The Patterns of Pa's: Pa Attributes and Site Selection on Banks Peninsula, NZ

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Abstract:

The Banks Peninsula region of New Zealand has been a site of Maori settlement since the 1300s. Many pa sites, a fortified part of most villages, have been found and excavated on Banks Peninsula (Brailsford, 1981). Finding and understanding these settlements provides precious insight into the daily lives and culture of the Maori people of this region. Promising work in geoarcheology has shown that the careful and creative application of Geographic Information Systems can be used to help identify likely locations of archeological significance (Siart et al., 2008). A variety of ArcGIS tools were used to identify spatial attributes of three well-documented pa sites, showing different types of settlement on Banks Peninsula. These attributes were minimum and maximum elevation, slope, distance from the nearest stream and distance from the coast or large bodies of freshwater. Based on these attributes the DEM, slope, and aspect maps of Banks Peninsula were reclassified and multiplied with buffered maps of the rivers and seacoast. This left only certain areas that contained all of the specified attributes, many of which matched with the locations of other known pa sites. The high correlation between the locations of known sites and the attribute projections developed in this study shows clear patterns that suggest there was careful assessment involved in the placement of settlements. Continued research into characteristics that affected the placement of Maori settlements, analysis of more known sites and examination of historical maps that show the old locations of streams, estuaries, and lagoons would help to further develop the patterns of pa placement explored in this study.

Introduction:

One of the most striking and enduring markers of the habitation of New Zealand by the Maori are the fortified villages known as pa's constructed during the later centuries of the past millennium. Often terraces, storage pits, earthwork ditches and wooden palisade posts are the only subtle signs left that mark the presence of a pa site (Brailsford, 1981). These signs are often indistinguishable on the ground and only during certain seasons, when the grass conditions are favorable, can some of these features be seen from aerial photographs (Brailsford, 1981). The artifacts and structures found in these settlements are essential for advancing the understanding of historical Maori society and have immense cultural significance.

An in depth understanding of historical Maori life is critical for identifying the factors the affected their settlement on Banks Peninsula, and therefore useful criteria for application within GIS. The Maori most likely came to New Zealand in the late 11th century from East Polynesia, although exactly when they arrived and where they came from is still a matter of considerable debate within the academic community (Wilmshurst et al., 2008). There are two major divisions of Maori occupation, the early Moa Hunter Maori and the Classical or Pa Maori whose culture was identifiable from the 14th century forward (Brailsford, 1981). The increase in fighting and the accompanying proliferation of pa's can be attributed to many factors. The extinction of the Moa and population pressures on previously cleared, easily farmed land likely contributed to an increase in fighting. The arrival of new Maori settlers from other parts of the pacific caused new tensions and added to the fight for land and resources (Brailsford, 1981). The settlement of Banks Peninsula has three distinct phases. The Waitaha tribe arrived in Banks Peninsula in the 1300s followed by two more migrations, the Ngati Mamoe tribe from the Wellington region in the 1500s and the Ngai Tahu in the early 1700s (Ogilvie, 1990). The arrival of each new tribe was not always peaceful and the older tribes were defeated and absorbed by the new arrivals (Brailsford, 1981).

One of the most important factors that affected the locations of villages and pa sites was the availability of food resources and a reliable fresh water supply. Therefore, many villages are located near springs, streams, or lakes (Chiewphasa,

2013). The Maori relied heavily on hunting and gathering as well as certain cultivated crops, namely the kumara. During the warmer times of the year groups of Maori would travel over their lands gathering food that would be brought back to the pa for preservation and storage for the leaner winter months (Okains Bay Maori and Colonial Museum). Before their extinction the Moa was a central source of protein, along with other birds like the wood pigeon. When overhunting led to the Moa's disappearance seafood took an even more central role in the Maori diet (Brailsford, 1981). Mussels and other shellfish were essential to the diet of the Banks Peninsula Maori, as well as fish, eels and marine mammals. Consequently most of the Banks Peninsula pa's are located very close to beaches and shore platforms (Challis, 1995).

Cultivated crops were also a central part of the Maori food supply. When the first Maori explorers came to New Zealand they brought kumara, taro, paper mulberry, bananas, breadfruit, and coconuts with them. However, in New Zealand's colder climate many of these plants were not able to survive. Taro, paper mulberry, and yam could only grow on the North Island because of its somewhat warmer climate. Through careful cultivation, the utilization of new cropping techniques and the optimization of microclimate conditions the Maori were able to grow kumara as far south as Banks Peninsula (Bassett, 2004). Proper garden site selection was crucial, and soils were often augmented by burning certain plants or adding gravels, to make the soil more suitable for kumara growth. North facing slopes allowed for slightly warmer conditions and carefully tended garden terraces with low stone wall barriers are still discernable in many of the pa sites around Banks Peninsula (Chiewphasa, 2013).

Thousands of pa's were built throughout New Zealand and were the center of a community's security and their commitment to defend their land (Knight, 2009). The Maori were experts in utilizing the natural landscape to their best advantage. Islands, hilltops, cliff faces and other natural defenses were incorporated into pa designs to great effect (Best, 1927). Ramparts, stockades, palisades, trenches and other earth and wood structures were used to make a pa as impregnable as possible (Knight, 2009). Many pa's had inner sections divided by ditches and palisades, so

that if one section of the pa was breached, the defending warriors could fall back and mount a second line of defense. Some pa's contained homes and were inhabited regularly while others were remote refuges that would provide protection in times of war (Best, 1927). There were three main types of pa's on Banks Peninsula; defensive terraces, flat elevated promontories with ditches and banks blocking access from the mainland, and cliff top and island pa's with ditches and banks in more the one direction (Challis, 1995).

The three pa's chosen for analysis in this study represent some of the many different styles of pa fortification. Pa Bay is located on the eastern side of Banks Peninsula, on a promontory next to a bay. A stream runs through the middle of the site and extensive offshore platforms are home to seal colonies, which provided a source of food for the village residents. Pa Bay Pa was a relatively large settlement and was likely home to a couple hundred people (Brailsford, 1981). It contained a garden, upwards of 60 terraces for over 25 houses, a storage pit for kumara, and a pa. Kumara was cultivated in a garden near the stream and stored underground for preservation. The pa was located at the end of the headland and was protected on three sides by steep cliffs and by a ditch-wall system on the side facing the village (Challis, 1995 and Brailsford, 1981).

Te Puia Pa represents a very different style of settlement. This sites is landlocked and located on a promontory overlooking Waikakahi Pa. Steep slopes protect the back of the pa while a ditch-wall-ditch system and palisades protected the headland approach. This pa is over 600 meters from the nearest stream and shows fewer signs of horticulture and habitation. Te Puia was likely a refuge pa for a Maori chief, Rangitamau (Brailsford, 1981).

Oruaka Pa stands on a headland overlooking the outlet of Lake Forsyth. A complicated defense system consisting of multiple lines of walls, ditches, palisades and enclosures protected the pa. The outlines of these fortifications are still very distinct and easily seen from aerial photographs (Figure 1). An eroded house site and layers of charcoal indicate that the pa was once occupied, but seems to have been empty by the 1840s, based on European accounts (Brailsford, 1981).

This study has begun the process of applying the vast capabilities of GIS to identify the spatial attributes of the three pa sites mentioned above and identifying areas on Banks Peninsula that share those attributes. Developing a more complete understanding of how the Maori assessed and chose sites for settlement is critical for furthering our knowledge of historical Maori culture. Applying the tools of GIS to Banks Peninsula has the potential to uncover complex spatial relationships between pa sites and reveal patterns of Maori settlement on Banks Peninsula.

Methods:

Extensive research into historical Maori life and culture was conducted to determine important factors that could have influenced the placement of settlements. A base-map of Banks Peninsula was constructed in ArcGIS 10.2 that included areal photographs, a digital elevation model (DEM), and vector files of the rivers, streams, and lakes of Banks Peninsula. Maps of each of the three chosen pa sites were obtained from Brialsford 1981 and georeferenced to aerial photographs. Slope, aspect, and contour maps were produced from the DEM. The zonal statistics tool was used to extract the minimum, maximum and mean slope, elevation and aspect of each site and the measurement tool was used to determine the distance to the nearest stream. The distance to the coast was measured for Pa Bay Pa and Oruaka Pa while the distance to lakes Ellesmere or Forsyth were determined for Oruaka and Te Puia pa's.

A buffer was placed around the stream, lake and coast layers based on the measured distances. The DEM and slope files were reclassified to exclude all values outside the determined range. These layers were multiplied together so that only locations that shared all of the attributes from each of the three test pa's remained. The Pa Bay attributes were also multiplied with the land on Banks Peninsula that had a northwest to northeast facing aspect. Maps of the locations of known pa sites on Banks Peninsula obtained from Brailsford 1981 and Challis 1995 was georeferenced and turned into a point file. The locations of these recognized pa's were layered over each of the three attribute projections and their correlations were ranked from 0-no correlation, to 5-a perfect match (Table 1).

Results:

The attributes determined from Pa Bay Pa were 6 to 121 meters elevation, land below a 24° slope, less then 115 meters from a stream and within 600 meters of the coast. The areas around Banks Peninsula that were within these parameters were further constrained by including areas with only northwest to northeast facing aspects (Figure 2). The projection produced from these attributes matched with many known pa sites, but had a very high correlation with the coastal pa's along the south and southeastern part of Banks Peninsula, including the Stony Bay Garden, Long Bay Pa, and Tumbledown Bay House (Table 1).

Oruaka Pa lies between 14 and 59 meters elevation, most of the land is below a slope of 20° and is 150 meters from the nearest stream. These basic attributes were further constrained by a 600-meter buffer from the coast and a 300-meter buffer around lakes Forsyth and Ellesmere (Figure3). The Oruaka and Pa Bay projections had similar correlations, however the Oruaka attributes highlighted the southern coastal pa's better then the southeastern sites (Table 1).

Te Puia Pa is landlocked and falls below 43 meters elevation and a 25° slope. The nearest stream is 600 meters away and the distance to Lake Ellesmere is almost 2,000 meters. The areas on Banks Peninsula that shared the three basic attributes, elevation, slope, and distance to stream were determined, and then further constrained by placing a 2,000 meter buffer around both Lake Ellesmere and Lake Forsyth. The Te Puia projections highlighted both Ripapa Island and Pa Bay Island pa's, which were not picked out by either of the other attribute projections. The Te Puia attributes also matched very well with the Little River, Waikakahi and Birdling's pa's near lakes Forsyth and Ellesmere (Table 1).

Menzies Bay, Parakakariki, Clay Point, and Onane pa's had relatively low correlations with all three attribute projections, while Onawe Pa and Moa Bone Point had no correlation with any of the projections. The Oruaka attributes highlighted a handful of locations around Lake Forsyth and a few next to Lake Ellesmere that had no corresponding known pa sites. Pigeon Bay showed many areas that matched both the attributes of all three pa's but no settlement sites are

recorded in that area. Overall, the attribute projections of the three test sites had some correlation with 33 out of the 35 known pa sites recorded in Brailsford 1981 and Challis 1995.

Discussion

Many of the sites predicted by the physical criteria of the three test sites were near or overlapped with the locations of known pa's. This suggests that this method has detected factors common to many pa sites. However, Onawe Pa and Moa Bone Point were not predicted by any of the three tests. A few other settlements, including the Menzies Bay Garden and Parakakariki Pa had only very low associations with the attribute projections. Onawe Pa is more then 600 meters from the nearest stream, which is why even the Te Puia projection, which was able to pick out the Ripapa Island and Pa Bay Island pa's, did not highlight this pa. The sites that were not well accounted for by the test pa's attributes may represent one or more styles of settlement different from the test pa's. Analyzing the physical attributes of these sites and creating a new attribute projection might reveal another set of representative criteria for settlement.

The high correlation between the attribute projections and the locations of known pa's shows that there are physical characteristics that link many of Banks Peninsula's pa's together. This provides strong support for the concept that the Maori carefully assessed locations and chose places for settlement based on certain physical characteristics of the land. This study has begun the process of determining these characteristics and further developing our understanding of historical Maori's knowledge and use of New Zealand's natural landscape. However, only a few physical attributes that likely affected settlement were evaluated here. There are many more factors that could have determined where the Maori chose to settle. Access to natural resources was critical and the proximity of a settlement to forests rich in timber and edible plants and birds would have been an important factor in a settlements survival (Brailsford, 1981). Unfortunately, today most of Banks Peninsula's native forests have been cleared and assessing the locations of pa's based on their proximity to forest resources would prove quite difficult. Another

significant source of food for the Banks Peninsula Maori were freshwater lakes, lagoons, and estuaries (Challis, 1995). Today many of Banks Peninsula's natural wetlands have been significantly altered to make the land more suitable for farming and housing. Studying historical maps of the area and determined the old borders of estuaries and inland lagoons, and analyzing their locations in connection to known pa sites, could refine the criteria for settlement developed in this study. Kumara was another essential source of food and was painstakingly cultivated in Banks Peninsula's cold climate. Utilization of north facing slopes helped to create a warmer microclimate for kumara gardens (Chiewphasa, 2013). Analyzing the land with north facing aspects in settlements that included gardens, like Pa Bay, could lead to a better understanding of the placement of horticultural sites.

Not only does analyzing the physical attributes of pa sites using GIS have the capability to aid out understanding of historical Maori society, it also poses a promising ability to predict likely locations of unknown pa sites. By identifying areas that share attributes with known settlements, and ruling out recognized pa locations, the areas that are left may well be sites of Maori settlement that have yet to be identified. All three of the projected sets of physical criteria highlighted land around Pigeon Bay and the Oruaka and Te Puia attribute projections picked out locations around lakes Forsyth and Ellesmere. Since these areas share the same physical attributes of the test pa's there may be pa sites in these locations that have yet to be discovered. Significant progress is being made using GIS to locate areas of archeological interest around the world and applying the methods of this study to that end could reveal new sites of Maori settlement in the future (Siart et al., 2008).

Conclusion:

These findings provide ample support for the idea that the locations for pa's and villages share certain physical features and therefore were likely carefully chosen. Highlighting areas using GIS with these shared attributes across Banks Peninsula holds the potential to identify locations of unknown pa sites and guide archeological work in the region. Recognizing settlement sites is essential for the preservation of these culturally valuable areas. Revealing the complex patterns of

pa's across Banks Peninsula poses a difficult challenge that could, with continued research, yield a much more complete understanding of the lives and culture of the Maori of Banks Peninsula.

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Figures:

Figure 1 The image on the left is an aerial photo of the site of Oruaka Pa near the outlet of Lake Forsyth. The markings of the defensive ditches are still easily recognizable. On the right is an image of the georeferenced map of the pa site from Brailsford, 1981.

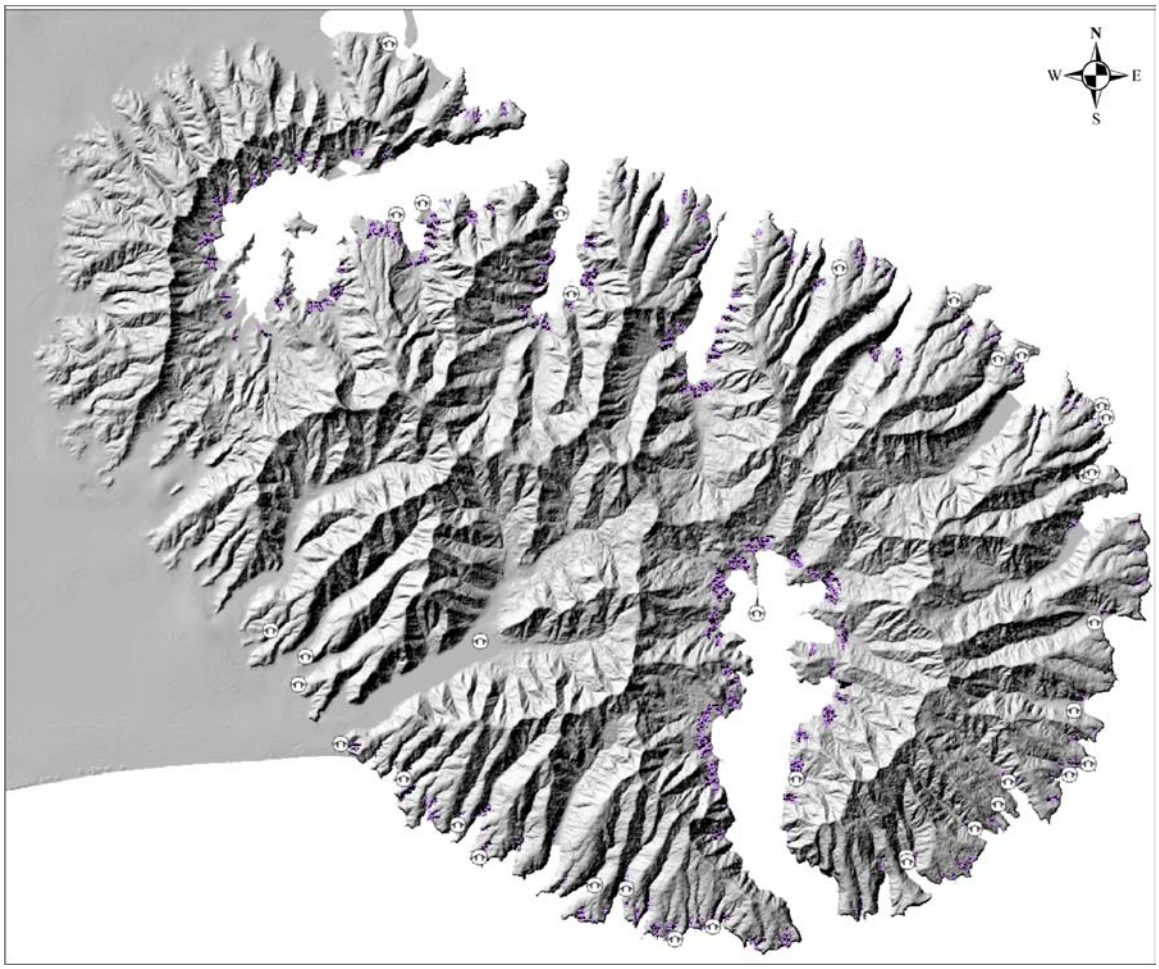

Figure 2 The white house symbols represent pa and garden sites. The areas highlighted in purple are the locations that matched the attributes of Pa Bay Pa. The areas highlighted in black show the locations that have a northwest to northeast facing aspect and match the attributes of Pa Bay Pa.

Site Name	Pa Bay Pa	Oruaka Pa	Te Puia Pa
Ripapa Island Pa	0	0	5
Kiatara Pa	1	1	4
Menzies Bay Pa and garden	1	0	1
Panau Pa and garden	3	2	4
Pa Island Pa	0	0	5
Pa Bay Pa and garden	5	5	5
Lavericks Bay Garden	1	1	3
Hickory Bay Garden	2	3	5
Okaruru Pa and garden	1	1	4
Nga Toko Ono Pa and Garden	4	3	1
Parakakariki Pa	3	1	2
Pae Karoro Pa	4	5	4
Onawe Pa	0	0	0
Birdling's Pa	0	0	3
Te Puia Pa	0	0	5
Waikakahi Pa	0	0	4
Oruaka Pa	5	5	5
Little River Pa	0	0	5
Moa Bone Point House	0	0	0
Stoddart Point Terraces	3	1	5
Port Levy Pa	5	5	5
Northwest Bay Pa	4	3	2
Ducksfoot Bay Garden	5	4	5
Clay Point Pa	2	0	2
Ontanerito Bay Pa	5	2	5
Stony Bay Garden	5	4	5
Flea Bay Pa	5	5	5
Red House Bay Pa	5	5	5
Onane Ditch	3	1	1
Whakamoa Bay Pa	2	3	4
Long Bay Pa	5	5	4
Horseshoe Bay Pa and Garden	5	5	4
Te Kaio Bay Pa	5	5	5
Tumbledown Bay House	5	4	5
Magnet Bay Pa	5	5	5

Table 1 This is a record of the correlation between known settlement sites on Banks Peninsula and the three attribute projections developed in this study. The scale ranged from 0-no correlation, to 5- a perfect match.

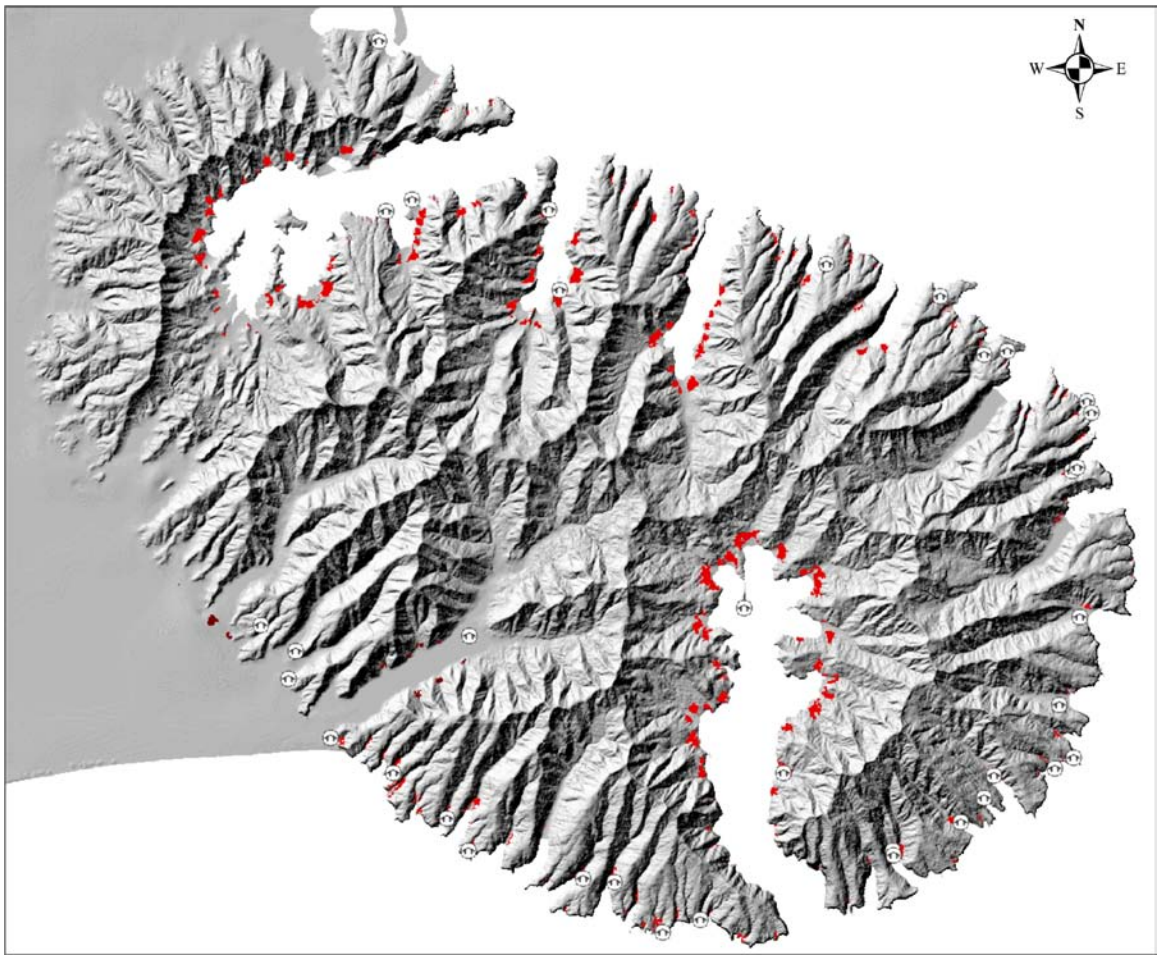

Figure 3 The white house symbols represent pa and garden sites. The areas highlighted in bright red are the locations that matched the basic attributes of Oruaka Pa and are within 600 meters of the coast. The small patches of dark red around Lake Forsyth and Lake Ellesmere are the locations that match the basic attributes of Oruaka Pa and are within 300 meters of the lakes.

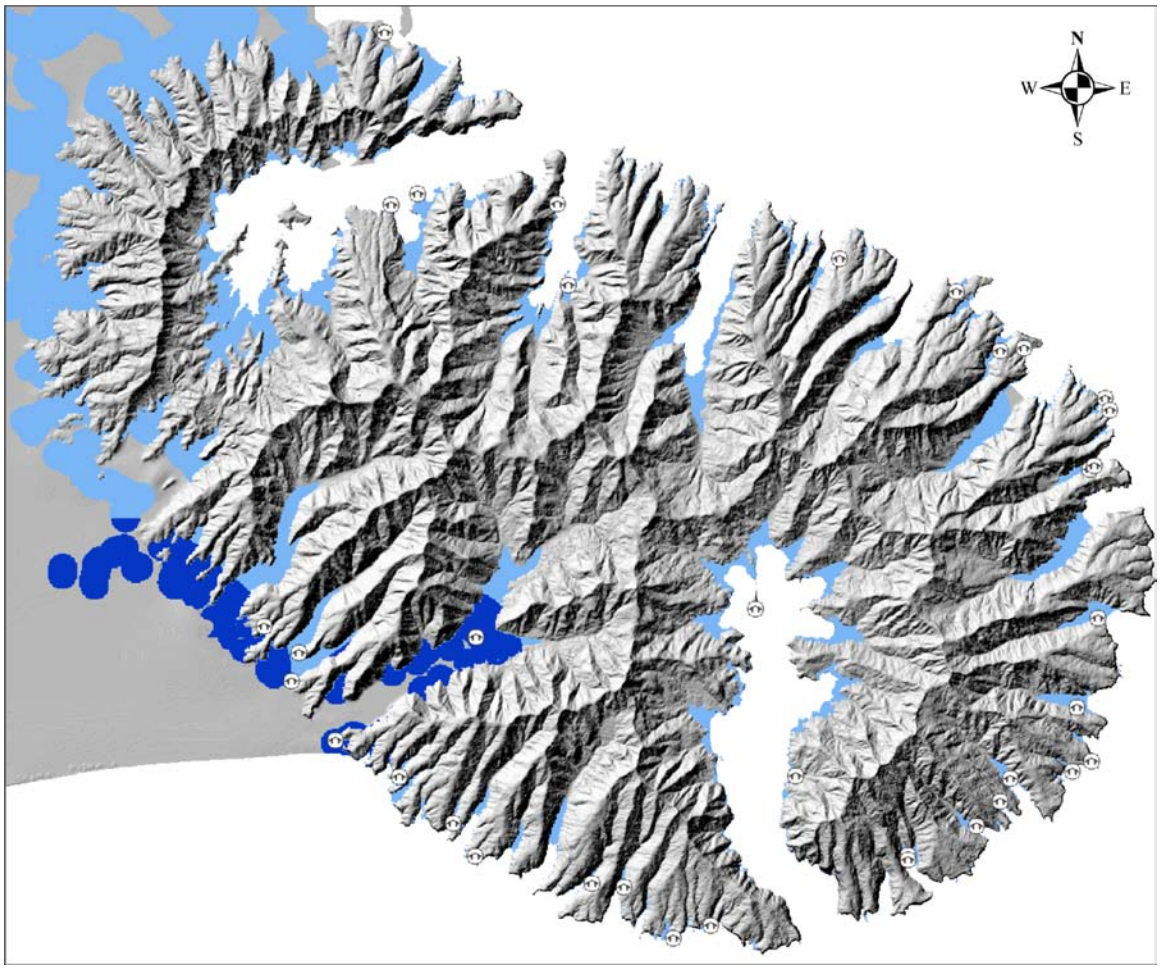

Figure 4 The white house symbols represent pa and garden sites. The areas highlighted in light blue are the locations that matched the basic attributes of Te Puia Pa. The patches of dark blue around Lake Forsyth and Lake Ellesmere are the locations that match the basic attributes of Te Puia Pa and are within 2,000 meters of the lakes.