and the abundance of unaware, easy to kill mammals. DT can be almost any value. The shortest known value is about 100 years for hunter-gather populations (Boone 2002, Gurven and Kaplan 2007), and the longest is infinity or a negative number, which is a dying population.

To illustrate the relationship DT and population I have created Table 1. As the reader can see, the population of 70 individuals must double approximately 12.8 times to grow to a population of 500,000 people, or only 17 times to grow to the estimated world population at 10,000 years. If we consider the shortest DT of 100 years mentioned in the previous paragraph, then it would take 1280 years (12.8*100) to grow to 500,000 people. This DT is obviously too short since Monte Verde dates to about 14,000 years or 4000 years before 10,000. Therefore with the above assumptions, the minimum DT for the New World has to be at least 312 years (4000/12.8) if the entry date is the same as Monte Verde's dates. If one believes the entry date was 35,000 years, then the associated DT value is 1953 years (25,000/12.8) to achieve a population of 500,000 people by 10,000.

Table 1

Population (people)	**Number of Doubles**
70	
140	1
280	2
560	3
1120	4
2240	5
4480	6
8960	7
17,920	8
35,840	9
71,680	10
143,360	11
286,720	12
500,000	**12.8**
573,440	13
1,146,880	14
2,293,760	15
4,587,520	16
9,175,040	17

To close this section, I want the reader to take away the fact that the three variables, initial population (P_0), final population (P_t), and DT are truly unknown during the Pleistocene. That said, any entry date calculation is possible because it is only based on the researcher's assumptions, which are influenced by their own beliefs. However, this is not a reason to abandon population dynamics. It still has value, as will be seen in the next section.

New World's Discovered-Archaeological-Record

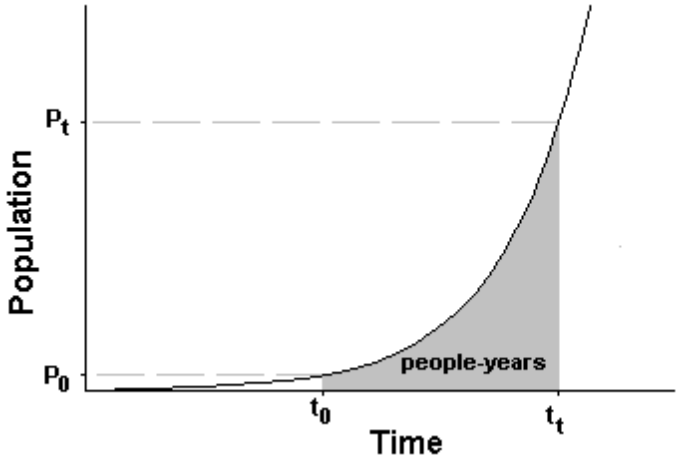
I personally believe the New World's discovered-archaeological-record is a representative sample of the total archaeological record. With this belief follows an acceptance of a late entry date on the order of 14,000 to 15,000 years. Other researchers believe that additional sites with much greater antiquity will ultimately be discovered and prove the entry date to be much earlier. In different words, they do *not* believe the current discovered-archaeological-record is representative of the New World archaeological record.

One of the reasons for my faith in the New World's discovered-archaeological-record is that I have seen some of the Old World's record. The Old World sites are not only more abundant and much older than the New World sites; they are also much thicker. I use the term thicker here to mean they have many, more centimeters of deposition on the living floors. The archaeology of the Old World sites remind me of the many coats of paint that are on the little building in Figure 1.[1] In contrast, the archaeology of New World sites is similar to a single coat of paint on a new house.

Figure 1

More sites, older sites, and more deposition means more people and time. The size of the archaeological record is related to the number of people on the landscape *and* the years they are on the landscape. For example, 1000 people on the landscape for 100 years will create a record that is similar in size to a record produced by 100 people on the landscape for 1000 years. In either of these cases there were 100,000 people-years to create artifacts and deposit them in the archaeological record. If we return to the growth equation of population dynamics and view it in graphical form, it looks like Figure 2. At time equal to t_0, the

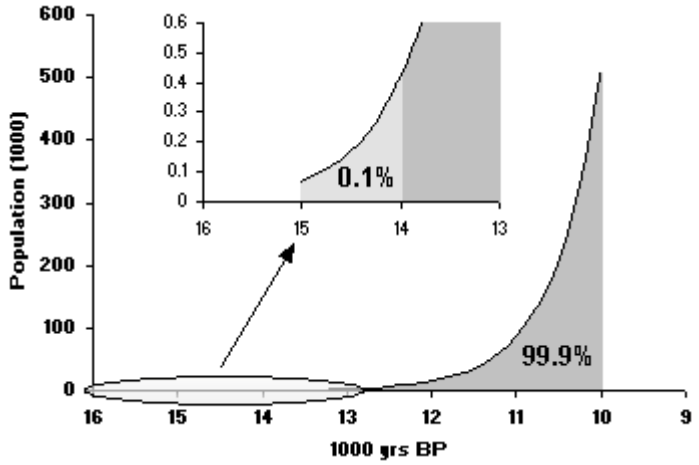
Figure 2



population is equal to P_0. At a later time, when time is equal to t_t, the population is equal to P_t. The area under the curve between t_0 and t_t, which is gray, is equal to people-years; the same people-years that create the archaeological record. This area is obtained by integrating the growth equation between t_0 and t_t.

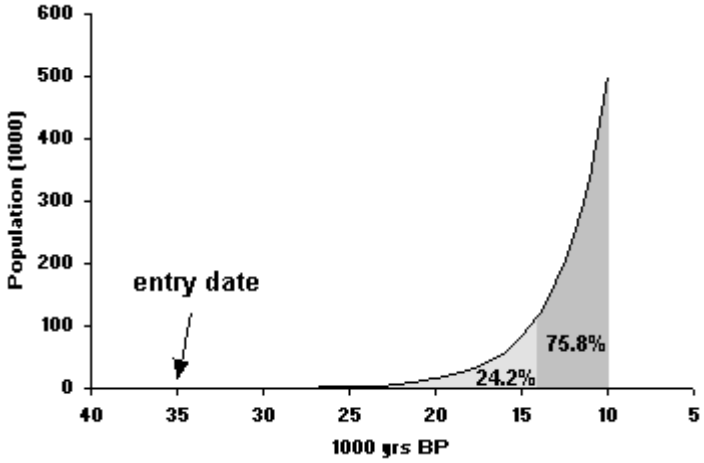
Figure 3 is a New World growth equation with the assumptions of an entry date of 15,000 years and an initial population of 70 individuals. Also, it assumes the population at 10,000 years has grown to 500,000. Therefore, the DT is equal to 391 years. A change in the gray shading occurs at 14,000 years to indicate the earliest date in the discovered-archaeological-record. As you can see, 99.9% of the people-years between 15,000 (entry date) and 10,000 occur between 14,000 and 10,000 years. Only 0.1% of the people-years occur between 15,000 and 14,000. In different words 99.9% of the New World archaeological record was created between 14,000 and 10,000 years. If this is the case, then the discovered-archaeological-record appears to be a representative sample.

Figure 3



Now contrast Figure 3 to Figure 4. Figure 4 has the same assumptions as Figure 2, with the exception of the entry date. The entry date is assumed to be 35,000 years and therefore the DT is 1953 years. The people-years between 14,000 and 10,000 now represent only 75.8% of the people-years between 35,000 and 10,000. Or, 24.2% of the archaeological record was created between 35,000 and 14,000 years. If this is the case, then the discovered-archaeological-record is not very representative of the archaeology record.

Figure 4



Continuing with the same logic, I have prepared Table 2 to further illustrate various entry dates with the associated percentage of people-years before 14,000. Additionally, I have added columns to include a population of 2 million people at 10,000 years. In all cases the initial population is 70 individuals. As can be seen from the table, the earlier the entry date, the larger the percent of the archaeological record has to be created before 14,000. And, this is only logical.

Table 2*

Entry Date (yrs BP)	Final Population = 500,000 at 10,000 BP		Final Population = 2 million at 10,000 BP	
	DT (yrs)	% of People-Years before 14,000 BP	DT (yrs)	% of People-Years before 14,000 BP
15,000	391	0.1%	338	> 0.1%
35,000	1953	24.2%	1689	19.4%
50,000	3124	41.2%	2702	35.8%
75,000	5077	57.9%	4391	53.2%
100,000	7030	67.4%	6080	63.4%

* See Note 2 for the associated mathematics

To reiterate the concepts in this section, people alone do not create the archaeological record. It takes both people *and* time. Again, 1000 people on the landscape for 100 years will create a record that is similar in size to a record produced by 100 people on the landscape for 1000 years. Therefore, when one looks at Figures 1-3, the size of the population at any given time is unrelated to the size of the archaeological record. The shaded area under the population curves, which denotes people-years, creates the archaeological record and is proportional to its size. So, when I say that 24.2% of the people-years between the entry date of 35,000 years and 10,000 years occurred before 14,000 years, I am also saying that 24.2% of the archaeological record was created before 14,000 years. More specifically, I mean that 24.2% of the artifacts were created or 24.2% of the sites were occupied before 14,000. So, if the entry date was approximately 35,000 years BP or earlier, how is it possible that the New World archaeology has not been able to find anything before 14,000 years?

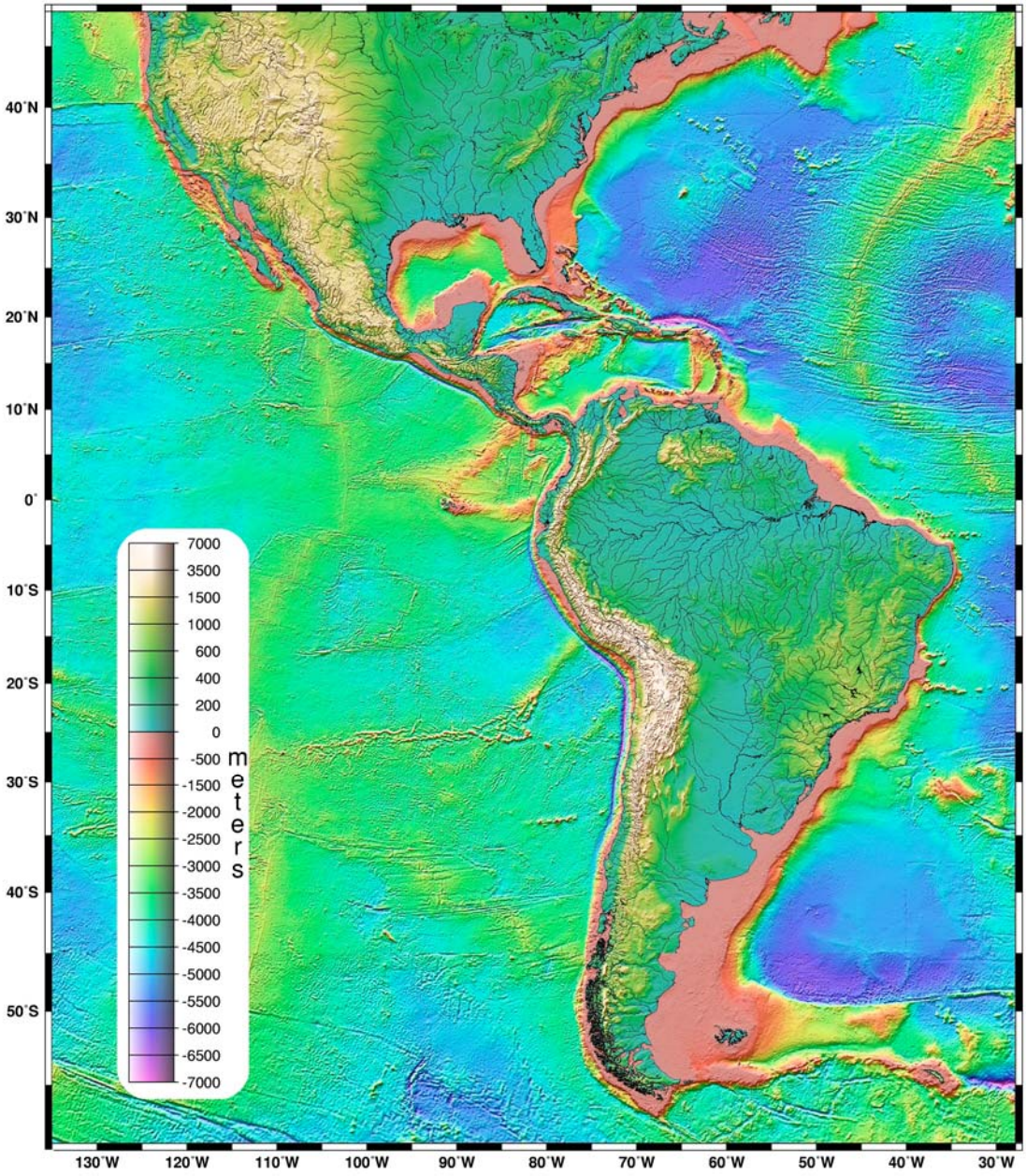
To put this question in perspective, consider an ordinary deck of cards that contains 12 face cards and 40 non-face cards. This is 23% face cards, which is close to 24.2%. The chance of drawing a non-face card from the deck is 77%. The chance of drawing a non-face card two times in a row is 59%, or 46% for three times in a row. Finally, the chance of drawing a non-face card 64 times in a row is 0.000,005%. I chose 64 because it is the sum of recorded Clovis (19) and Folsom (64) sites reported by Haynes (2002:12-13) and Meltzer (2006:2). With just these 64 sites, not considering any of the other Pleistocene sites of the New World, it is obvious the chance of *not finding* a pre-14,000 year old site is *zero* if the entry date was as early at 35,000 years. Therefore, the above question looms even larger. How is it possible that New World archaeology has not been able to find anything before 14,000 years, if the entry date is significantly earlier than 14,000 years ago?

The Lost Continent of Atlantis

One line of thinking that recognizes the lack of pre-14,000 year old sites and still argues for an early entry date is to locate the early sites underwater. During the last 100,000 years, the sea level has been lower than it is today. During the last glacial maximum, approximately 20,000 years, it dropped to its lowest level of about 120 meters before present day levels (Peltier and

Fairbanks 2006). This obviously exposed additional land is known as the continental shelf. It is on this now-submersed continental shelf that these pre-14,000 year old sites could be located.

Figure 5 *(must be seen in color)*



To help put this concept into prospective, I created Figure 5, which elegantly depicts the continental shelf for the portion of the New World that was not glaciated.[3] Based on the scale in Figure 5, the depth of the shelf is 500 meters or deeper. Assuming the shelf is gently sloping, the portion of it that was exposed during the last glacial maximum is about 24% (120/500 meters) of the depicted shelf. This submerged site model then has the pre-14,000 year old sites located on

this narrow strip of land. If the entry date was 35,000 then this line of reasoning has 25% of the total archaeological record located on this strip of continent shelf. And, at 14,000 years ago when the sea level rose to around 80 meters below modern levels, the people then move on to the continents and change from a marine-adapted economic to a terrestrial one.

I can only conclude this section by saying that even with my liberal way of thinking, this hiding of the early archaeological record on the continental shelf is a stretch.

Summary and Conclusions

The New World Pleistocene discovered-archaeological-record is very short in duration. Monte Verde at 14,000 years is the grandfather of all the sites in the New World with Clovis and others following in increasing numbers. When I was a teenager in the 1960's and becoming interested in Paleoindians, the story was much the same. Clovis was then the oldest at 13,000 years and Monte Verde had yet to be discovered. Therefore, in the last 50 years, archaeology has only been able to add 1000 years to the discovered record. Yes, I know there are other locations that are argued to be older sites but I, and I believe most archaeologists, do not recognize these locations. The bottom line is that we continue to sample the archaeological record each time a new site is found, but each new sample continues to produce the same late Pleistocene dates.

I was aware of the above facts for the last ten-to-fifteen years, but their significance eluded me because I did not know how to put them into mathematical perspective. And, their significance would still be invisible to me today, if Carlos Soler had not introduced me to population dynamics and the associated equations. This was the tool I needed to play "what-if" games with the archaeological record. And for the last six months I have done a bunch of game-playing.[4]

The outcome of this six months of investigation was the realization that the New World discovered-archaeological-record is truly a representative sample of the total archaeological record. There are few or no sites in the New World that are older than Monte Verde. For sure, first entry occurred after the last glacial maximum.

I hope the reader reads this entire paper in addition to reading only this Summary and Conclusion. It is only when one appreciates population dynamics, is one going to appreciate the absence of pre-14,000 year old sites in the New World discovered-archaeological-record.

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Notes

1 – The little building in Figure 1 is called the "Pump House." It is located next to a football stadium shared by numerous high schools in the city of Denver, Colorado. Each time a team plays their homecoming game in the stadium, the Pump House gets painted. This tradition is over 60 years old. No paint has ever been removed.

2 – Mathematics of Population Dynamics used in this paper.

$$NumberOfDoubles = \frac{\ln\left(\frac{P_t}{P_0}\right)}{\ln(2)}$$

$$DoublingTime = \frac{t_t - t_0}{NumberOfDoubles}$$

$$PerCentPeopleYears\_Before\_14000 = 100\,\frac{2^{\left(\frac{EntryDate - 14000}{DoublingTime}\right)} - 1}{2^{\left(\frac{EntryDate - 10000}{DoublingTime}\right)} - 1}$$

3 – I created Figure 3 from downloaded images from the *Scripps Institution of Oceanography's* public ftp site at ftp://topex.ucsd.edu/pub/topo_tiff .

4 – One of the tangential efforts of playing with population dynamics was the creation of a First Entry Calculator. See http://ele.net/1stentrycalculator.htm .