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EVIDENCE OF ABSENCE OR ABSENCE OF EVIDENCE? - AN EXPLORATION OF THE SETTLEMENT DATE OF NEW ZEALAND BY MĀORI

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Introduction

The settlement of New Zealand by Māori is now commonly cited as being in the thirteenth century CE. One can look to evidence of presence and evidence of absence in support of a settlement date. The sort of evidence admissible in support of presence clearly are dated sites with the right early cultural associations where the dates meet the test of chronometric hygiene. In support of absence are the series of dates on rat-gnawed seeds and rat-killed snails which have a distinct early cut off that can be argued is the date on which rats arrived. They must have arrived with people for they are commensal. However did every arriving canoe have rats, or specifically the first? We cannot know. A key event in this consideration of absence is the well dated Kaharoa ash of 1305 ± 12 CE (95% confidence limits) (Higham *et al.* 2000). Here there is but a trace of disturbance to vegetation in pollen deposited just before the eruption over the area in which it fell, the Bay of Plenty to Northland. Clearly there was no great forest disturbance at any time depth prior to the Kaharoa ash. This is reinforced by the palynology on the deposits from Lake Pupuke in Auckland prior to the last Rangitoto ash (Horrocks *et al.* 2005). There is only one known site that stratigraphically pre-dates Kaharoa ash despite the considerable extent of the ash – the lowest layer in the Cross-Creek midden which has a series of dates consistent with occupation just before the eruption (Furey *et al*. 2008).

On a view of the evidence that is based on fact – that is empirical – the case for the thirteenth century settlement seems watertight. Indeed the vox pop that this author organised at the 2014 New Zealand Archaeological

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On a personal note in the earlier polls I had always been at the recent end of the range of settlement dates. In the Christchurch poll result I was somewhat nonplussed to find I was distinctly at the early end. One influence on my view was that sites dated to the fourteenth century seemed to be too common for there to be so few, or some would have it, no earlier sites. Another influencing factor was the exploration of the putative interaction area of the Kermadecs, Norfolk Island, Auckland Islands and the Chatham Islands, which must have centred on voyages from New Zealand. Given voyaging was a major investment of effort and a risk, it seems likely to have been undertaken from a reasonable population base and hence not all undertaken soon after settlement.

If Nigel Prickett characterised the trend of the series of polls as being the "reluctant converts joining the party" then I was an early convert that had perhaps left the party. My discomfort was in being trained and having practised in a strongly empirical discipline, I seemed to be somewhere else. In further considering that position I felt that there has not been enough consideration given to the old question – is absence of evidence, evidence of absence?

Association's Christchurch conference strongly confirms it is commonly held by archaeologists (Law 2014).

In 2014 some newly reported studies, too late to have influenced the poll, have reinforced the scale of the impact of man on New Zealand flora and fauna and the rapidity of change, which was in effect our first biodiversity crisis (Holdaway *et al.* 2014, McWethy *et al.* 2014, Perry *et al*. 2014). However it can be questioned if the treatment of human settlement and population growth in some of these studies fully accounts for the reasonably large number of people (strictly the women) who arrived (Murray-McIntosh *et al.* 1998, Penny *et al.* 2002, Whyte *et al.* 2005) Their numbers estimated, being from modern rather than ancient mtDNA, can be questioned to some extent on that basis. Nichol's (2001) criticism of the modelling of Murray-McIntosh *et al.* (1998), as exaggerating the numbers settling here still seems valid and is applicable to the later work as well. Still the number appears to be large enough that the arrival process must have been through multiple events. The variable arrival of plants and lack of two animals (pigs and chickens) must also have had some bearing on the settlement process, along with the arrival of rats in particular.

An early small population would have had the need for fuel and horticultural land. In a forested land the beaches must have been littered with timber, as indeed some still are. It must have been a considerable resource, reducing the need to clear forest for firewood. Again a small initial population could be sustained by a few hundred hectares of horticultural land, even with a long cycle of reuse. The need to clear any substantial proportion of New Zealand for that purpose was not apparent. (The North Island is over 11 Mha. In modern New Zealand cropping and horticulture land is 2% of land area, and about 0.1 ha per person). The signature of forest clearance and burning could initially have been quite slight in such a large area. This argument needs to be considered in relation to the fragility of the New Zealand environment. It could only be considered as applicable for decades rather than centuries.

This paper reports the first part of an investigation that uses modelling to assess what might be the frequency of the loss of early sites. This considers their likelihood of surviving until they are available for modern investigation and dating.

Site Loss

Loss or damage of Archaic sites from the inventory is a well-enough known modern phenomenon – with common causes being coastal development and coastal erosion, the latter no doubt exacerbated by sea level rise in the past two centuries (see the evidence for sea level being stable in the period -1000-1800CE but rising thereafter (Kemp *et al.* 2011)). Up until 1800 any sea level change-induced site loss is therefore likely to be caused by local tectonic effects where different stretches of the New Zealand coastline are either rising or falling, frequently by earthquake related incidents.

Tsunami effects on archaeological sites have been documented by McFadgen (2007). While the interpretation of this as driving cultural change has not found common acceptance the evidence of the physical effect is still there. For the most part the observed effects of modern tsunami seem to be adding sediment carried in by the waves rather than removing material already in place on the water's retreat. Thus they may only rarely be removing sites, though if this were occurring it would not be readily observable through archaeology. The large older tsunami educed by McFadgen seems to be outside the known population of tsunami experienced since 1840. The case can perhaps be made that the frequency of larger tsunami as determined by shoreline deposits is not part of a continuous statistical population, as the smaller ones of recent experience have commonly not left such deposits. Rather the large tsunami only have effect when they are triggered by very large events – earthquakes and submarine slides – that create waves that greatly exceed the normal range of tide and storm effects on beaches. This might then break the uniformitarian expectation we have from the period since 1840, that the evidence of tsunami follows some sort of size / frequency relationship in which modern experience forms a part.

Bob Jolly took an interest in site destruction on the Coromandel from the 1950s onwards. Here while there was loss of Archaic sites to coastal erosion more were lost to property development, almost always residential development (Jolly n.d.). In contrast the systematic coastal Southland surveys (Brooks *et al.* 2008, Jacomb *et al.* 2005) of the past decade in an area with less development pressure found that sites were being damaged and lost primarily to coastal erosion. No doubt such regional differences occur elsewhere as well for modern destruction. Prickett (1985) has shown the different nature of destruction of inland sites in Taranaki.

Shore whaling sites as analogues

Prickett (2002) has provided an overview of the corpus of shore whaling sites of early historic New Zealand. Most of those he lists have come to his schedule of sites through being known through the historical record, though a few may have come to account first through being recognised as archaeological sites before being located in historical records. There may be a small bias in the sample through that latter process towards extant sites.

The shore whaling sites are strictly coastal, and in locations where there was access to open ocean for small boats. They are predominantly East Coast. In their sorts of locations many align with the leeward province Anderson (2002) recognised as the preferred early settlement location and in more detail to the preferred locations of many Archaic sites: near the mouths of large harbours, just inside small harbours, and at larger river mouths where canoe access to the sea could be achieved but where fresh water was available and a range of shore and land resources could be accessed.

The distribution of the sites considered here is shown in Figure 1. There are some obvious concentrations of the whaling sites in Foveaux Strait, Banks Peninsula, Kaikoura, Port Underwood, Kāpiti Island and Mahia. These concentrations depart in detail from the known Archaic site distribution concentrations, but they do overlap in a general way.

Prickett gives estimates of when the sites were occupied and in the commentary notes if the sites are destroyed, and if so, the mechanism of their destruction that can be differentiated into natural processes or more recent development of the site. The character of the best preserved sites can be seen in Smith and Prickett‘s reports on investigations of two of them (2006, 2008). Most of the sites are quite constrained as to their time of use – their ends commonly aligning with the collapse in the 1840s of the whale population that visited the New Zealand coast. Hence there is a useful period of time over which they have been exposed to loss. Moreover Prickett has considered whether the sites are destroyed for the purpose of archaeological investigation. It is noted that in some instances this means the site is not obliterated – some residual trace

Figure 1: Shore whaling sites considered here. Map data ©Google 2015

of it may remain in scattered artefacts for example. This is not incompatible with considering the destruction of Māori sites for this purpose for it is the survival of datable sites that is being considered, not their total obliteration.

In considering the whaling sites some have been discounted for this purpose. Five sites that are in the Chatham Islands and on Campbell Island have been excluded as non-representational. On the same basis some other sites were excluded, these being sites that were the scene of more recent industrial scale operations, namely Fishing Bay, Tipi Bay, Yellerton, Whangamumu and Whangaparapara. The Weller site or sites in Otago Harbour have three site numbers but were treated as a single site for this purpose. Prickett did similarly. He also lists some sites where the evidence for there ever being a site is dubious. They have not been included in Prickett's tabulation of sites (his Appendix 1) and nor have they been further considered here.

The sites are classified by Prickett as follows: confirmed as to location, known to a more general locality only, or not confirmed. Despite the lack of location certainty in some cases it was apparent that some sites were destroyed, and where that had happened, what the cause was. Supplementary material to this paper on-line covers more detail of the site classifications as to survival and condition.

		Condition		Mode if destroyed		
	Total	Unknown	Destroyed	Human or both human and natural	Natural	Unclear
Location confirmed	42	2	6	4	2	0
Locality only	21	18	3	2	1	0
Not confirmed	14	6	8	4	3	1
Total	77	26	17	10	6	1

Table 1: Shore whaling site status

Table 1 summarises the state of knowledge of the 77 sites used here.

For some sites both natural processes and human intervention are mentioned as the causes of destruction. This differentiation does not matter when considering destruction rates since 1840 but the intention here is to apply the natural rate of site destruction to sites older than 1840. Here a conservative approach has been taken in that only sites where it appears the destruction is convincingly natural have been considered in this category, not sites where both may have occurred. This is likely to be a conservative approach yielding a lower natural destruction rate. Obviously it would be desirable for the state of knowledge to be such that the "Locality only" and the "Not confirmed" sites had been found. As it is the destruction rates have been taken as 6.5 (6 plus a half score for the unclear site) out of 51 sites (= 77-26) for destruction caused by natural causes or 12.7%, and 17 out of 51 sites for all forms of loss or 33.3%.

A perhaps more conservative approach might have been to take the' all causes' destruction rate on confirmed sites only and thus 4 out of 42 (discounting two where the condition is unknown), or 9.5%. However this introduces a substantial bias because the site confirmation is largely driven by finding archaeological remains. The wider sample of 51 sites is preferred.

The question needs to be asked if the "Unknown" condition of most of the "Locality only" sites and many of the "Not confirmed" sites is as a result of site destruction. Alternatively it is possible that some of these sites do exist but are not as yet found. The former circumstance would lead to an underestimate of site destruction here and the latter to an overestimate. While it is feasible to include estimated figures for sites that exist but are not yet found, this does not improve the validity of the statistical approach and consequently it has not been used here.

An annual probability of the destruction of the whaling sites can be estimated from these figures, for either natural destruction or both forms of destruction. The probability has been considered as an unvarying annual probability. This approach needs consideration. Some of the dates of destruction will be known, and in some cases there will not be a single date as the destruction would have been progressive. Here a single destructive event model only has been considered. This is obviously more valid for small sites, likely to have been lost in a smaller time interval. The sites considered here are small. Being invariant through time also needs consideration. It is possible the natural loss rate through coastal process has increased over time linked with modern sea level rise but this is not the only coastal process cause that is possible. With human-caused loss it is apparent these coastal sites were subject to loss starting shortly after their whaling use as they were favoured locations for colonial occupation with their good sea access, if not just coastal location – a favoured site for later occupation as it was for early settlement. Varying rates through time have not been modelled here.

Tsunami have not been considered here either as tsunami loss does not appear to be a factor for the whaling sites. Lastly, as the 'natural causes' rate is being extracted here, it is pertinent to consider if some of the sites classified as being destroyed by humans might have been subject to natural destruction before their apparent human-caused destruction. While it is possible to mathematically allow for this by considering the two forms of destruction independently (which would increase the natural destruction rate), this has not been done. This is because the two forms of destruction are unlikely to be independent. A site reoccupied and thereby destroyed after its whaling use is likely to have been assessed as to its risk of natural destruction by the re-occupiers before they commenced re-occupation. The fact of reuse means the re-users have considered there was little risk of loss, at least in part evidenced by the found state of the location. This reduces the independence of the two means of destruction.

The mathematical treatment of loss is by a decay curve loss treatment, exactly analogous to radioactive isotope decay, exemplified for archaeologists by the C14 decay curve. Here the loss of sites is not a straight line down to zero, rather a proportion is lost in each time period so the survivors are fewer but the loss rate slows in proportion to the number remaining, so the approach to zero is asymptotic. The annual probability can be given as a best estimate and because the sample size is not large, using Poisson probability the 95% probability limits can be given as well - see Table 2.

An alternative presentation is to give the half life for the survivorship of a site – see Table 3. Again the 95% probability range is shown.

	Annual probability of survival		
	low	best	high
All causes	0.998448	0.997410	0.994932
Natural only	0.999624	0.999246	0.998058

Table 2

	Half life years		
	low	best	high
All causes	446	267	136
Natural only	1841	919	357

Table 3

It should be apparent that the rate of loss of the whaling sites is not immaterial. The natural modes of destruction apparent here include coastal erosion, other erosion and landslip. Supplementary material to this paper on-line covers the mathematical approach to the estimation in more detail (see: http://tinyurl.com/ozaw6rc).

Applying the model

The whaling sites are considered analogous to a good many Archaic sites on the basis of their strictly coastal nature and requirement for access to open ocean and to basic terrestrial resources. The annual loss rates calculated here have been applied to the Archaic over their much longer histories. The decay model has been applied to consider sites that were intact - at least in part – in 1950. This date is used here as it was the date of Duff's book (Duff 1950) and the decade that the New Zealand Archaeological Association was founded so the characteristics of early sites were known to an interested public and scholars. A site that existed then is likely to have been recognised since then as it has either survived until the present or if destroyed after 1950, then recognised before, or as it was destroyed. Early sites were thereafter much less likely to be lost without first being recognised.

If as per McFadgen (2007) there were more frequent large tsunami in the past they may have caused site loss in episodic events prior to 1840, but they are not modelled here.

Figure 2 shows site survivorship as derived from these data, in the form of decay curves from 1100CE and 1450CE. These show how the number of sites surviving might diminish quite severely over time. The confidence limits set on these curves derive entirely from the size of the sample of the whaling sites. Note also that the two curves are not independent. One cannot pick a high range in the band from 1100 and a low range in the band from 1450. They derive from the same data so they need to be read consistently. Because the whaling site data are for small, short-lived sites any application is best to consider like sites. This is important because it is well-known that some early sites are not small and this model can scarcely be applied to them. Why 1100? It is considered here as the early limit to likely first settlement based on the dates of settlement of Central Polynesia and 1450CE is considered a point where sites that are regarded as characteristically early ceased to be occupied.

On the "most likely" lines the figure shows that about 45% of small sites dating from around 1450CE might have been lost by 1950CE and that the sites, if any, from around 1100CE might have about a 55% chance of being lost by 1950. From such an early time there would be a small population of sites so loss of them would be more of a downward "random walk" of loss of individual sites than a steady decay. It is important to emphasise this can only apply to small sites like those of the shore whalers, and that the end point of being destroyed from the point of view of archaeological value is not quite the same as complete non-existence. Some traces might remain, such as spot finds, as they do with some of the whaling sites.

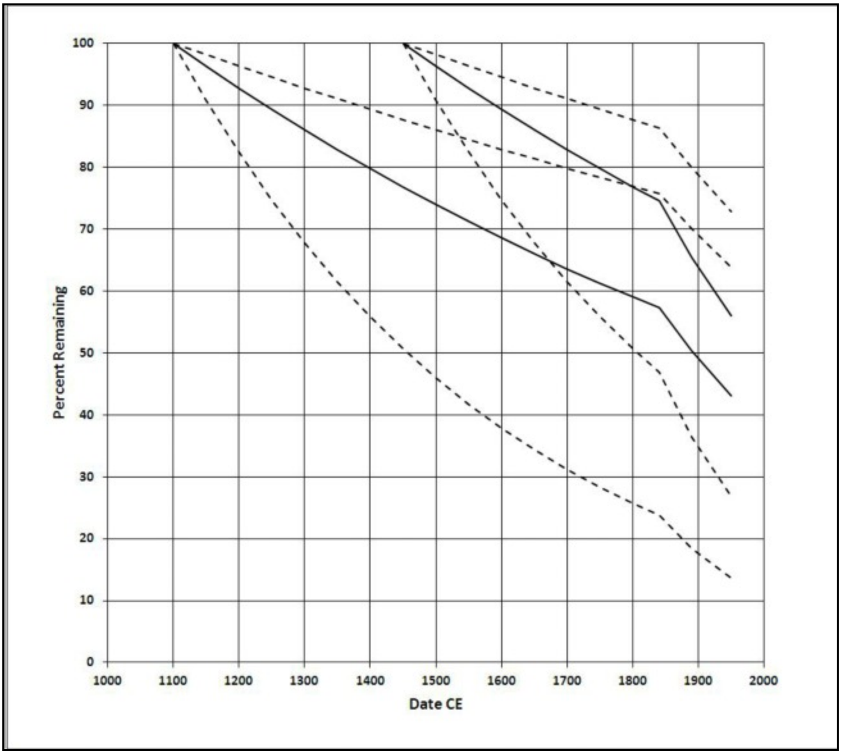

Figure 2: Decay curves showing the path of site loss from 1100CE and 1450CE based on the whaling sites data. For a small early population of sites it can be considered as a probability of loss, while it might be closer to the actual loss for a higher later population of sites. Natural loss only is applied to 1840 and then all causes from then on. The dashed lines are the 95% confidence limits.

The following tables consider the potential weaknesses of the approach:

As Modelled	**Discussion**
The loss rate is assumed as constant	The rates may have varied through time, possibly increasing with land development and with sea level rise, or reducing after the archaeological provisions of the Historic Places Act passing in 1975, so it might be better considered an average, best applied only to the overall period from which it was derived.
Loss of individual sites is considered as independent	Nearby sites could well be destroyed by a single event and will thus not be independent. This is mitigated to some extent by the wide distribution of the sites considered and thus beyond a single event and hence not all at risk of simultaneous loss.
The modelling of loss does not include the degradation apparent in the data as site changes in condition from outstanding to good to poor.	Site loss may often be progressive but some is near instantaneous through storms or rapid modern development. Such loss can occur irrespective of the prior condition. The supplementary material on-line considers a progressive loss model. It shows that if the probabilities are all equal of transition from existing to lost from each of the three prior states of outstanding, good or poor, then the decay curve style of loss still results.

Table 4: Whaling Site Loss

As Modelled	**Discussion**
The loss rates are assumed as constant	General sea level rise is not an issue in the period modelled to 1840. The post 1840 rate applied to 1840-1950 covers most of the period from which it was derived of circa 1840 to circa 1990.
Loss of individual sites is considered as independent	As above and see below for tsunami
There are no large recent tsunami in the period from which the data are derived	If the model is applied to periods before that from which it was derived then tsunami destruction of sites may be underestimated.
The data are from smaller sites than some Archaic sites.	The model is best considered as applicable to sites of like size
The whaling site locations are not a perfect match to Archaic sites	The eastern emphasis is a reasonable match but site location to access whaling grounds is a different locational emphasis.
The natural rate of loss involves interpretations that this mode operated from recent observation rather than historic record.	The interpretation has been conservative so where both human-caused and natural mechanisms have or may have operated on a site it has not been classified as destroyed by natural means. Where unconfirmed sites do not exist because they have been destroyed – as seems likely because they were not found, then leaving them out of consideration is again conservative as far as human, or natural rates are concerned.

Table 5: Application to Older Sites

The decay diagram (Figure 2) says nothing about the relative frequency of sites at the two ages modelled, however one might easily assume that if there were any of 1100CE date they were originally much less frequent than ones of 1400CE because the population would have had to have been smaller.

The obvious follow up to this is to see if we can identify obvious missing sites and by further modelling of the settlement process consider if the loss of sites is likely to have caused us to have missing years of occupation in our record.

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Supplementary Material

This is available at http://tinyurl.com/ozaw6rc

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