Moriori tree carvings, Chatham Islands

Close-range photogrammetric record and survey

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Rakau Momori

Moriori are a distinct group of Polynesian people, who migrated to their present homeland on Rekohu from the middle of the Pacific, and later from the east coast of New Zealand itself. Due in part to their geographical isolation, the Moriori evolved a unique culture, the central tenets of which were environmental sustainability and peaceful interaction. The emphasis on peace is embedded in the culture because of a covenant made by Nunuku Whenua, a Moriori chief, nearly 500 years ago, who stated that from that day forward, upon the first blood drawn, all fighting would cease. The covenant has been passed on from generation to generation ever since, and has never been broken.

The presence of the carvings on living Kopi trees, known to Moriori as rakau momori, are of emotional and spiritual significance to our people. Moriori are the only Polynesian people known to have carved living trees. Today, for the Moriori descendants of those who lived on the islands prior to 1835, the tree carvings provide one of the few remaining pieces of evidence of the Moriori karapuna (ancestors).

The preservation of these tree carvings is of high priority to all Moriori. During recent history, our tikanga and even our very existence as a people has been challenged. However the carvings have remained as beacons of hope in the reassertion of Moriori culture and identity.

Unfortunately, in the past, these taonga have suffered greatly through stock grazing and wind erosion. The Department of Conservation has worked with Moriori representatives to try to provide better protection for the remaining rakau momori. We welcome the publication of this report as another step toward the preservation of our taonga.

Today, Te Iwi Moriori are rightfully acknowledged as the kaitiaki or spiritual guardians of these sacred taonga. Appropriate consultation and authorisation with Moriori in regards to the management, recording, and use of rakau momori and their images will ensure that the mauri of the culture is maintained.

TE TANGATA HOU RONGO

Abstract

Moriori tree carvings in the Chatham Islands (Rekohu), New Zealand, were recorded and located. Trees with carvings were found in 5 separate areas on Chatham Island: Te Waroa, Hapupu, Taia, Lake Kairae and New Barker Bros Ltd Block. Carvings on 147 trees were recorded using stereophotogrammetry. The location of each tree was recorded by cadastral survey. The locations are shown on maps of each area, and tables of coordinates are provided. Comments, based on field observations, are made about the reasons for the carvings.

Keywords: Moriori, tree carving, dendroglyph, stereophotogrammetry, Chatham Island, New Zealand, karaka, kopi.

1. Introduction

For five weeks in November and December 1998, the authors of this report—Fraser Jopson and Craig McKibbin—carried out a project in conjunction with Chatham Islands (Rekohu) Moriori, the University of Otago, and the Department of Conservation. This project had two goals. The first was to photograph the Moriori tree carvings (rakau momori) using a close-range photogrammetric method. The second was to survey the position of each tree bearing a carving to an accuracy of +/- 1 m. The two goals were set with the understanding that the Moriori tree carvings are living organisms and as such have a finite life expectancy. By completing the project, all the groups involved would have a photographic record of what each Moriori tree carving looked like and their exact location on the Chatham Islands, even when the actual trees no longer exist.

In this report, and on the plans of the carvings' positions, there is terminology used that will be unfamiliar to many readers. This has been necessary because there are some aspects of this project that will require surveyors, or other trained professionals, to return to the work completed by the authors and make some changes. The terminology used is for the benefit of these professionals and aims to make their job easier. Every effort will be given to clearly explain these aspects in the relative parts of this report.

It must also be noted that throughout this report the exact number of trees and carvings found in each area will be referred to. This is not meant to suggest that the authors believe they have located all of the carvings that are present on the Chatham Islands. Though we believe that we have located the majority of the carvings, the fact that almost every time we walked through the areas being surveyed we saw more carvings, and the condition of the trees (a lot were thickly covered with moss), leads us to believe that there are still carvings that have yet to be located.

It is important to bear these comments in mind as you read this report.

2. Overview

The locations of trees with carvings were determined by completing a cadastral survey traverse, similar to what is done to survey a property boundary, through the areas known to contain such trees. Bearings and distances were then taken from the pegs making up the traverse to the carvings in order to generate coordinates for each tree (see Appendix 1). Once coordinates were established, a plan was created showing the position of the trees in relation to the area they are contained in (see Appendix 2).

The carvings were photographed using a close-range photogrammetric method. This required a frame, with known control points marked on it, being placed in front of, but not covering, the carving. A stereo pair of cameras (two cameras on a metal bar separated by a distance that recreates the geometry of the human eyes) were placed at a predetermined distance away from the frame and an overlapping pair of photos were taken. This method means that not only was a photographic record of each carving made, but the overlapping pair of photos allows a 3-dimensional (3-D) model of each carving to be created. The creation of a 3-D model means that measurements and analysis of each carving can be generated without having to touch and perhaps damage any of the trees. Also, having a 3-D model means that it is not necessary to return to the trees in order to collect data.

Prior to the authors arriving to undertake this project, a lot of work had been done identifying trees with carvings on them. Much of this was by D.R. Simmons of Otago Museum in the 1950s and 1960s. This work included painting numbers on trees and photographing the carvings. Rumour and hearsay suggested that up to 1400 carvings had been located by Simmons and others during this time. Their work had formed the basis of the continuing work undertaken by local Moriori and the Department of Conservation in locating and protecting the carvings; including that of Ian Hill (Canterbury Conservancy, Christchurch) during the time he was responsible for Moriori tree carvings whilst the Chatham Islands were administered as part of Canterbury Conservancy. (The Chathams are now part of Wellington Conservancy). Ian Hill was able to accompany the authors for part of the survey.

However, during the five weeks that the authors were on the Chathams, only ***147 trees were located in five specific areas with approximately 185 carvings present on them***. All carvings were on Kopi (*Corynocarpus laevigatus*) trees. Photographs were taken of all carvings that were of a quality that would allow a good image to be achieved. Others that were too faint to photograph were drawn so that they would also be recorded. It must be noted that many of the carvings photographed were originally identified by Simmons and have continued to be marked as carvings for that reason. However, the authors are not convinced that all of the carvings identified by Simmons and others are true Moriori tree carvings. The reasons for this belief are explained as this report progresses.

The report provides details of each area where carvings are located and which were surveyed, and explains why specific decisions were made. Finally, the authors offer their thoughts and recommendations as to how the groups involved with the Moriori tree carvings can best conserve and protect those carvings that still remain.

3. Te Waroa

Plot 1: **Eight (8) trees, 8 carvings**
(see Appendix 1,2 for coordinates, Appendix 3 for plot)

Personnel: **Fraser Jopson, Craig McKibbin (University of Otago)**

Ian Hill (Department of Conservation, Christchurch)

Alfred Preece Jr (Chatham Islands)

Te Waroa was selected as the first block to be surveyed because it is small and had recently been fenced off. This meant that the undergrowth had not had a chance to fully regenerate, providing excellent search conditions and ease of access to the carvings. Also, the availability of Alfred Preece Jr, who knew where most of the carvings were, meant that more time could be invested in sorting out search and photography problems than in actually having to locate the carvings. A walk through by all four people found no other carvings present than the eight that had already been located. However, as some of those found were very faint, it is possible that there may still be undetected carvings present in the Te Waroa Reserve.

Because Kopi forests have a very thick canopy, which prevents a clear sky view, and the GPS receivers that we brought with us would not give +/- 1 m accuracy in the field, a decision was made to use cadastral survey methods to locate the position of the trees. Since the boundary fence of the Te Waroa Reserve had not been surveyed at this time, and there were no other survey marks present, a local coordinate grid was set up using the lagoon side fence as the origin of bearings. Two pegs were offset by 0.05 m at the 19th and 36th post from the north end corner with a third peg being positioned in the middle of the majority of the carvings. This allowed observations to seven of the carvings from the one set-up in the forest itself. The 8th carving, distant from the main group, was positioned by a tape and compass survey from a post located at the south end of the fence. For identification, all three posts used have been marked with permalat tape.

Because a local coordinate grid was used, the block has not been orientated to true north. This will cause confusion to people who know the area well but can be easily overcome when the boundary of the Te Waroa Reserve is surveyed. By including Peg A and B (as shown on Plot 1) in the survey, an orientation correction can be arrived at which will correct the fieldwork undertaken. This will orient the traverse to true north and correctly position all of the trees accordingly.

All carvings, apart from N0437, appeared to be genuine and were photographed accordingly. Ian Hill took a photo of N0437 as a record. N0432 is a dead tree with the carving starting to deteriorate. Some effort should be spent in attempting to preserve this carving as it appears to be a good example of the type of carving found on this side of the island.

4. Hapupu

Plot 2: **Eighty-two (82) trees, 98 carvings**
(See Appendix 1,2 for coordinates; Appendix 3 for plot)

Personnel: **Craig McKibbin, Fraser Jopson (University of Otago)**

Ian Hill (Department of Conservation, Christchurch)

Hapupu was recognised some time ago as being an area of significance with regards to the Moriori tree carvings. This had been demonstrated by the creation of the Barker Bros Ltd Reserve over 15 years ago to protect and nurture the 82 trees that remain which have been identified as having carvings on them. A short track has been developed to allow easier access to view some of the prime examples of carvings which are found in the Hapupu block. A rough outline of the track is shown on Plot 2 (Appendix 2) and follows the traverse from peg B through C,D,E,F,G,H,J,K,L,M,N,P, and close back on peg F.

That the fencing off of the Barker Bros Ltd Reserve has protected the Kopi trees inside the reserve can be seen in the dead stand of trees that lies outside of the reserve. However, the length of time that the reserve has been shut up did cause some problems during the surveying and photography work. Those carvings that are not right beside the track have been surrounded by regenerated undergrowth, some of which is now 15-year-old trees, making progress through the reserve and access to some carvings difficult. Fortunately, these were not insurmountable problems and all carvings found were surveyed and photographed.

During an inspection of the Barker Bros Ltd Reserve boundary fence several survey pegs were located. A phone call to New Zealand got the relevant survey plans sent to the Chathams and the survey work was able to be tied in with known points already present from previous surveys. This allowed the correct orientation to be applied to all the traverse and location work and all coordinates generated by this project are in the Chatham Island Map Grid.

As with all of the 5 blocks that carvings were found in, it is not possible to say that every single carving has been found in this block. Several new carvings were found during the initial search made through the Hapupu block to find those that had already been tagged. New carvings continued to be found with each subsequent pass through the forest. While new carvings were found, it must be noted that questions were raised about many of the carvings originally identified by Simmons. It is the opinion of the authors that up to 20% of the tagged carvings are not carvings at all, but rather tree damage that has occurred through vine growth or perhaps one tree falling on another. Comparisons of carvings M1803, M1804, M1805, M1806, M1807 and M1808 with those carvings found close to the track provide prime examples of this. All carvings that the authors thought were dubious have had this concern noted on their description sheets, but were photographed and located so that a record is held of them in case these opinions prove to be invalid.

One area of concern that did arise during the time spent in Hapupu was the condition of tree M1820. It is the only tree found on the Chathams which had 4 carvings present on it. However, it has died and the condition of the carvings is deteriorating as a fungus grows over them and the bark starts to drop off. Some attention needs to be given to this tree soon if it is to be preserved intact with the carvings.

5. Taia

Plot 3, 4: **Twenty-one (21) trees, 26 carvings**
(see Appendix 1,2 for coordinates, Appendix 3 for plots)

Personnel: **Craig McKibbin, Fraser Jopson (University of Otago)**

Ian Hill (Department of Conservation, Christchurch)

Taia again demonstrated that it is impossible to guarantee that all the carvings have been located. Three previously unrecorded carvings were located only 5 m from others that had been found during the last search. This is not a failure on the part of the previous searchers, but is, rather, the result of differing light conditions which determine whether a carving can be seen or not. A large amount of money and human effort would need to be spent to offer any assurance that all carvings had been found.

Because Ian Hill's time with the project was limited, it was necessary to make the best use of his knowledge by searching all of the areas where he had located carvings on previous trips. Rather than lose time when the conditions were not ideal for working in Hapupu, the group made a search of both the Taia and Lake Kairae blocks so that the trees that were already tagged could be returned to easily. This proved to be invaluable for the authors when Ian had left, and saved a great deal of time.

The Taia block turned out to be the most challenging in terms of the survey work. As with the Hapupu block, the boundary of the reserve had previously been surveyed in 1974. Unfortunately, the pegs from that survey that were found proved to be unreliable and the fence lines indicated on the plans had long since rotted away. This meant that any of the old pegs found could not be used for the new survey work. In order to complete a survey that would be able to be reused in future, it was necessary to start the survey at a position that could be easily returned to. The boundary fence beside the row of pines was selected and a local coordinate grid established with the origin of bearings being a gate post roughly 450 m away. All significant posts have been marked with white permalat tape labeled with what peg they represent.

The survey itself is quite large with some long lines observed. This helps improve the accuracy of the survey, but the geometry of the traverse—long with two sides being almost parallel—is not the preferred method. The

accuracy of the positions will be well within the +/- 1 m range. As with the other local coordinate grids used in this project, it will be necessary to correctly orientate the pegs used when a more accurate survey of the reserve boundary is undertaken.

To be sure that there were no major groups of carvings missed, the authors undertook a final walk through of the entire Taia reserve. While this did not reveal any new carvings, it must be noted that N0405 managed, somehow, to avoid being found. With the searching complete, photographs were taken and all necessary records made. Upon returning to New Zealand and drawing up the plans, the authors decided that, due to the size of the traverse, it was necessary to produce a larger scale plot (plot 4) of the position of the trees so that a better visual understanding of the area could be attained.

6. Lake Kairae

Plot 5: **Sixteen (16) trees, 22 carvings**
(see Appendix 1,2 for coordinates, Appendix 3 for plot)

Personnel: **Fraser Jopson, Craig McKibbin (University of Otago)**

Ian Hill (Department of Conservation, Christchurch)

As mentioned in the section on Taia, Ian Hill's time available for work in the Lake Kairae block was limited to searching for the carvings that had already been found so that the authors would have an idea of where they were located. All of the previously located carvings had been found along the eastern fenced boundary of the reserve, but the authors found that after talking to Ted Hough it was necessary to do a complete search of the block. Ted had remembered seeing up to 30 carvings somewhere in the middle of the block when he was younger and the block had been open to grazing. Two passes through the block failed to find any carvings in the area Ted had indicated, but there was evidence that there had been a lot more Kopi trees in the block than was present during the search. It was obvious that many Kopi trees had had their tops knocked over in strong winds and only stumps roughly 1.5–2 m high remain without any bark left on them. These stumps may be the remains of the trees and carvings that Ted saw.

Like the Hapupu block, Lake Kairae has been fenced off for over 15 years and was surveyed in 1979 and 1982. However, sand and water movement has obliterated all evidence of the survey marks positioned within a practical distance of the carvings. Fortunately, the previous surveyors took shots to the boundary fence posts and marked their position with nails. While the nails have since disappeared, the holes that they created were still visible and able to be verified as being reliable. Using a missing line calculation it was possible to correctly orientate the survey work and generate coordinates in the Chatham Island Map Grid. It must also be noted that the pegs placed in the ground for this project will be hard to find in the future due to the movement of sand in the area. It is possible that the only reliable marks that remain will be the fence posts.

All of the previously identified carvings, apart from N0428, were surveyed and photographed. No major problems were encountered, although the undergrowth was well established is some areas. This meant that movement when carrying the equipment was sometimes difficult. Three previously unrecorded trees with carvings were located at the south end of the fence and have been tagged as N0461, N0462, and N0463.

7. New Barker Bros Ltd Block

Plot 6: **Twenty-two (22) trees, 24 carvings**
(see Appendix 1,2 for coordinates, Appendix 3 for plot)

Personnel: **Fraser Jopson, Craig McKibbin (University of Otago)**

The New Barker Bros Ltd Block, also known as the Barker Bros Ltd Covenant Area, was the fifth and final block surveyed. The difference with this block was that no-one had completed a thorough search of the whole area and only three carvings had ever been seen, and these were at the edge of the forest. This meant that with the block being roughly two kilometres long there were a lot of trees that had not yet been studied. Fortunately, the area had only been fenced-off in the last two years and movement through the forest was unhindered.

While the block was very long, its width was never greater than about 100 m and this was to prove to be helpful during the search. Three days were allocated to the search for new carvings and, as it turned out, every hour was needed as the authors found it necessary to make three passes along the entire length looking at each tree as we went. A total of 22 trees were found to have carvings on them.

As with the blocks surveyed earlier in this project, it was necessary to set up the survey work in a local coordinate grid because of the lack of other recent survey work in the area. Because this was the last area to be surveyed, we were starting to run low on pegs for the traverse. To solve this problem we cut our own pegs from small trees that had been knocked over in the sand dune; but because these may be hard to return to in the future, observations were made to the boundary fence and nails placed in the top of the posts so that a more permanent mark was created. Since posts are hard to set the instrument over, some traverse marks are actually in the strainer post and have also been marked with a nail.

Since the majority of the carvings were located in the first half of the block, two traverse circuits were run. While this is not the most accurate method, the closes were very good and the authors are confident in their work.

The photography work went well, except for those carvings that were near the edge of the forest where lighting was difficult. This meant that shading methods used where conditions were better were not successful and may mean that it was not possible to achieve clear photos. The photos do, however, provide a record.

When the plan was drawn it was noted that the scale was quite small for the type of record that the authors were trying to achieve. To overcome this problem diagrams (not to scale) have been inserted on plot 6, giving a better representation of the position of the trees. All relevant pegs and posts have also been shown in the diagrams so that there is little confusion as to their actual position.

8. Observations

During the five weeks that the authors were on the Chatham Islands carrying out the Moriori tree carving project, a lot of their time was spent looking at the carvings and pondering all of the information that had been received from various sources involved with the project about why the carvings were made. While the true reason for the carvings may never come to light, the following observations may assist the debate.

The information that the authors had at the outset of their work was that carvings would be located close to areas of midden and usually not more than 50 m behind the sand dunes; and that the carvings had strong spiritual value to the Moriori people. The large piles of midden would seem to back up the belief of spiritual importance, as they would only build up over many years, if not centuries, as the tribes returned repeatedly to see the carvings and gather food from the area. Ian Hill stated that from all of the photos and drawings of the carvings that he had seen, including some from the 1800s, it appears that the carvings were cared for, with regular removal of undergrowth and suckers from around and on the trees. If this is correct then this also seems to indicate the importance of the carvings to those who made them.

Another piece of information received from several sources involved the way that Moriori buried their dead. When a person died they were buried in the sand dunes facing out to sea. Their knees would be pulled up to the chest and their elbows tucked in with only their head left out so they could see where their spirit was going.

By combining all of this information, the authors came to the conclusion that the carvings were signs or marker posts for the tribes who made them. However, it was noticed (C. McKibbin, pers. comm.) that nearly all of the figures have been carved in a way that seems to represent how the Moriori buried their dead. The carvings appear to have their knees pulled up and the elbows tucked in, and it may be that the carvings are markers for where the dead were buried. If the sand dunes in line with the carvings could be checked for remains, then this theory could be tested. To go one step further, the carvings may be more like head stones for the dead, which would also explain the care and attention given them, as indicated by Ian Hill. The fact that carvings are only found on Kopi trees, which also have spiritual importance to Moriori, further strengthens this line of thought.

Other observations of the carvings reveal that they vary in size, detail, and position on the tree, and not all carvings appeared to be of human figures. While

those that were not figures can probably be easily explained as indicating areas of importance for food gathering (the only non-figure carvings appear to be of flounders, birds, and other foods), the authors developed some possible explanations for the differences in the figures. Firstly, it is noted that there were three tribes of Moriori on the Chathams, but that carvings are only found on one side of the island, and the most 'basic' carvings are located in the Te Waroa block. The more 'basic' carvings may have been made by less 'artistic' tribes as they moved around or by inexperienced carvers.

The size and detail of the carvings may indicate age and position within the tribe. The smaller, more 'basic' figures could be those of children, while the larger figures with many ribs and facial features may indicate a powerful elder or chief of a tribe. The direction that the carvings face seem to be random. Using the best surface of the tree may have determined where the carving was placed.

These ideas, like the purpose of the carvings, are probably impossible to prove or disprove.

9. Recommendations

While it is not the authors' intention to say how conservation and protection of the Moriori tree carvings should proceed, we did develop some ideas which may enhance the carvings. We would like these to be noted by all groups involved in management and protection of the carvings as areas for further discussion.

1. Fencing off the areas is a very good idea which allows regeneration of the undergrowth and protection of the Kopi trees, as the difference between the reserves and the dead areas outside the fences demonstrates. However, it must be remembered that the reserves have been created to protect the tree carvings, not the other trees that would normally have been grazed away. If this means that undergrowth around the carvings or even suckers on the trees have to be removed for the good of the carvings, then it should be done.

2. Since all of the trees that have carvings will die sometime in the future, a plan needs to be organised now for preserving carvings when the Kopi tree that they are on dies. There are already two dead trees—one in Te Waroa and one in Hapupu—that will soon lose their bark and the carvings along with it. If nothing is done there will be five fewer carvings, which is a large amount considering that fewer than 200 located carvings still exist.

3. The Department of Conservation has a large role to play in the protection of these carvings. Staff that are involved with any Moriori tree carving projects should have a good working knowledge with regards to the carvings. To this end, Ian Hill of the Canterbury Conservancy of the Department of Conservation should retain some involvement, even though responsibility for the Chatham Islands has now passed to Wellington Conservancy.

4. The Moriori tree carvings are worthy of having every effort made to conserve and protect them. This will only be done if a concerted effort is made by all parties involved to work together for the good of the carvings.
5. If access through tracks is wanted to other carvings beside those that the track at Hapupu already allows, then a great deal of thought needs to be given to the benefits and costs to the carvings if this was to occur, as this will permit more access by tourists and other vivsitors.
6. The survey work of the reserve boundaries should be completed as soon as possible so that the information gathered from this project is not lost.

Readers of this report may feel that it has raised more questions than answers. If this is the case, and you wish to discuss any aspect of the report, please feel free to contact the authors through the Department of Conservation.

10. Acknowledgements

Rakau Moriori was provided by Maui Solomon, Trustee, Te Iwi Moriori Trust Board.

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The Chief Surveyor, LINZ, Wellington, for provision of survey data.

We also thank everyone else who helped us.

Appendix 1

COORDINATE SPREADSHEETS

Location: **Te Waroa**

Plan reference: **Plot 1**

No. of Trees: **8**

Coordinates: **Local Grid Coordinates**

Coordinate listing	Tree / Mark	Northing (m)	Easting (m)
Pegs	Peg A	7000.00	3000.00
	Peg B	7083.66	3000.00
	Peg C	7048.04	2948.66
Trees	N 0431	7052.77	2951.88
	N 0432	7039.97	2937.56
	N 0433	7034.57	2932.71
	N 0434	7027.70	2954.42
	N 0435	7040.75	2965.46
	N 0436	7047.40	2967.00
	N 0437	7096.68	2938.36
	N 0438	No coordinates as tree only taped and compassed.	

Location: **Hapupu**

Plan reference: **Plot 2**

No. of Trees: **82**

Coordinates: **Chatham Island Map Grid**

Coordinate listing	Tree / Mark	Northing (m)	Easting (m)
Pegs	Peg 1	672262.03	362940.14
	Peg A	672287.26	362897.70
	Peg B	672297.06	362762.73
	Peg C	672256.18	362749.95
	Peg D	672238.03	362766.45
	Peg E	672220.02	362780.33
	Peg F	672196.43	362803.03
	Peg G	672173.20	362791.89
	Peg H	672418.29	362790.59
	Peg J	672133.19	362819.04
	Peg K	672145.31	362832.32
	Peg L	672153.11	362840.83
	Peg M	672170.13	362857.27
	Peg N	672177.14	362840.87
	Peg P	672180.36	362827.77
	Peg Q	672169.26	362883.48
	Peg R	672197.80	362892.80
	Peg S	672217.55	362890.52
	Peg T	672257.13	362890.52
	Peg U	672285.15	362904.57
	Peg Aa	672290.47	362853.62
	Peg Ab	672275.41	362849.99
Trees	M 1801	672246.22	362755.21
	M 1802	672248.15	362760.87
	M 1803	672277.88	362847.56
	M 1804	672280.78	362847.77
	M 1805	672281.96	362849.93
	M 1806	672278.84	362852.65
	M 1807	672270.65	362856.87
	M 1808	672270.51	362854.24
	M 1809	672266.99	362860.42
	M 1810	672275.34	362870.67
	M 1811	672282.72	362893.12
	M 1812	672266.64	362921.28
	M 1813	672252.19	362944.48
	M 1814	672246.88	362943.86
	M 1815	672239.61	362962.60
	M 1816	Tag M 1816 missing. Now tag N 0443.	
	M 1817	672171.21	362801.38

Coordinate listing	Tree / Mark	Northing (m)	Easting (m)
	M 1818	672173.37	362808.29
	M 1819	672141.04	362810.88
	M 1820	672147.76	362815.00
	M 1821	672141.00	362813.43
	M 1822	672146.87	362810.16
	M 1823	672169.68	362828.22
	M 1824	672174.68	362838.13
	M 1825	672170.09	362876.47
	M 1826	672185.19	362818.98
	M 1827	672167.01	362865.82
	M 1828	672172.04	362857.29
	M 1829	672166.10	362844.33
	M 1830	Photographed but missed during traverse.	
	M 1831	672147.71	362818.92
	M 1832	672143.03	362821.38
	M 1833	672136.79	362822.18
	M 1834	672137.43	362815.81
	M 1835	672207.79	362777.47
	M 1836	672235.82	362780.75
	M 1837	672242.72	362788.46
	M 1838	Photographed. Could not sight to.	
	M 1839	672224.50	362866.65
	M 1840	672250.51	362874.81
	M 1841	672209.70	362897.46
	M 1842	Tag M 1842 missing. Replace with tag N 0451.	
	M 1843	672211.37	362919.38
	M 1844	672210.92	362918.49
	M 1845	672202.74	362926.32
	M 1846	Not located.	
	M 1847	672178.91	362792.04
	M 1848	672153.20	362777.00
	M 1849	672152.48	362787.33
	M 1850	672145.51	362791.19
	M 1851	Not located but believe to be dubious.	
	M 1852	Not located but believe to be dubious.	
	M 1853	672144.48	362831.62
	M 1854	672151.37	362833.34
	M 1855	672156.49	362857.28
	M 1856	672172.75	362853.78
	M 1857	672188.22	362839.41
	M 1858	672174.14	362876.10
	M 1859	672184.57	362833.90
	M 1860	672141.33	362831.62
	M 1861	672128.28	362823.51
	M 1862	672132.36	362821.80
	M 1863	672124.77	362817.85
	M 1864	672122.84	362812.37

Coordinate listing	Tree / Mark	Northing (m)	Easting (m)
	M 1867	672113.44	362817.09
	M 1868	672127.69	362809.92
	M 1869	672131.42	362807.35
	M 1870	672118.57	362804.18
	M 1871	672117.98	362799.02
	M 1872	672139.12	362791.29
	M 1873	672138.55	362794.74
	N 0430	672133.24	362826.23
	N 0443	672188.90	362812.67
	N 0444	672180.82	362809.97
	N 0445	672144.57	362814.94
	N 0448	672248.95	362939.72
	N 0449	672212.73	362799.75
	N 0450	672147.33	362805.43
	N 0451	672224.96	362916.61
	N 0452	672265.64	362951.02
	N 0453	672253.79	362905.01

Location: **Taia**

Plan reference: **Plot 3, Plot 4**

No. of Trees: **21**

Coordinates: **Local Grid Coordinates**

Coordinate listing	Tree / Mark	Northing (m)	Easting (m)
Pegs	Peg I	7000.00	3000.00
	Peg II	6808.19	2978.73
	Peg III	6789.54	3057.94
	Peg IV	6900.43	3222.08
	Peg V	7004.50	3309.85
	Peg VI	7089.72	3305.59
	Peg VII	7108.36	3243.86
	Peg VIII	7058.28	3237.03
	Peg IX	7046.51	3275.98
	Peg X	7002.50	3301.92
	Peg XI	6884.92	3171.57
	Peg XII	6849.05	3042.25
	Peg XIII	6901.47	3017.79
Trees	N 0401	7988.56	3254.66
	N 0402	7075.11	3255.60
	N 0403	7084.98	3257.24
	N 0404	7117.77	3283.49
	N 0405	Unable to be located.	
	N 0406	7120.63	3259.11
	N 0407	7111.83	3243.50
	N 0408	7107.08	3240.99
	N 0409	7106.41	3238.40
	N 0410	7102.52	3237.72
	N 0411	7100.42	3236.93
	N 0412	7084.04	3235.19
	N 0413	7086.33	3241.71
	N 0414	7074.60	3233.78
	N 0415	7047.10	3237.92
	N 0416	7039.93	3244.55
	N 0429	Photographed but unable to sight to.	
	N 0439	7051.19	3245.01
	N 0440	7049.43	3244.66
	N 0441	7050.44	3252.14
	N 0442	7053.16	3246.73

Location: **Lake Kairae**

Plan reference: **Plot 5**

No. of Trees: **16**

Coordinates: **Chatham Island Map Grid**

Coordinate listing	Tree / Mark	Northing (m)	Easting (m)
Pegs	Peg A	666224.22	358577.61
	Peg B	666274.92	358602.74
	Peg C	666295.02	358608.78
	Peg D	666313.48	358616.63
	Peg E	666342.54	358629.54
	Peg F	666318.83	358637.75
	Peg G	666238.47	358605.39
	Peg C1	666299.47	358586.74
	Peg E1	666355.30	358597.81
Fence Posts	Fce 1	666182.24	358542.31
	Fce 2	666220.24	358573.71
	Fce 3	666254.11	358591.99
	Fce 4	666352.26	358632.34
	Fce 5	666398.47	358646.48
Trees	N 0417	666297.87	358579.32
	N 0418	666296.44	358580.34
	N 0419	666295.64	358578.65
	N 0420	666303.25	358581.20
	N 0421	666316.57	358593.61
	N 0422	666326.50	358593.26
	N 0423	666278.41	358586.43
	N 0424	666289.04	358590.60
	N 0425	666350.36	358584.67
	N 0426	666357.2	358582.12
	N 0427	666365.67	358614.36
	N 0428	Unable to be located.	
	N 0446	666295.38	358571.55
	N 0447	666296.29	358591.91
	N 0461	666222.42	358574.10
	N 0462	666228.31	358575.65
	N 0463	666227.63	358564.51

Location: **New Barker Bros Ltd Block**

Plan reference: **Plot 6**

No. of Trees: **22**

Coordinates: **Local Grid Coordinates**

Coordinate listing	Tree / Mark	Northing (m)	Easting (m)
Pegs	Nail 1	3000.00	1000.00
	Nail 2	3067.07	961.27
	Peg A	3121.42	1080.53
	Peg B	3207.32	1090.14
	Peg C	3293.60	1152.69
	Peg D	3379.24	1183.81
	Peg E	3502.46	1239.67
	Peg F	3561.40	1256.28
	Peg G	3642.36	1305.57
	Peg H	3683.51	1281.13
	Peg J	3700.61	1249.86
	Peg K	3569.15	1102.59
	Peg L	3166.01	922.53
	Peg M	3915.65	1400.68
	Peg N	4093.74	1392.21
	Peg P	4223.74	1476.91
	Peg Q	4351.82	1605.25
	Peg R	4475.84	1773.74
	Peg S	4363.35	1609.17
	Peg T	4224.03	1459.73
	Peg U	4077.05	1371.60
Posts	Post 0	2962.27	989.61
	Post 1	2999.99	1001.02
	Post 2	3066.63	960.39
	Post 3	3166.04	921.49
	Post 4	3439.14	1049.99
	Post 5	3569.96	1102.07
	Post 6	3573.26	1156.58
	Post 7	3745.11	1283.83
	Post 8	3938.12	1417.24
	Post 9	4093.42	1393.17
	Post 10	4223.13	1477.71
	Post 11	4350.83	1605.45
	Post 12	4357.66	1672.77
Trees	N 0500	3220.73	1079.5
	N 0501	3232.11	1077.01
	N 0502	3380.41	1173.03
	N 0503	3379.91	1175.85

Coordinate listing	Tree / Mark	Northing	Easting
	N 0504	3382.73	1189.61
	N 0505	3506.97	1230.09
	N 0506	3520.45	1225.09
	N 0507	3533.20	1245.14
	N 0508	3557.18	1247.50
	N 0509	3556.89	1233.54
	N 0510	3646.17	1290.80
	N 0511	3666.37	1291.98
	N 0512	3657.82	1312.73
	N 0513	3675.05	1298.99
	N 0514	3889.63	1454.45
	N 0515	3895.90	1445.83
	N 0516	3898.71	1438.85
	N 0517	3943.58	1452.26
	N 0518	4458.85	1822.80
	N 0519	4470.11	1827.46
	N 0520	4471.67	1828.47
	N 0521	3192.21	1101.73

Appendix 2

GPS COORDINATES FOR FENCE POST REFERENCE MARKS

B.G. McFadgen, Science & Research Unit, DOC

Coordinates in terms of Chatham Island map grid for fence post reference marks (Table 1) were found using a Pro-XL GPS receiver with readings differentially corrected from the Terralink Wellington Base Station. Equipment malfunction prevented setting up a local base station. Conversion parameters between WGS84 and Chatham Island 1979 datum are listed in Table 2, and Chatham Island false origin data are listed in Table 3. The coordinates are likely to have a maximum error of about 2.5 m.

TABLE 1. COORDINATES IN TERMS OF CHATHAM ISLAND MAP GRID FOR FENCE POSTS USED AS REFERENCE MARKS.

MARK	NORTHING (m)	EASTING (m)
Barker Bros Ltd Post 3	675272	364851
Barker Bros Ltd Post 2	675166	364839
Barker Bros Ltd Post 1	675088	364843
Barker Bros Ltd Post 0	675001	364756
Taia Gatepost	664059	357257
Taia Post next to Peg I	663595	357356
Taia Post next to Peg II	663403	357376
Te Wairoa Post next to Peg A	653238	355736
Te Wairoa Post next to Peg B	653189	355668
Te Wairoa Strainer Post Diag.A	652982	355479

TABLE 2. PARAMETERS USED TO CONVERT BETWEEN WGS84 AND CHATHAM ISLAND 1979 DATUM.

Tx = 174.05 m
Ty = -25.49 m
Tz = 112.57 m
Rx = 0 sec
Ry = 0 sec
Rz = -0.554 sec
Scale = 0.2263 parts per million

TABLE 3. CHATHAM ISLAND FALSE ORIGIN DETAILS.

Latitude = 44° South
Longitude = 176° 30' West
Scale factor = 1
False Easting = 350000
False Northing = 650000

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Appendix 3

MORIORI TREE CARVING PLOTS (1-6)