Overnight Facility Use

in the

Tongariro Northern Circuit

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Abstract

The Tongariro Northern Circuit is located in the central North Island on the volcanic plateau, and encompasses both Mt Ngauruhoe and Mt Tongariro. The Circuit has high day and overnight use during the summer season and has been classified as a Great Walk by the Department of Conservation who administer it. This thesis focuses on the summer season use of the overnight facilities on the Tongariro Northern Circuit (TNC) with the intention of providing DoC Management with an accurate and detailed profile of users, the factors that influence use and the problems being generated by it.

- *Profile of users:* This describes who uses the facilities, when they are used, the tracks and directions predominantly used and methods of transportation to and from the Circuit.

- *Factors influencing use:* These include the time of year and week, the weather and the effect of weather forecasts.

- *Problems:* Congestion in huts is discussed, including the related hut design flaws.

The thesis makes comparisons with information gathered seven years ago and identifies the changes in the both the user groups and their preferred routes within the Circuit. The profile of the New Zealand users as a group differs significantly from that of international users. These differences are explored.

Two models are presented that account for about 80% of the variation in the highly fluctuating overnight use. These models also estimate the effects of weather on use.

Three main sources of data have been used in this thesis. They include a survey that was designed specifically—the full process of gaining approval, creating and running the Tongariro Northern Circuit 2000/1 summer survey is presented along with the results. The other two main sources of data include the Great Walks pass butts and the hut wardens' observations of use.

Acknowledgements

There are numerous people within the Department of Conservation who have assisted me with this research. I wish to thank two people in particular:

- Harry Keys who saw value in the research, helped co-ordinate the acceptance of the original survey proposal, and provided ongoing support when required

- Jimmy Johnson who co-ordinated the survey collection, provided the hut warden observations and the Great Walks pass butts.

I am also grateful to the many Tongariro Northern Circuit Hut Wardens who encouraged the overnight facility users to complete the surveys during the three and a half months the survey ran. Thanks too to Barbara Curtis and Kathleen Hubay who provided the complete set of Metservice weather forecasts used in the modelling.

From DoC Head Office: Thanks to Chris Edkins who provided the electronic copies of the Tongariro Northern Circuit map and DoC logo which were used in the survey; and to Gordon Cessford who provided fast access to relevant management documents, the 1993/4 Great Walks survey database, and who also relayed many bundles of completed surveys and weather forecasts to me for analysis.

Stuart Burgess of The National Institute of Water and Atmospheric Research Ltd (NIWA) provided various climatic datasets for model investigations, without which the overall modelling would not have been as comprehensive.

Geoff Jones undertook to supervise this project and provided support and encouragement throughout. He also introduced me to the capability of gam modelling which has added another dimension to my research.

Finally to Cris, my wife, who put up with my relative seclusion during my involvement with this thesis , and for her time spent proofreading, I am very grateful.

Contents

Certificate of Originality

I, David William Olsen certify that the research carried out for this thesis and the thesis itself represents my original work except where acknowledged.

Signed: .....

Date: .....

Part I

Preliminaries

Chapter 1

Introduction

This chapter outlines the rationale, aims and objectives of my research. It looks briefly at the needs of the Department of Conservation (DoC) for such information, introduces the area being researched, the primary sources of data, and outlines the structure of the thesis.

1.1 Rationale and goals

Management needs up-to-date information to effectively manage the areas that they are responsible for. This thesis and my related report *Overnight Facility Users on the Tongariro Northern Circuit—An analysis of the 2000/1 summer season use with comparisons from 1993/4* (October 2001/unpublished) for the Tongariro Northern Circuit Management team, provides detailed information about the overnight facility users on the Tongariro Northern Circuit.

The research and analysis carried out for this thesis provides the first detailed breakdown of the movement, or flow, of overnight facility users within the Tongariro Northern Circuit. Comparisons are made with similar information gathered during the 1993/4 summer season, and the major changes have been noted.

My thesis also helps to bring closure to my original investigations and report for the Tongariro Northern Circuit Management team from November 1994: *Tongariro Northern Circuit Summer Season Overnight Users Analysis – Part One – Analysis of Great Walk Pass Butts* (unpublished). The report emphasised the dearth of information on overnight facility users and use trends, and since the 1993/4 summer season (on which the report was based), all summer seasons have been recorded except for one: the 1994/5 summer season. With the increasing amount of historical data, more statistical opportunities become available and there is increasing statistical validity. The modelling investigations carried out for this thesis are one such example.

My original goals for this research and thesis were to:

(i) gain approval for, develop and run a survey during the 2000/1 summer season gathering similar information on the user group and flow patterns to that gathered during the 1993/4 summer season

(ii) determine and document the internal use patterns (routes followed) and general movement (combined flow) of overnight facility users within the Tongariro Northern Circuit

(iii) compare changes in the user group and user patterns with data collected seven years ago

(iv) ***identify*** past seasonal use patterns noting the extremes brought about by the Christmas holidays, Auckland Anniversary Weekend and Easter, and the general weekday versus weekend fluctuations. This also includes a nationality breakdown of users to illustrate that the New Zealanders' use pattern is significantly different from that of international users, and hence they will need to be treated differently in order to more accurately predict future use

(v) investigate the issue of crowding in huts and document both the pressure on the individual overnight facilities, and the user impressions of crowding on the Tongariro Northern Circuit

(vi) produce a preliminary report of the findings in a timely manner so as to be of use in the development of the new DoC business plan

(vii) ***quantify*** the influence of the external factors mentioned previously–in part (iv)–on the number of overnight facility users in the Tongariro Northern Circuit. Also as background to modelling, determine if a relationship exists between overnight facility use and:

- the number of international visitors to the country
- the elements of the weather (such as wind, rain, sun and temperature)
- weather forecasts.

These last two factors were expected to determine and/or alter users' trip patterns, and impact on the number of nights they stayed in the park.

(viii) develop a simple heuristic model, a mathematical/time-series model and if time permitted a simulation model for overnight facility use

(ix) forecast use for the next three, five and ten years, providing limits of accuracy for the forecasts.

However not all of these goals have been able to be met, and the reasons for this are:

- incomplete NIWA data for most of the earlier years
- the overnight facility use patterns were not well suited for time-series modelling due to the extreme influence of weather
- time constraints

and all of these factors contributed to difficulties in long term forecasting.

1.2 The lack of information on overnight facility users

Intermittently between 1988 and the start of the 1993/4 summer season I was a volunteer hut warden concerned about the lack of detailed information on both the use of facilities and the user groups. During this time I introduced various forms for hut wardens to record observations of use while working, though staff coverage at most facilities was, at best, intermittent and did not extend over the full summer season. No comprehensive data on the use or users of overnight facilities on the Tongariro Northern Circuit had ever been collected. This made it impossible to monitor changes in the user group or use patterns as there was no data to compare against.

During the 1993/4 summer season two main events took place to rectify the problem:

- I instigated the first comprehensive attempt to record the numbers of overnight facility users on the Tongariro Northern Circuit. This was the second year with a limited number of paid hut-wardens employed throughout the summer season, and I was employed as the senior hut-warden/hut-warden co-ordinator during the first few months of the season, which provided me with the ideal opportunity to ensure that the data was being collected. Volunteer hut-wardens boosted paid-staff coverage of the facilities and when facilities could not be staffed at all, extraordinary efforts were made by the other staff within the TNC to obtain accurate information on occupancy levels.

- The Great Walks Survey, coordinated by Gordon Cessford from DoC Head Office, gathered detailed information about the overnight user group and their experiences. A map was added to the questionnaire for those surveyed to record the users' movement within the Tongariro Northern Circuit.

The main success in recording seasonal use and the ability to identify the different seasonal use of New Zealanders versus international users came later in 1994 with the processing of the 1992/3 and 1993/4 Great Walks pass-butts. Through the efforts of the 1993/4 hut-wardens, compliance (checking passes to ensure users have paid) rates increased, and by processing the Great Walks pass-butts certain patterns emerged. My 1994 report to DoC Tongariro Northern Circuit Management provided the first comprehensive documentation of the fluctuating use within the seasons. This report contained an outline of procedures used to analyse the data with the hope that other conservancies would be interested in gathering similar information about their overnight facility user group and use patterns.

Since 1993/4, with the exception of 1994/5, annual reports for each summer season have been completed, including monthly totals for both use and nationality of users, as well as financial information.

In 1993/4 Head Office produced a report to try to standardise—and encourage—the collection of track-use information. Track counters were introduced at various locations on the Tongariro Northern Circuit, however these are still not functioning as they should and Management has no hard data on which to estimate the number of day-walkers completing the *Tongariro Crossing*.

1.3 Information needs of the Department of Conservation

This section looks briefly at the needs of the Department of Conservation for information in the context of this research on recreational use. It then identifies where this research may fit into the Department's mandate for information gathering and dissemination. This is done to highlight the dearth of information available in certain areas and give meaning to the recommendations that have been made.

Problem areas—the need for information

There are two main groups that need recreational information: Management, and the recreational users themselves.

Within Management there are three main issues relating to information:

(i) **The underlying need for information in order to manage the Tongariro Northern Circuit most effectively**. This issue relates primarily to the shortage of data/ information. Often decisions have had to be made without the hard data to be guided by, as it has not been available.

(ii) **Identifying what information is best to collect, and how to collect and present it to aid in the decision-making process**. This requires Management to be proactive and foresee future needs as well as develop a plan to meet them. While it is not always possible to predict future needs for information, many information needs are in fact predictable and procedures need to be put in place to ensure the efficient collection of relevant information. Regular reporting procedures need to be established where appropriate.

(iii) **Predicting future use**. Park use is increasing, which puts pressure on existing facilities. It is important for Management to foresee and plan for increased use. Knowledge of the carrying capacities of the existing facilities and when they are likely to be exceeded, or reach unsatisfactory levels, is essential for effective management.

Recreational users need the information, as it will allow them to choose the experiences they desire. They need to know what what the conditions are likely to be at the time they plan to visit.

The Department of Conservation's solution

Management within the Department of Conservation are working proactively to improve their information-gathering and reporting procedures. Much of the following material has been obtained from the Department's Strategic Directions Document (2 October 2000) to assist Management with the preparation of their current business plans.

In the introduction the DoC Director-General, Hugh Logan, has written:

> "There will be a strong emphasis on promoting recreation, to encourage public enjoyment and to strengthen a sense of public ownership of protected areas. A wide range of recreational opportunities will be provided *by focusing and aligning recreation facilities and information services.* We will seek to ensure that recreation facilities meet appropriate standards and that a balance is achieved between the long-term maintenance requirements of the facilities provided and the resources available." (my italics)

Logan also provides the following diagram identifying the key steps required in order to meet government goals:

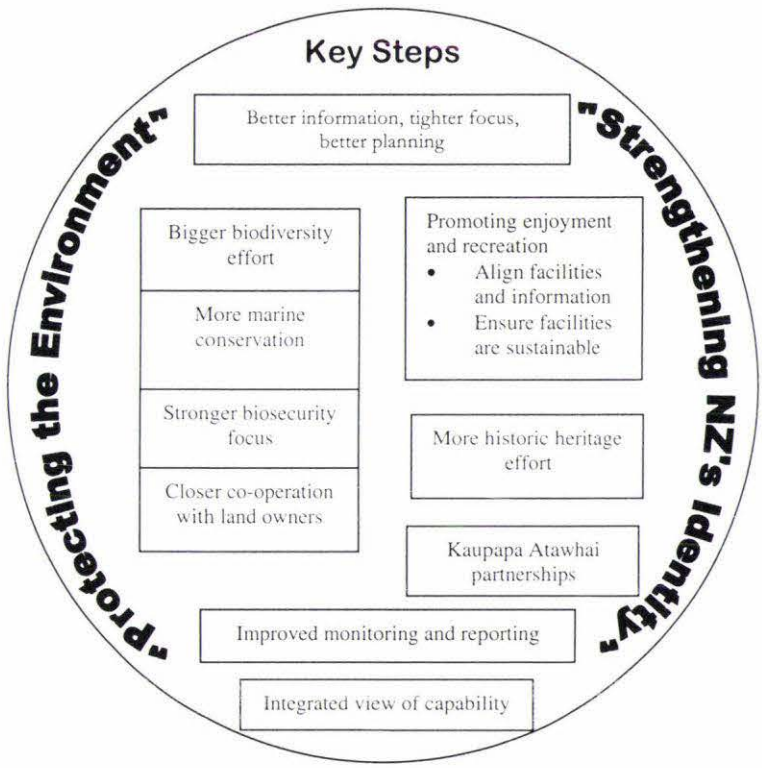


Figure 1-1: *Key steps to meet the government's key goals*

The three areas that I have shaded in the diagram are particularly relevant to this research.

How this thesis may help

This information and analysis is timely for the Tongariro/Taupo Conservancy of the Department of Conservation as their business plan is currently being written and my reports submitted during 2001 have heightened their awareness of several issues, as well as use-patterns. But the value of this research should go well beyond the immediacy of the business

plan—it is hoped that it will be utilised in the greater context of the information needs that have been clearly outlined by Logan (Fig 1-1).

For DoC Management this research contains:

(i) a wide range of information relating to the Tongariro Northern Circuit, providing a picture of actual use and potential problem areas. This information has been lacking in the past.

(ii) a raft of tables and charts to help Management identify key data that should be collected in order to help with monitoring and reporting.

(iii) a discussion of the problems affecting congestion in huts, bringing an awareness that crowding impacts are felt well before all bunks are occupied

(iv) the development of models identifying and quantifying the relative influences of factors affecting overnight facility use

(v) predictions or forecasts of increased use which should help with the business plan process.

For the overnight facility users this research could help in the following ways:

(i) DoC Management may use the information to help *align information services with the recreational opportunities provided* on the Tongariro Northern Circuit (Logan, page 6). This means that the information could be made available to the public, and overnight facility users would then be able to seek out the experiences they desire—prior knowledge of crowded facilities at certain times of the year may alter use patterns for example. To date, year after year the Easter use is excessive and many leave dissatisfied with the experience

(ii) DoC Management may also respond to crowding issues and move to increase or modify the existing facilities

(iii) The most-used tracks and facilities, as revealed by the research, may begin to receive more upkeep in the future thus improving the experience for the majority.

1.4 The Tongariro Northern Circuit

Location and map

The Tongariro Northern Circuit (TNC) is located in the heart of the volcanic plateau in the centre of the North Island. It lies approximately 15 kilometres southwest of the southern shoreline of Lake Taupo. The Tongariro Northern Circuit consists of four overnight facilities and tracks around Mt Ngauruhoe and across the Mt Tongariro massif.

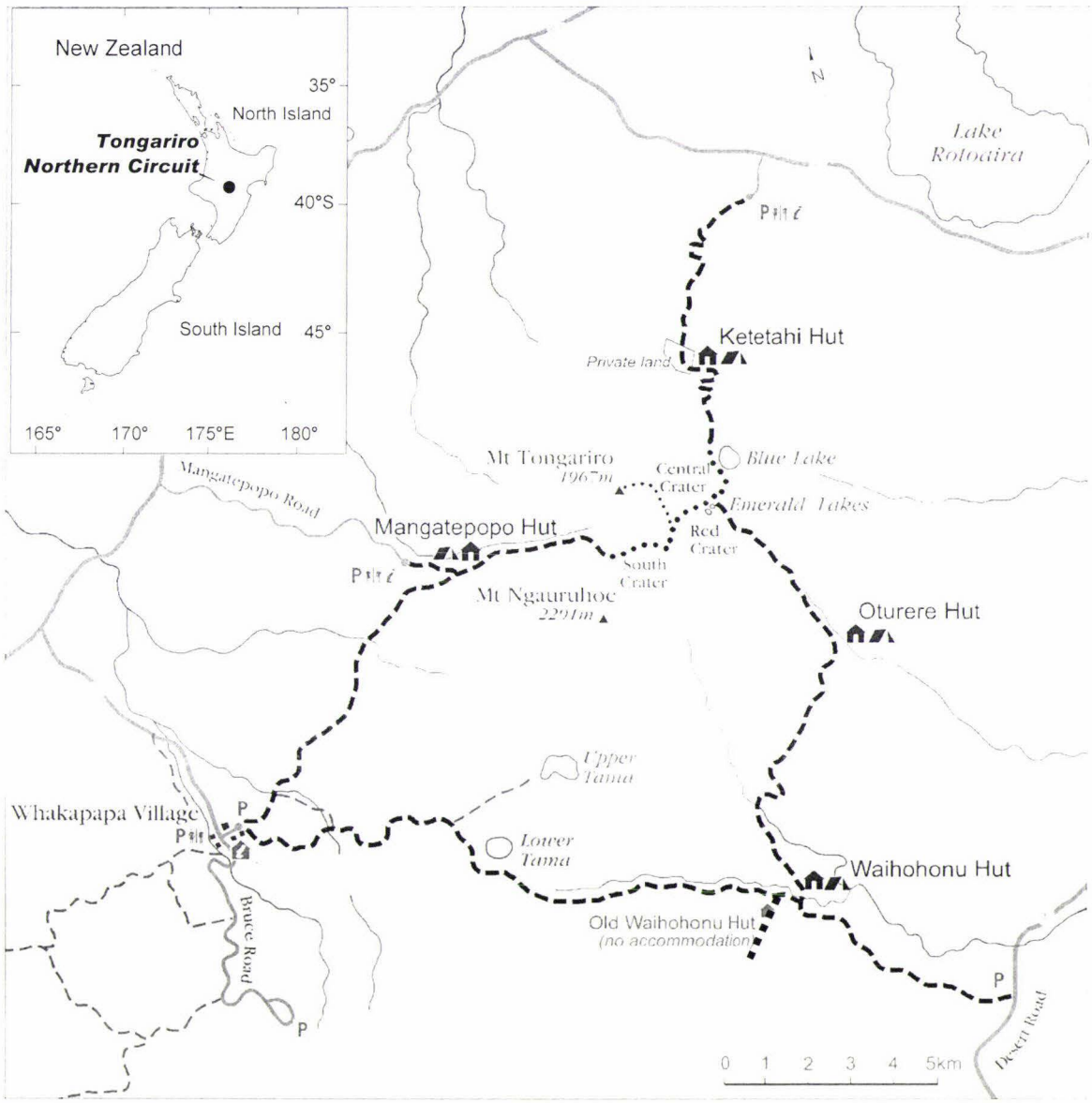


Figure 1-2: The tracks and overnight facilities on the Tongariro Northern Circuit

There are four sites with overnight facilities on the TNC. These are Mangatepopo, Oturere and Waihohonu (all located on the circular track around Mt Ngauruhoe) and Ketetahi (located on the northern slope of Mt Tongariro).

The attraction

The DoC webpage simply states:

"The Tongariro Northern Circuit winds its way over Mt Tongariro and around Mt Ngauruhoe. This walk passes through unique and stunning landforms which include volcanic craters and glacial valleys."

The *Tongariro Crossing*, the route explained in detail in Section 5.4, is often referred to as one of the best day walks in the country. On fine, calm days during mid-summer there are frequently over one hundred day-walkers completing the seven to eight hour *Crossing*. Approximately 1,500 overnight facility users also complete the *Crossing* each season over a period of two–three days.

There is a large variety of recreational opportunities available within the Tongariro Northern Circuit with the majority of visitors only visiting by day. These include short walks to waterfalls, strolls up the Mangatepopo Valley or into Waihohonu from the Desert Road, and more energetic trips climbing to South Crater, Red Crater and/or taking in the peaks of Mt Tongariro and/or Ngauruhoe. Rock-climbing is also popular on Pukekaikiore in the Mangatepopo Valley. Schools from as far away as Wellington have annual visits for classes studying geography (land formation, regeneration on the differently aged lava flows, erosion etc) and some have annual tramping trips in the Circuit as it provides a relatively safe, accessible, backcountry experience for students in an alpine environment.

Visitors speak highly of the splendid alpine views from the exposed ridges, some even describing it as a spiritual experience in hut logbooks.

The Tongariro Northern Circuit entity

The Tongariro Northern Circuit was given **Great Walk** status within the Department of Conservation when the concept was first introduced in 1992. This status recognised the relative importance, high use and high profile of the tracks and overnight facilities. Two significant changes came with the Great Walk status:

(i) It allowed for the introduction of its own overnight pass system. The Great Walks pass system ensured that money could be collected locally for the overnight use of facilities and these funds could be utilised immediately for the maintenance of those facilities.

(ii) Central funding was provided for the employment of a limited number of hut wardens during the summer season. These then became the first paid hut wardens on the Tongariro Northern Circuit with responsibilities which included compliance (checking passes to ensure users have paid), general public relations, and public safety.

The more expensive Great Walks pass charges of the high-use summer season can be seen by the users to finance the increased number of facilities and services (cooking rings/burners, flush toilets and hut-wardens). During the off-season the additional facilities and services are removed and the charges for the overnight facilities revert back to the previous national backcountry pass system.

Prior to 1992 there were no DoC staff assigned specifically to the Tongariro Northern Circuit. The development and maintenance of facilities on the Tongariro Northern Circuit was, and still remains, under the care of two Field Centres—Turangi and Whakapapa—and the Tongariro Northern Circuit represents only a small part of their overall responsibilities. The Whakapapa Field Centre, located primarily in the Whakapapa Visitor Centre, is responsible for the maintenance of the Mangatepopo facilities and westernmost tracks from the Tama Lakes to Red Crater, with the Turangi Field Centre being responsible for the rest. During the 1992/3 summer season the Field Centres selected and employed their own hut wardens. In 1993/4 the senior hut warden position was introduced and since then has been based in the Turangi Field Centre which has responsibility for three of the four overnight facilities. The senior hut warden became responsible for the selection, training and placement of all hut wardens on the Tongariro Northern Circuit during the summer season. The Field Centres continue to assign the local day-to-day tasks performed by the hut wardens on tracks and facilities, though site-specific training usually rests with the senior hut warden.

The Tongariro Northern Circuit Management Team consists of staff from three entities: area planning and maintenance staff from the two Field Centres, and staff with regional planning and financial responsibilities from the Tongariro/Taupo Conservancy Office (based in Turangi alongside the Turangi Field Centre).

1.5 Primary sources of data for this thesis

This section gives a brief introduction to the primary sources of data analysed in this thesis. The specific content of each data source is described in more detail in various Parts, Chapters and Sections of this thesis, the references for which are provided here. There are three main sources of overnight facility-use data and three sources of weather data.

The 2000/1 Summer Survey

This survey (Appendix A) was created as part of my Masters research and thesis to provide DoC Tongariro Northern Circuit Management with current overnight use information and to identify how use has changed from seven years ago. As well as user information the survey has also gathered information on the movement of overnight facility users within the TNC. The setting up of the survey is covered in Chapter 2, data entry in Chapter 3, survey results in Part II, and comparisons with seven years ago in Part IV.

Great Walk pass butts

These pass butts are filled in when the Great Walks passes are purchased. They are used in this thesis primarily to provide a picture of the seasonal use of facilities and different use patterns of nationalities and youth use (Chapter 9). They also provide an annual breakdown of total use by nationality.

Hut warden observations of use

The hut wardens provide the numbers of those using hut and camp facilities at each location. These are used to show the fluctuating use of individual facilities and the pressure that users place on facilities (Chapter 10). These observations, dating back to 1993/4, also provide the base information for modelling seasonal use (Chapter 15).

Weather forecasts and other weather records

There are three sources of data in this area (Chapter 14):

(a) NIWA has provided historical weather records from Whakapapa and Turangi (Section 14.2). These are used to determine whether climatic variables have played a part in overall TNC use.

(b) Hut wardens have recorded local weather observations from Ketetahi and Mangatepopo through most of the last summer season. This has provided more accurate weather details for modelling purposes (Section 14.3).

(c) DoC Turangi has gathered the Mountain Weather Forecasts for 2000/1 summer season from the MetService in Wellington. The morning forecasts have been collected to determine whether they can be used to improve models of overnight facility use (Section 14.4).

1.6 The structure of this thesis

It is divided into six parts:

I **Preliminaries**

This introduces the thesis, providing the rationale for the research and an overview of the process required to set up and run the 2000/1 summer survey, then enter the results.

II **Survey Results**

This presents the findings of the 2000/1 summer survey providing an analysis of the user groups, arrival and departure modes of transport and user movements within the Tongariro Northern Circuit.

III **Times of Overnight Facility Use**

This contains the analysis of the two other sources of use information—the Great Walks pass butts and the hut wardens' observations of use—and discusses crowding and congestion issues.

IV **Comparisons Between Data Sets**
Sources of Bias

This discusses the changes in the user group and facility use compared with seven years ago. It also suggests explanations for the differences evident between data sets that have collected the same information. Sources of bias are discussed.

V **Model Development**

This outlines the weather data sources that have been obtained to improve models of overnight facility use, and then develops models of use.

VI **Summary, Conclusions and Recommendations**

Chapter 2

Setting up the 2000/1 Summer Visitor Survey

2.1 Introduction

This chapter outlines the steps involved in setting up the Tongariro Northern Circuit 2000/1 summer survey. It describes the procedures used to gain the approval necessary to conduct a survey on the DoC Estate, the ethical considerations necessary for Massey University research, the survey design, and the training of those conducting the survey.

The steps involved were made easier due to both my previous involvement with DoC surveys, which gave me an understanding of the internal procedures that needed to be followed to gain survey approval and the fact that I knew most of the DoC Management staff, having worked with them seven years ago. However there were four main differences this time:

(i) I was not a DoC employee, so essentially I was an outsider requesting permission to conduct a survey on the DoC Estate. This required a more formal approach, with extra consideration needing to be given to any additional expenses that might be incurred by DoC as a result of the surveying process.

(ii) I was not in charge of, and did not know, those who might/would be assisting with the surveying.

(iii) Previously there had been no need to go through a formal ethical approval process.

(iv) I was working full-time in Lower Hutt, over 300 kilometres away from the primary management site of the Tongariro Northern Circuit, Turangi. This made it necessary to enlist the help of others to ensure that the approval for the survey would be granted.

2.2 Survey approval

The proposal for a survey on the Tongariro Northern Circuit was formally raised with various members of the Tongariro Northern Circuit Management Team on **25 June 2000**. During the previous six months, I had talked informally with various past and present DoC staff, I had also enrolled and was undertaking papers at Massey which would provide a greater statistical foundation for analysing multivariate survey data and time series data. My first organised meeting to discuss the survey was with the DoC Tongariro/Taupo Conservancy Scientist—Harry Keys—on **5 July 2000**, where the value of the research was noted and encouragement received. During the next few months we worked towards developing the survey focus that would best aid with the DoC requirements for information. Harry liaised with many of the other DoC TNC Management staff assisting with the approval process and refining the information that would be most beneficial for Management planning.

Management was keen to establish when the carrying capacities of the huts would be exceeded, so with this in mind I sent two documents: *Load Analysis of the Tongariro Northern Circuit for the Summer of 1998/9* (7 August 2000), which gave consideration to the numbers using the facilities (Appendix B); and *Tongariro Northern Circuit overuse/limited space in overnight facilities* (4 September 2000), which outlined the real problem that currently exists with the huts becoming crowded well before being full (Appendix C). I hoped to precipitate a discussion on what constitutes threshold carrying capacities for the huts, but it is an issue that DoC's Management Team has to further come to terms with yet.

On **Friday 13 October** Harry reported "There is general agreement that the analysis work is important and could be useful to us". Survey development plans escalated from here with the 2000/1 summer season about to start. On **9 November** the proposed survey was discussed in detail with DoC TNC Management and as the meeting concluded, approval for the survey was given, subject to the survey questionnaire meeting with their approval.

2.3 Questionnaire design

Keeping the questionnaire short and to one side of a page was paramount due to the potential complications with survey administration overheads and the public's time involved when completing the survey. With the 1993/4 four-page Great Walks survey requesting approximately 120 responses, it took most people between 20 and 45 minutes to complete. The aim this time was to design a questionnaire that would capture the desired information in as few questions as possible, and that could be completed in just a few minutes, without the need for outside assistance.

The extent of the 'additional' questions or analysis required was not clear until a meeting with the DoC Tongariro Northern Circuit Management Team on **9 November 2000**.

The first draft survey was produced on 10 November for comment, with one more draft on **8 December** and the final version on **15 December 2000**. The main improvements and modifications consisted of including a digital DoC Logo and Map (4 December), and the removal of one question, which was finally judged to be unnecessary. The original design was based around:

- the map question (1993/4 Greats Walks Survey attachment form)
- the questions from the first page of the Great Walks Survey
- and an additional question that arose out of the meeting, which was to capture the users' modes of transport.

2.4 Methodology

My original proposal (emailed on 7 July 2000) was to survey all users on nine different nights (three non-consecutive nights during three non-consecutive weeks) netting an estimated 300–450 surveys. The rationale behind this was twofold:

(i) to obtain a reasonable sample size to produce a good picture of the movement within the park and

(ii) such a plan would require only a minimal staffing overhead. Initially I requested the assistance of hut wardens, but a new development of friends offering to help meant that the surveying could actually have been completed without adding any extra duties onto the hut wardens.

This proposal was not ideal because it did not follow the same methodology as the 1993/4 survey, but would in fact provide me with sufficient data for comparisons, whilst requiring minimal assistance from DoC. My concerns were that the demands of my research should not become too much of an imposition on the staff working at DoC.

The ideal plan would be to have the full support and backing of DoC, and use the [modified] Great Walks methodology of surveying only people on their final night in the park, at all huts, continuously throughout the peak summer season and over the Easter break. This would achieve the greatest sample size and allow for a direct comparison with the 1993/4 Great Walks survey. It would also be a good public relations opportunity for DoC as it would be seen to be a DoC-administered survey for DoC Management, with the implication that it would assist with the planning for future users. With the users on side, the survey would be likely to achieve the highest survey completion rate as well. However, I was uncomfortable with pushing too hard for this plan to be used as it might be seen as requiring or demanding too much assistance from the hut wardens.

There was a meeting on 9 November and these two proposals were discussed in detail. I was very gratified and appreciative that it was agreed the original proposal be abandoned in light of the benefits offered by the second plan. DoC were prepared to offer their full support subject to the approval of the questionnaire which would be required to include the questions decided upon at this meeting.

The second plan based on the 1993/4 Great Walks survey was what the questionnaires, in-hut posters and training documentation were prepared for following the November meeting. However it was made clear the day before the surveying commenced (21 December 2000) that if the administrative time involved by hut wardens was too great (and 15 minutes a night was specified) then the survey would need to be downsized. This was not a problem as the survey was designed to be administered during the hut-wardens' evening duties, and required no more than five to ten minutes of their time at most.

My offer of support during the survey period was refused as it appeared that there would be sufficient hut warden staff throughout the time so as not to require further help.

Fortunately the survey overhead *was* proven to be minimal and the survey could be carried out easily during the hut wardens' evening duties. I also received reports that they actually enjoyed administering them due to the pleasant public relations opportunity they offered.

2.5 Hut warden training and supporting survey documentation

On Friday 15 December 2000 the hut warden training materials were sent to Turangi with the final version of the questionnaire. On Monday 18 December I received the recommendation to visit and train the hut wardens to ensure that the surveying started before Christmas. Complicated plans were developed in the next few days for me to train the hut wardens in the Tongariro Northern Circuit at the Emerald Lakes on 22 December. However on 21 December I was suddenly informed that the training could take place in Turangi the next day as the hut wardens were changing shifts and this made the task much easier.

A survey briefing and training exercise took place in Turangi on the afternoon of Friday **22 December 2000** just prior to the four hut wardens entering the Tongariro Northern Circuit for the lead up to Christmas. The training materials were included in the survey packs (listed below) and they were to be left in the TNC huts for later reference. The survey briefing and hut warden training lasted 20 minutes with the hut wardens completing a few practical exercises to ensure understanding. Also present at the meeting was Tom May (Senior Conservation Officer responsible for the huts and track maintenance for the greater part of the Tongariro Northern Circuit), who spoke of the importance of the research, its value towards understanding what was going on within the Circuit and the fact that it would aid in both the management of the area and the business planning process. Jimmy Johnson, also present, undertook to train the subsequent hut wardens who would work during the rest of the summer season and I was very grateful to him for this.

Each hut warden was presented with a survey pack which would remain at the hut that they were initially responsible for. The packs consisted of:

- a relatively sturdy clear folder holding the following contents:
- 150 surveys
- a dozen new red pens
- a promotional poster for the hut notice board advising facility users that the survey was being conducted and asking for their support (Appendix D)
- a one page survey summary sheet with helpful hints (Appendix E)
- Support/background reading material outlining (i) the importance of this survey (ii) the role of the surveyor (iii) a description of how to approach people and the reasons for the

questions being asked (iv) key points to remember and (v) map notes giving examples of how the maps should be completed and some blank maps to be completed during the training exercise (Appendix F)

- plastic sleeves to allow for the transportation of surveys
- 20 cover sheets for the hut wardens to record the number of surveys collected and the number of groups collected from each night during their shift. (Appendix G)

Jimmy Johnson also received a set of training materials and a box containing another 600 questionnaires to replenish the hut supplies when they ran low.

2.6 Ethical considerations

In pursuing the highest ethical standards for research conducted by staff and students, Massey University has a Code of Ethical Conduct. For this survey the process of peer review provided sufficient evaluation so that no formal application needed to be made to the Massey University Human Ethics Committee (MUHEC). The documentation submitted for peer reviews are in the appendices as follows:

- The completed MUHEC application form, Appendix H (six pages)
- The Visitor Survey, Appendix A
- The information poster, Appendix D
- The TNC Summer Survey Summary and Helpful Hints, Appendix E
- The Additional Reading for the Tongariro Northern Circuit Summer Visitor Survey, Appendix F (eight pages)

Information about the Code of Ethical Conduct is viewable and can be downloaded from the website http://www.massey.ac.nz/~muhec/.

2.7 Summary and possible improvements

Gaining approval to conduct the survey took longer than I had anticipated, with most progress only being made in the last two weeks before the 2000/1 summer season began and during the first few weeks of the season itself (I had requested permission in July 2000).

Even after the survey had begun there was still uncertainty regarding the ongoing support available from DoC.

I felt that the biggest hurdle in gaining approval to conduct the survey came from not being currently employed by DoC and hence the survey needing to undergo a more stringent cost-benefit analysis. As well as this issue, the bottom line was that the drive for the survey was my Masters' research, and hence it was not perceived as being of vital importance to DoC, and at least in the early stages, the value of this research for their own management of the Tongariro Northern Circuit had not been realised by all.

In hindsight, I feel that the only way that this could have been circumvented was to solicit and gain senior management support from either the Conservancy Manager or Head Office. This would also have undergone a cost-benefit analysis, but if the significance of the research had been seen and supported by senior management things would probably have happened a lot more quickly and there would have been no issue surrounding ongoing support.

Chapter 3

Trip Coding, Data Entry and Interim Results

In order to speed up data entry, the one question that required independent coding was processed prior to entering the survey details into the computer. The explanation of the coding key sheet is covered in Section 3.1. When all of the maps had been coded, a rapid entry routine was used to enter each survey directly from the survey form; the format and an explanation of the entry aid is covered in Section 3.2. After entering each new batch of completed surveys an analysis-update sheet was completed and sent to the DoC Tongariro Northern Circuit Management Team. The software used for an analysis is outlined in Section 3.3 and a brief explanation of the content and rationale behind the analysis updates or interim results are covered in Section 3.4.

3.1 Trip coding

By using a two to four digit code it has been possible to code the majority of trips undertaken by the overnight facility users. Most codes are only two or three digits and they capture the entry and exit points, the combination of overnight facilities used and the direction of travel.

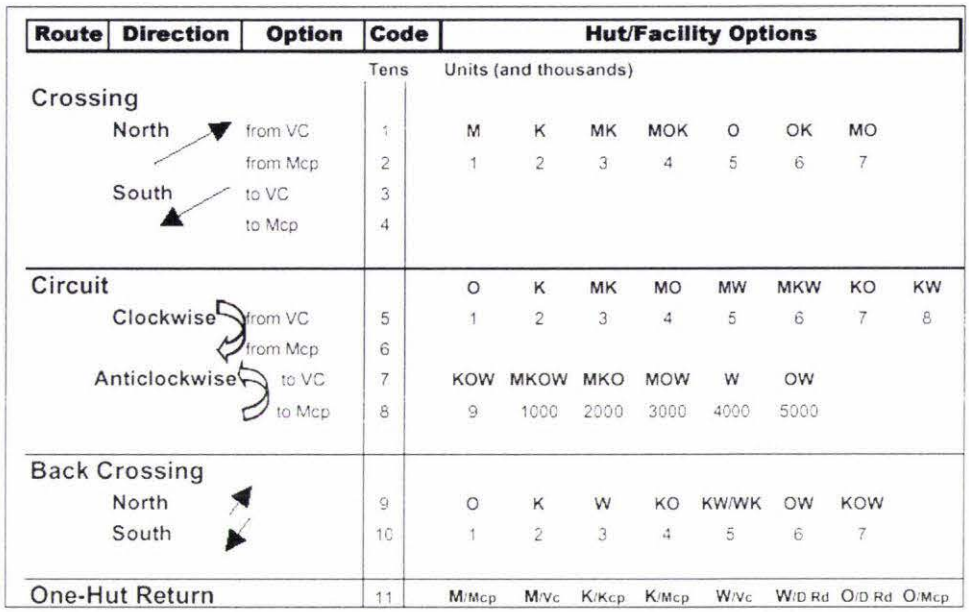
The trip direction and route followed is given by the tens digit (or hundreds and tens for less frequent routes), and the units give the combination of huts used for that route followed. With reference to Figure 3-1 the following codes are explained to aid understanding:

Examples of coding:

i) A group completing the *Tongariro Crossing* moving from the Whakapapa Visitor Centre to the Ketetahi car park staying only at Ketetahi would be coded as 12.

ii) A group completing a *Circuit* around Ngauruhoe from the Mangatepopo car park to the Whakapapa Visitor Centre, staying at Mangatepopo and Waihohonu huts would be coded as 65.

iii) If the group in (ii) had stayed at Oturere and Waihohonu the code would have been 5060.



Route	Direction	Option	Code	Hut/Facility Options							
			Tens	Units (and thousands)							
Crossing											
	North	from VC	1	M	K	MK	MOK	O	OK	MO	
		from Mcp	2	1	2	3	4	5	6	7	
	South	to VC	3								
		to Mcp	4								
Circuit				O	K	MK	MO	MW	MKW	KO	KW
	Clockwise	from VC	5	1	2	3	4	5	6	7	8
		from Mcp	6								
	Anticlockwise	to VC	7	KOW	MKOW	MKO	MOW	W	OW		
		to Mcp	8	9	1000	2000	3000	4000	5000		
Back Crossing											
	North		9	O	K	W	KO	KW/WK	OW	KOW	
	South		10	1	2	3	4	5	6	7	
One-Hut Return			11	M/Mcp	M/Vc	K/Kcp	K/Mcp	W/Vc	W/D Rd	O/D Rd	O/Mcp

Figure 3-1 Part of the TNC Map Route and Facility Coding Sheet.
(Full version is in Appendix I.)

The trip coding options closely follow those used for the 1993/4 add-on to the Great Walks survey. There are two main differences:

i) The facility use codes have been added to or extended slightly because of the increased variety of trips undertaken by those completing surveys.

ii) The decimal coding was not used in this survey whereas in 1993/4 those surveyed were instructed to record the use of road-end toilets, lunchtime use of the hut facilities they passed en route to their next overnight location, side trips such as climbing Mt Ngauruhoe or Tongariro and day trips for example from the Mangatepopo Hut to Red Crater and back.

The decision to exclude the decimal codes—part (ii) above—came as a result of considerations of space and time. With the need to include management questions on the survey form there was inadequate space to include instructions. In order to save time, only the party leaders were asked to complete the map, whereas in 1993/4 all those surveyed were asked to complete the map question allowing for the discernment of the numbers using road-end or other toilet facilities.

3.2 Data entry

There was a direct letter/numeric correspondence existing with all the remaining survey questions (see Figure 3-2), excluding nationality (see Table 3-1 for nationality codes). With no need to spend more time coding, the surveys could be entered directly into the computer.

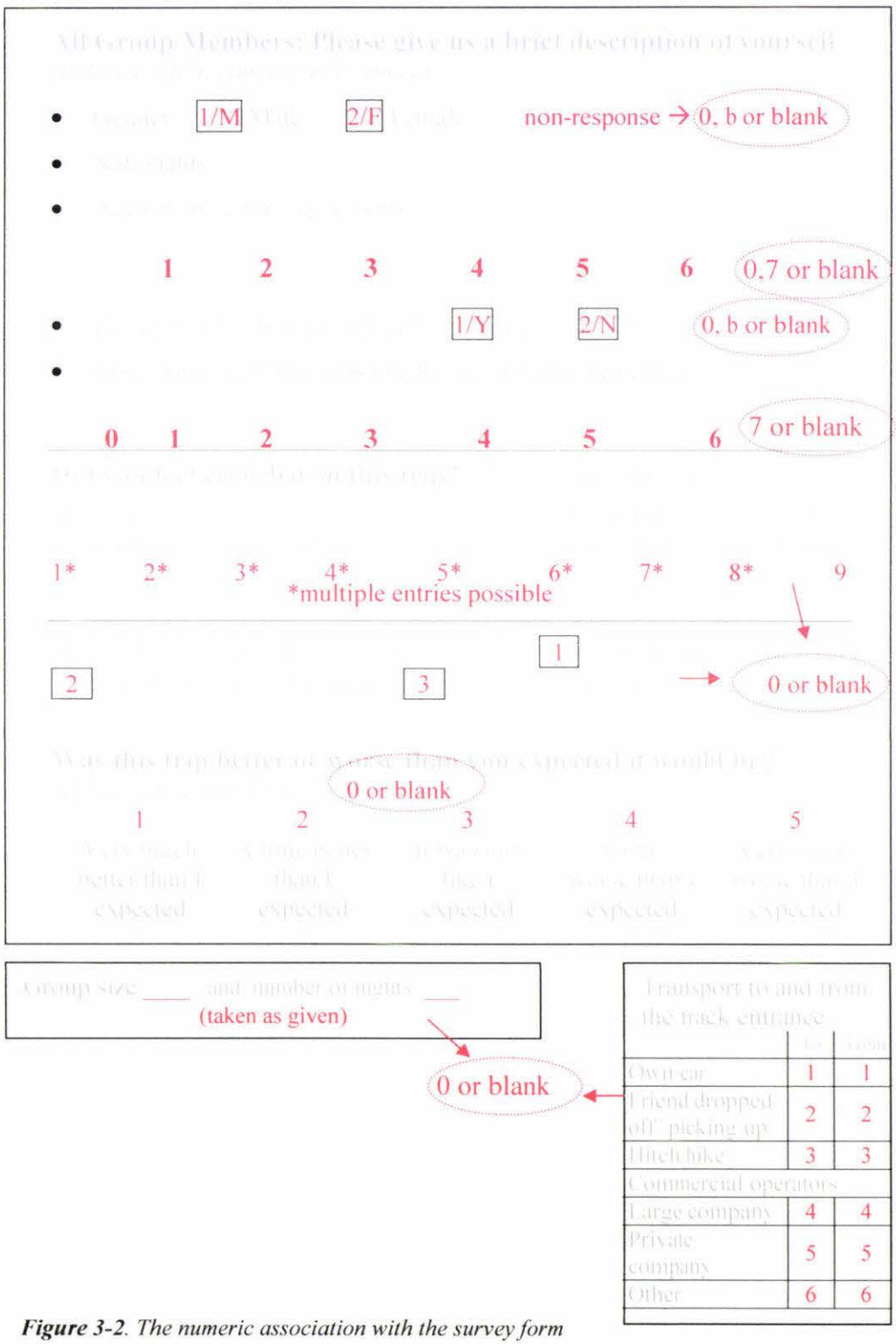


***Figure 3-2**. The numeric association with the survey form*

A DBase IV entry screen (Figure 3-3) with error checking and carry-forward features was used for rapid data entry. Most fields were entered using only the numeric keypad–for maximum speed–though some also accepted the specified letters. Any response outside those listed or valid non-response codes required correction before continuing with data entry. For the single character/digit fields the cursor would automatically advance to the next entry field removing the need to press the enter key after every entry.

Table 3-1: Nationality codes

Code	Nationality
A	Australian
C	Canadian
D	Swedish
E	European
G	German

Code	Nationality
I	Irish/British/Scottish
J	Japan
K	Netherlands
N or NZ	New Zealander
O	Other (non-Pacific)

Code	Nationality
S	Swiss
U	USA
X	Other (Pacfic)
Y	Israeli

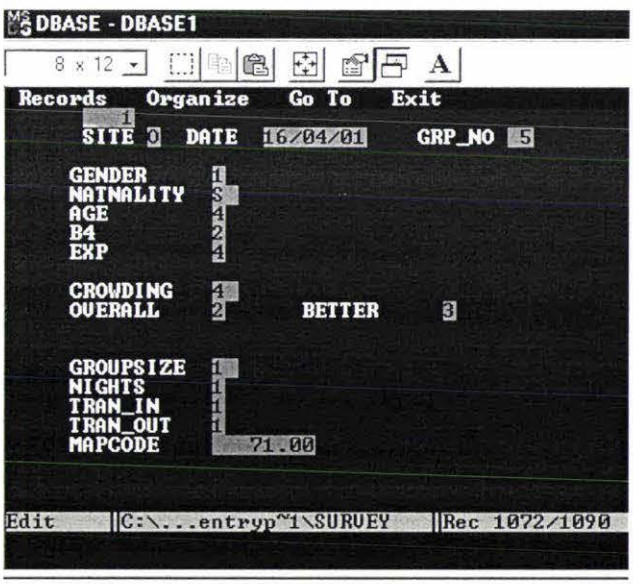


Figure 3-3: DBase IV rapid entry screen example

Unscrambling the code:

This is the first member of group 5 recorded at Oturere on the night of 16 April 2001.

Personal details:
Male, Swiss, 40-49 years old, first time to the TNC having experienced 21-50 similar trips.

He felt slightly crowded, expected to see the same number of people and his experience matched his expectations.

He was travelling alone, stayed only one night, arrived and left using his own car.

He completed the *anti-clockwise long Circuit*, starting and finishing at Whakapapa Village and stayed only at Oturere.

His survey is numbered 1072 if it needs to be referenced.

The carry-forward capabilities of the entry screen are highlighted in Figure 3-4. The collected surveys came in from each hut warden at the end of their shift in the park. Typically the hut warden stayed at only one hut and they were collected and/or sorted into groups by date. The site, date and group number are carried forward to the new next record, reducing the number of times these fields would need to be altered. Similarly with the group/party leader's details being entered first and carrying forward, these fields did not need to be re-entered for the remaining party members. All other fields were essentially set to their non-response values, except for Gender and B4 (whether they had been in the park before). These were set to the most common letter response, though during entry they were changed to the numeric equivalent. This removed any favouritism towards the common response and provided a check to see that this was not occurring.

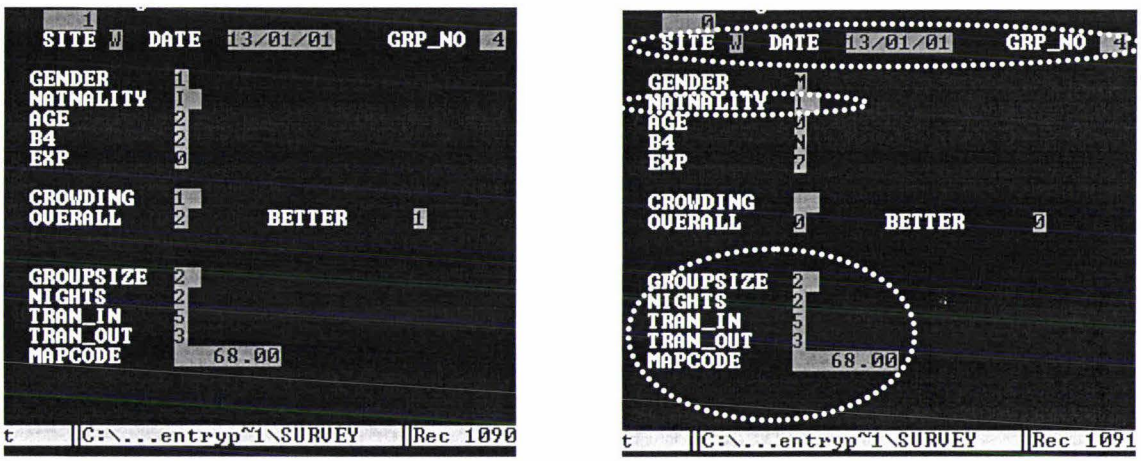


Figure 3-4: Survey carry-forward example to demonstrate increased entry speed. The identified fields carry forward removing the need to change these for other members of each group surveyed etc.

The surveys (hard copies) were numbered just prior to data entry with the survey number representing their original order of entry. In this way the original survey form could be referenced if it needed to be. During the process of reading the database files into Excel for subsequent analysis, the record numbers became a permanent field.

3.3 Decoding and analysis software packages used

The trip decoding routine written in DBase IV (Appendix J) extracts the detail captured within the code. Almost no analysis was completed within the Dbase IV package but the database file was read directly by Microsoft Excel for the initial analysis and later the Excel file was used within SAS, SPlus, Minitab and ASTSA where appropriate.

Some older DBase IV programs were used for the pre-analysis/manipulation of the 2000/1 Great Walks pass butts that I developed for my 1994 analysis.

3.4 Interim results

When visiting DoC friends in Turangi in late 1994 I became aware that the relevant information that had been gathered during the 1993/4 Great Walks survey was not readily accessible to the Tongariro Northern Circuit Management team. I then had helped DoC staff extract relevant information from the raw data file that I had obtained for my own research, so that it could be of use in the development of their new business plan.

In gaining approval for the survey I had undertaken to give feedback and analysis on the surveys collected in a timely manner. I saw that I could do this in two ways: firstly through the provision of analysis updates that I would complete after receiving each batch of surveys, then by providing the DoC Tongariro Northern Circuit Management Team with a report on my preliminary thesis research before it was due.

Eight interim analysis-update reports were completed and emailed to the TNC Management team during the first six months of 2001 (Table 3-2).

Table 3-2: *Analysis updates sent to the DoC Tongariro Northern Circuit Management team*

Update	Date sent (Surveys)	Topics covered
TNC opening analysis Appendix K	23/1/2001 (238)	Incoming questionnaires by site analysis and most popular routes
TNC analysis update-2 Appendix L	18/2/2001 (462)	Gender/Age/Nationality crosstabs
TNC analysis update-3 Appendix M	11/3/2001 (739)	Preliminary flow/ movement within the park
TNC analysis update-4 Appendix N	17/5/2001 (1,090)	Survey results: individual question response summary
TNC analysis update-5 Appendix O	17/5/2001 (1,090)	Directional flow/movement comparison of 2000/1 with 1993/4 seasons
TNC analysis update-6 Appendix P	18/6/2001 (1,090)	Crowding and trip expectations/Satisfaction indices
TNC analysis update-7a Appendix Q	18/6/2001 (1,090)	Movement to and from each overnight facility
TNC analysis update-7b Appendix R	25/6/2001 (1,090)	Movement from and to the access (entry and exit) points

Most analysis-update reports were one page and each contained a different area of analysis.

My report for DoC TNC Management: *Overnight Facility Use in the Tongariro Northern Circuit—An analysis of the 2000/1 summer season use with comparisons from 1993/4* (53 pages, unpublished)–was completed in October and 15 copies were bound with most going to the TNC Management team, and PDF files were provided both for further distribution and to be used if further copies were required.

Part II

Survey Results:

The Overnight Facility Users

Chapter 4

Characteristics of the Overnight Facility Users

4.1 Introduction

The 2000/01 summer survey (see Appendix A) gathered more detailed demographic information than the Great Walks pass butts provide. However there are a few limitations with regard to how well the survey results represent the full population of overnight users. The limitations include the facts that:

- it only ran for about three and a half months during the middle of the season
- not all people answered the survey. Those not filling in the survey:
    - may have been unwilling
    - may have had no hut warden present on their last night
    - may have decided en route not to stay for their planned last night and left earlier than anticipated.

In all 1,090 surveys were collected on the Tongariro Northern Circuit between 22 December 2000 and 16 April 2001. These account for approximately 33% of the users and 36% of the overnight facility bednights during the survey period. They also represent approximately 19% of users and 21% of the overnight facility use when comparing with the full summer season.

The surveys contained unanswered questions. The omission or non-completion rate for each individual question is approximately 1%. For example 1,080 of the 1,090 surveys contained Nationality data, this representing a 0.9% omission rate. The charts and tables that follow contain the results of the completed questions only.

4.2 Nationality

New Zealanders made up approximately one third (34%) of the summer surveys and they accounted for 31% of the surveyed facility use nights. These figures are approximately 5% below the annual use figures obtained from the Great Walk pass butts (see Chapter 9) but

they are representative of the users during the central summer season. The three largest nationality groups are New Zealand, Germany, and UK/Ireland. Together these three nationalities account for 60% of those staying overnight in the TNC. The next eight most popular countries range from 3% to 7% of the total occupancy and together make up most of the remaining 40% of users.

Table 4-1: The proportion of surveys collected and associated overnight facility use broken down by nationality:

Nationality	New Zealand	Germany	UK/Ireland	Other European	Australia	Netherlands	USA	Canada	Israel	Switzerland	Sweden	Japan	Other
Surveys	34%	14%	13%	7%	6%	6%	5%	4%	4%	4%	3%	1%	0%
Bednights	31%	14%	12%	7%	7%	7%	6%	4%	3%	4%	3%	1%	1%

4.3 Length of trip

Table 4-1 shows a 3% drop in the proportion of New Zealand bednights compared with the proportion of New Zealand responses. This is due to New Zealanders staying on average fewer nights than their international counterparts. This tendency is shown in the Table 4-2 below.

Table 4-2: Survey numbers by nationality and length of stay

	Length of stay (nights)				Total passes	Average number of nights	Proportion staying one night
Nationality	**1**	**2**	**3**	**4**			
NZ	153	138	62	10	363	1.8	42%
Germany	52	59	36	2	149	1.92	35%
UK/Ireland	50	67	20	2	139	1.81	36%
Other European	24	22	24	2	72	2.06	33%
Australia	12	35	23		70	2.16	17%
The rest	64	141	78	4	287	2.08	22%
Total	355	462	243	20	1,080	1.93	33%
Per cent of total	33%	43%	23%	2%			

Less than half of all New Zealanders surveyed stayed only one night and this differs from the pass butt analysis in Chapter 9 where over half of the New Zealand pass butts are for

one night only. In Table 4-2, the proportion of New Zealanders staying only one night is clearly higher than any other nationality.

The survey results indicated that the average number of nights for a female was 1.96 nights, which is 3.5% longer than the male average of 1.89 nights. This difference is not statistically significant *(p=0.312)*.

4.4 Gender

Of the 1,086 surveys that contained gender information 592 (55%) were male and 494 (45%) female, indicating significantly more males than females *(p=0.002)*.

A breakdown of the nationality groups by gender indicates that the primary nations contributing to the gender imbalance are New Zealand, UK, other Europe, Australia and USA. It is interesting to note that the second largest nationality group, the Germans, had an almost even gender balance. Also, more females than males completed surveys from Holland and Canada and Sweden.

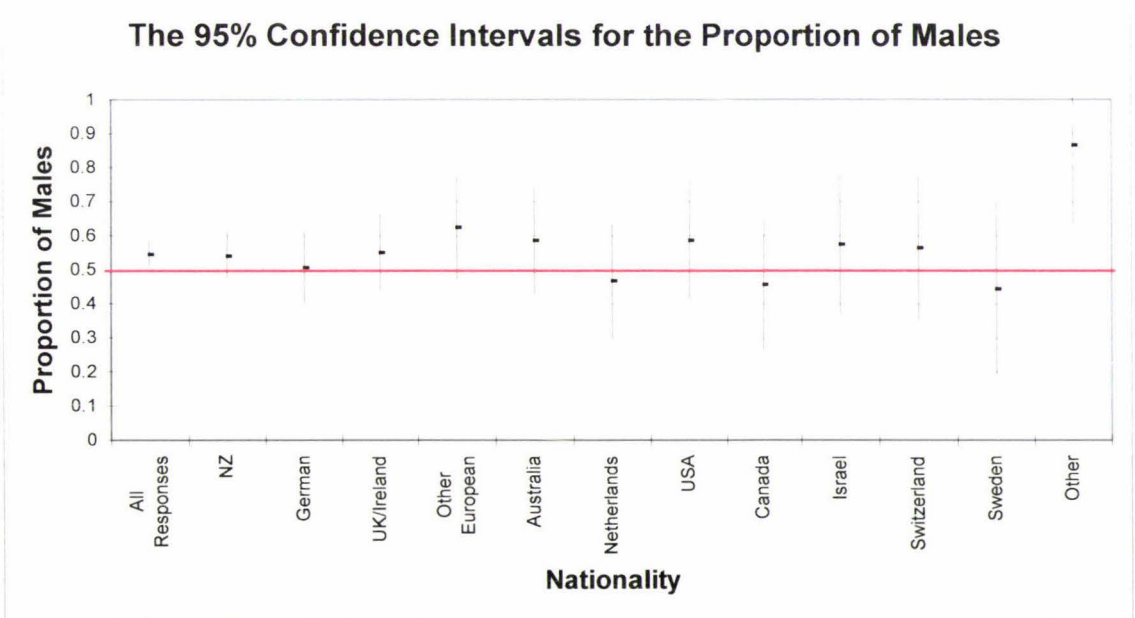


Figure 4-1: *Proportion of males surveyed by nationality, with 95% confidence intervals*

In the Figure 4-1 a nationality group has a significant gender imbalance if the confidence interval does not include 0.5 (50%). The key factor determining the width or length of the interval is sample size: the larger the samples size the smaller the length of the interval. All the nationality groups combined as one group produces a significant gender difference;

however the nationality groups individually do not have a significant gender difference (due to a smaller sample size).

The 'Other' category in the above chart consists of only 15 observations and is made up of those surveys from Japan, Korea, South Africa and the South Pacific. Only two of these surveys were completed by females, producing a significant difference. However due to the small size of the 'Other' sample it is not this which causes 'All Responses' to become significant.

4.5 Age

The two largest age groups are those in their 20s (49%) and 30s (24%). This is true for both New Zealanders—with 52% in their 20s and 30s—and International users—with 82%.

There is a highly significant difference between the age distribution of New Zealanders and the international users *(p=0.000)*. New Zealanders made up only one third of those surveyed yet they were the majority of those surveyed under 20 years of age, and those over 40. This is represented best in Figure 4-2 below:

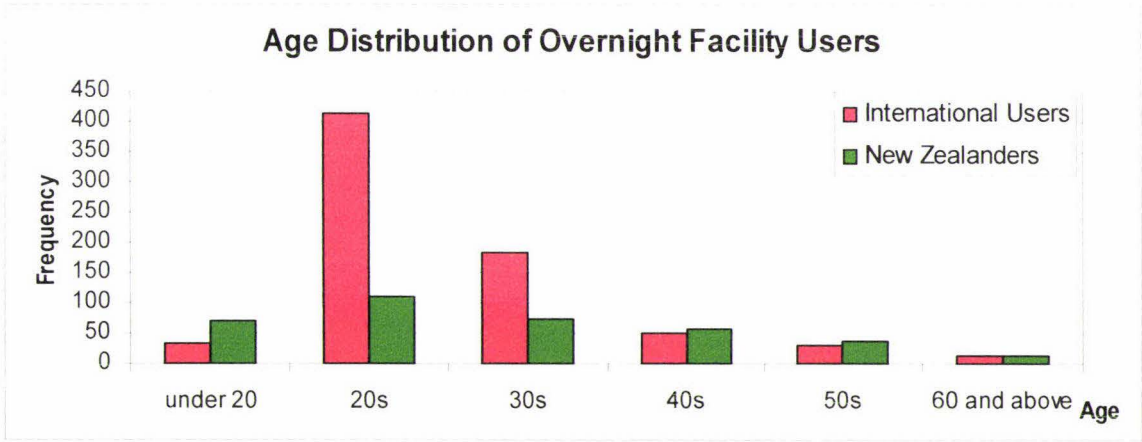


Figure 4-2: *Age distribution of overnight facility users*

4.6 Previous visits to the Tongariro Northern Circuit

Thirteen per cent of all overnight facility users have been on the Tongariro Northern Circuit before. Again there is a highly significant difference between the proportions when comparing New Zealanders returning to Tongariro Northern Circuit (29%) with international users returning (5%) *(p=0.000)*. This is to be expected due to the relative accessibility of the TNC for those living in NZ relative to those living overseas.

If thirteen per cent of all overnight facility users have been on the Tongariro Northern Circuit before then 87% are staying for their first time. This 87% is comprised of 71% of all New Zealanders and 95% of all international visitors.

4.7 Previous overnight tramping experience

When comparing the New Zealand users' previous overnight tramping experience with that of their international counterparts, the differences borders on being significant *(p=0.063)*. Some international users found the question ambiguous (see Questionnaire, Appendix A) and qualified their answer, and if this is taken into account the real difference is probably not significant at all. The confusion is discussed below:

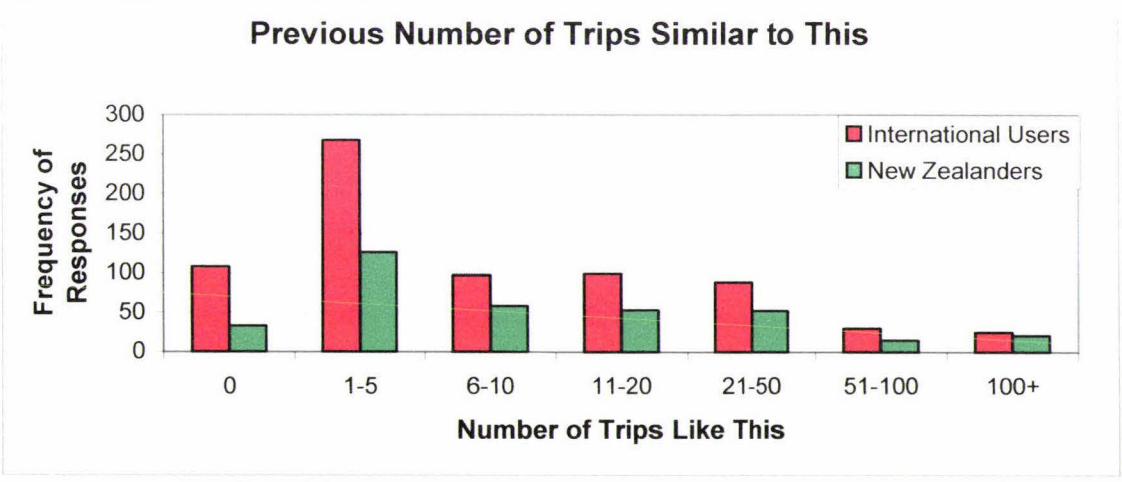


Figure 4-3: *Previous completed trips similar to this one*

There are two sources of confusion inherent in this question. When comparing the responses of international users with those of New Zealanders the following needs to be taken into account:

- Firstly, many nations do not have the same type of recreational opportunities in their own countries as are available on the Tongariro Northern Circuit and elsewhere within New Zealand. Therefore some international users may have interpreted the question as referring to staying overnight in a public facility in the backcountry within a National Park

- Secondly many international users qualified their answer by adding 'in NZ' on the survey form. Some of these users may have acknowledged the confusion in (i), or have interpreted the question as relating to their New Zealand experience only.

An international user with extensive backcountry tenting experience may respond as having little previous experience due to this confusion.

4.8 Perceptions of crowding

Analysis of the crowding question reveals a highly significant difference between the New Zealand user responses and the International users *(p=0.000)*. Figure 4-4 indicates that there are a higher proportion of extreme responses from New Zealanders, particularly towards the 'Extremely crowded' end. This may be a result of the higher use on weekends by New Zealanders, and thus their experience of the more crowded facilities.

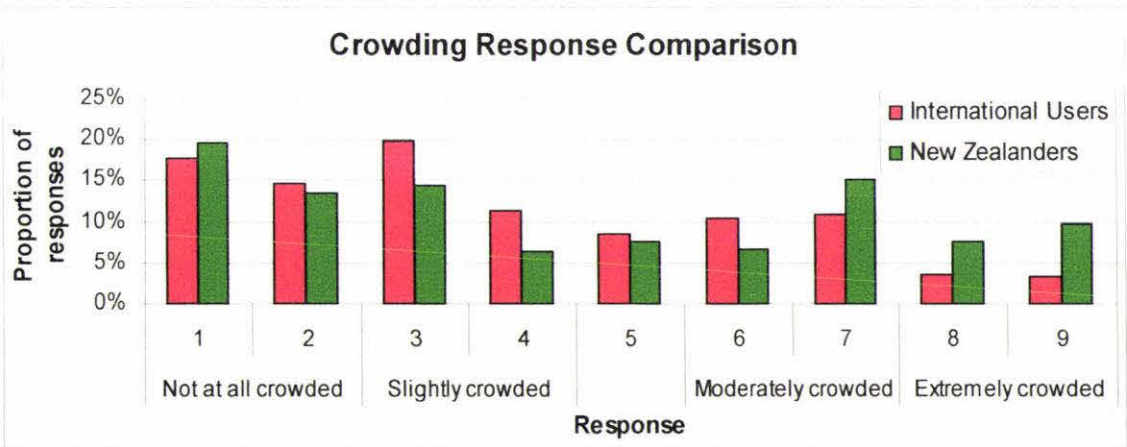


Figure 4-4: *Experience of crowding*

When comparing responses of those completing the *Crossing* to those completing the *Circuit* (defined in Chapter 5) the differences again are highly significant *(p=0.000)*. Overnight facility users completing the *Crossing* have the greater proportion of their responses at the extremes, and particularly those representing higher levels of crowding.

Over one third (34%) of those completing the *Crossing* gave a '7' or more compared with 17% of those on the *Circuit*.

Ten per cent of those surveyed gave multiple responses to this question, clearly distinguishing between their experiences of crowding on difference sections of the track, or between hut and track congestion. *Circuit* goers tended to comment that the tracks and facilities on the *Crossing* were busier than the rest [Eastern and Southern Ngauruhoe *Circuit* tracks and facilities], while those completing the *Crossing* commented that the huts were more crowded than the tracks.

Seventy per cent of those surveyed indicated experiencing some form of crowding (grouping the responses '3' or more). Using the summary of accumulated results by Shelby *et al.* (1989) their judgement is that:

> "Studies and management are necessary to preserve recreation experiences, especially if low visitor impacts (social/physical) are important components. Immediate management to control use levels at around 65% level of crowding conditions may be considered as an option. Research may be needed to establish more long-term solutions." (sited Cessford page 55.)

The problems of crowding and hut congestion are discussed in greater detail later in Chapter 11.

Responses to the question asking if they expected to see more, the same number, or less people on their trip also resulted in a significant difference between New Zealand users and international users *($p=0.011$)*. Responses from New Zealanders tended to indicate that they expected to see less people than their international counterparts:

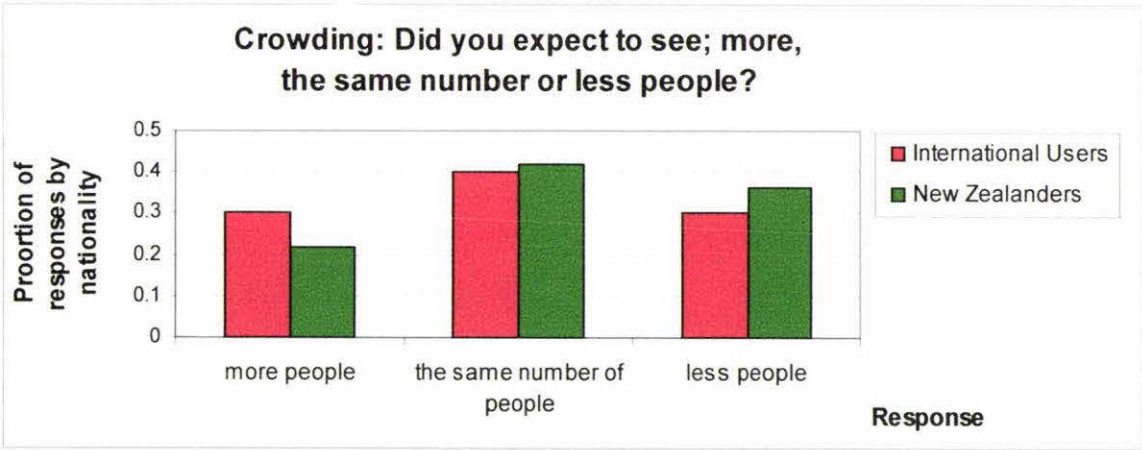


Figure 4-5: *Trip expectations regarding the number of people seen*

4.9 Trip expectations

Approximately 5% of those surveyed indicated that they did not have any preconceived ideas or expectations for their trip and did not answer this question. By far the majority (88%) of those answering this question reported that the trip was at least as good as expected:

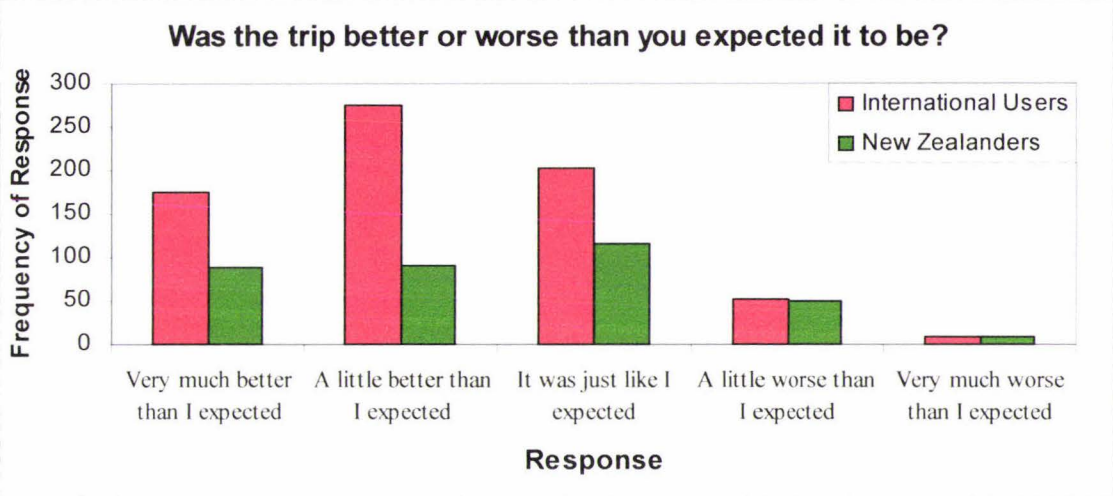


Figure 4-6: *Trip expectations*

Again the New Zealanders' responses are significantly different to those of the international users *(p=0.003)*, with a higher proportion of New Zealanders indicating their trip was worse than expected. One might conjecture that New Zealanders have more realistic expectations for their trip with a greater proportion returning to the area than their international counterparts do, as their responses are more normally distributed. However most of those responding "Very much worse than expected" qualified their answers stating such things as "due to the weather". This casts doubt on whether the question is actually obtaining the type of information being requested.

4.10 Group/party size

International overnight facility users tend to travel in pairs (49%) or as individuals (19%). New Zealanders on the other hand predominantly travel in larger groups consisting of three or more (62%). However the single most popular NZ group size is also two (31%). These differences are highly significant *(p=0.000)*. The mean group sizes for International overnight facility users is 2.8 and New Zealanders is 4.2, and the medians are 2 and 4 respectively.

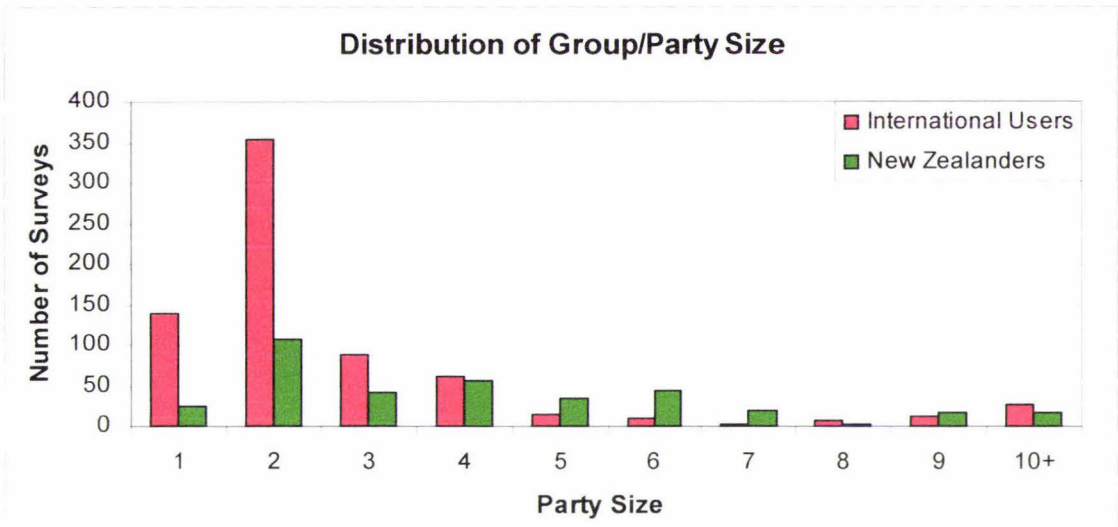


Figure 4-7: *Comparing the distribution of group/party sizes*

4.11 Summary

Compared with each other New Zealand users and their international counterparts responded quite differently to most survey questions. Overall New Zealanders display a more even age distribution, so their average age is higher, they stay fewer nights, travel in larger parties, experience greater crowding and expect to see fewer people. Greater proportions of New Zealanders have been on the Tongariro Northern Circuit before and consider their trip to be worse than expected.

Chapter 5

Where the Overnight Facility Users Go and Where They Stay in the Tongariro Northern Circuit

5.1 Introduction

This chapter describes the overall movement or flow of overnight facility users within the Tongariro Northern Circuit (Section 5-2). There is a wide variety of trip options and these are grouped into popular routes. The routes are described and the relative popularity of different trip options given (Section 5-4). The preference of New Zealanders for travel within the Tongariro Northern Circuit differs significantly from the preference of international users. These are identified and discussed (Section 5-5).

5.2 The overall picture of movement within the TNC

The map in Figure 5-1 indicates the overall movement or flow of overnight facility users surveyed during the 2000/1 summer season on the Tongariro Northern Circuit. It shows that the track section of highest use by overnight facility users runs between Ketetahi Hut and the Emerald Lakes. The higher use is caused by 28% of the overnight facility users doubling back over this section of track after spending the night at the Ketetahi facilities. The next most highly used track is in the Mangatepopo Valley, and following that are the main *Circuit* tracks on the southern and eastern sides of Mt Ngauruhoe.

The percentage figures can be viewed as per hundred overnight facility users entering the Tongariro Northern Circuit. One point, the Emerald Lakes has a throughput of over 100% (117%), due primarily to those completing the *Circuit* staying at Ketetahi. This group of users essentially gets counted twice as they approach this point from different directions.

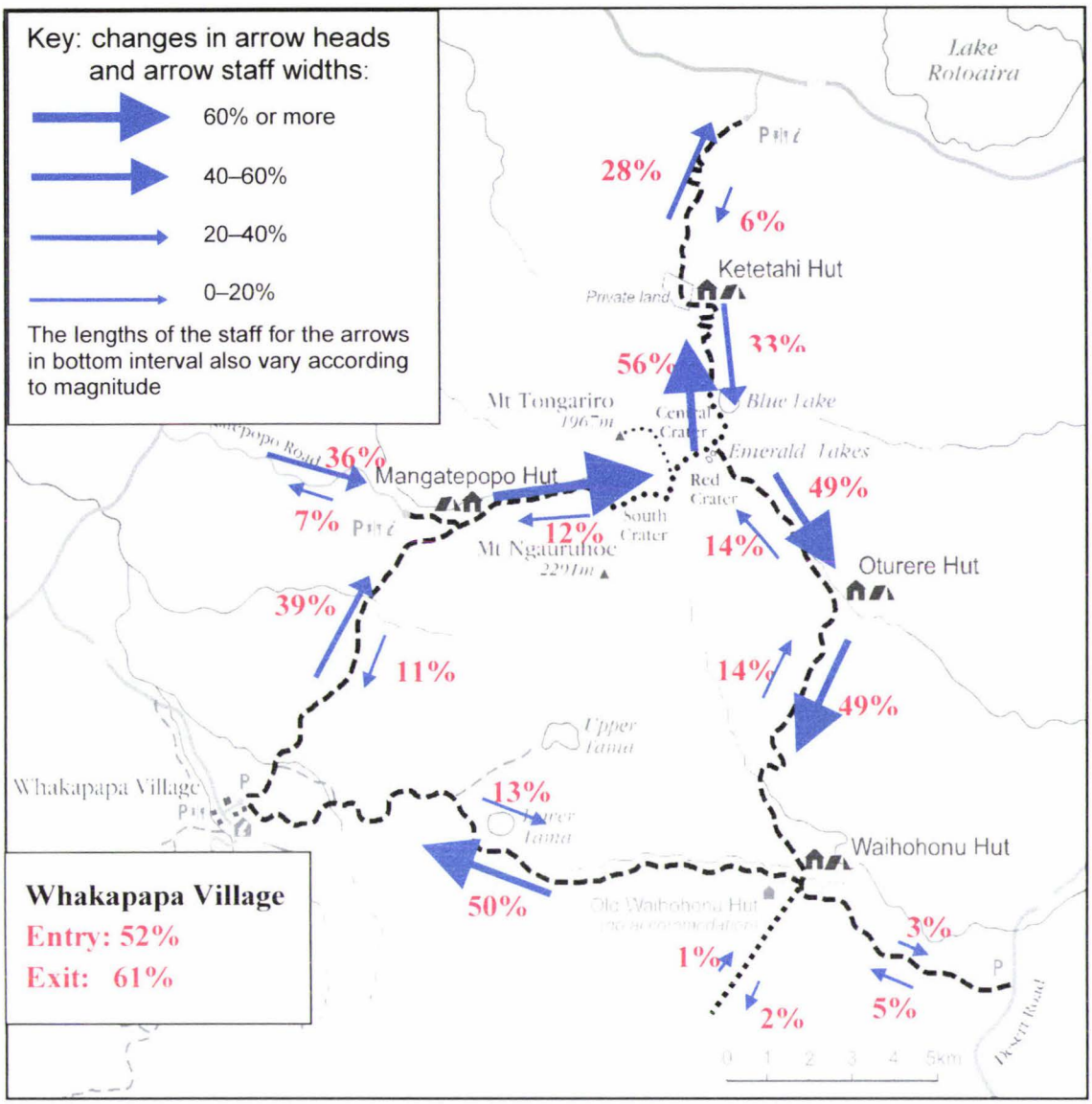


Figure 5-1: *The 2000/1 summer season flow of overnight facility users within the Tongariro Northern Circuit*

5.3 The diversity of trip options

The 1,090 surveys contained approximately 100 different trips, and an increase in sample size is likely to produce an even greater diversity of trips. With five entry/exit points and four overnight facilities there are in excess of 400 possible trips without allowing for the possibility of a party staying more than one night at any given facility.

It is helpful to define the use of the following terms to aid with the subsequent discussion:

- A **trip** is where a person or group/party walked and stayed. It consists of their entry and exit points, the tracks they followed, their direction of travel where appropriate, and the specific hut or combination of huts used.

- A **trip pattern** refers to general groupings of similar trips following a given route. Trip patterns may vary with direction of travel, length of trip and/or combinations of huts used.

- **Route**: a combination of track sections used, or trip characteristics, that aids in classifying trips. Routes typically have a significant component in common. The route is non-directional by definition, so groups various trips and trip patterns.

5.4 Main trip groupings

To simplify the analysis and gain a picture of the movement of overnight facility users within the Circuit, it is helpful to group the trips that have similar/significant elements in common. Most of the trip groupings follow routes like the *Crossing* and the *Circuit*, however, with the diversity of the less popular trips without a significant number of track sections in common, other trip characteristics have been useful such as 'One-Hut Return', or 'Desert Road Entry/Exit' and Around Ruapehu Entry/Exit (those entering or exiting via the round the mountain [RTM] track).

Table 5-1: *The popularity of different overnight routes on the Tongariro Northern Circuit*

	Surveys		Bed nights	
Route	Numbers	Per cent	Numbers	Per cent
Circuit	567	53%	1330	64%
Crossing	268	25%	370	18%
One hut return	109	10%	154	7%
Desert Road entry/exit	58	5%	91	4%
Back crossing	34	3%	74	4%
Around Ruapehu entry/exit	33	3%	50	2%
Other	10	1%	21	1%

The Table 5-1 indicates that over half of all Tongariro Northern Circuit overnight facility users are completing the *Circuit* and one quarter are completing the *Crossing*. Short and long options occur in these two most popular routes. The long options include the section of track between the Mangatepopo Valley and the Whakapapa Village, often referred to as the *Ditch* by DoC Management. Both routes also have two direction-of-travel options.

A description of the route classifications and a breakdown of the primary trip patterns and trips follow.

The Ngauruhoe Circuit alias the Circuit

The *Circuit* is made up of all the tracks around the base of Mt Ngauruhoe (Figure 5-2). Almost all those completing the *Circuit* either start and/or finish at the Whakapapa Village so there are four main trip patterns based on the direction of travel (clockwise or anti-clockwise) and the length, either short or long depending on whether the *Ditch* is included.

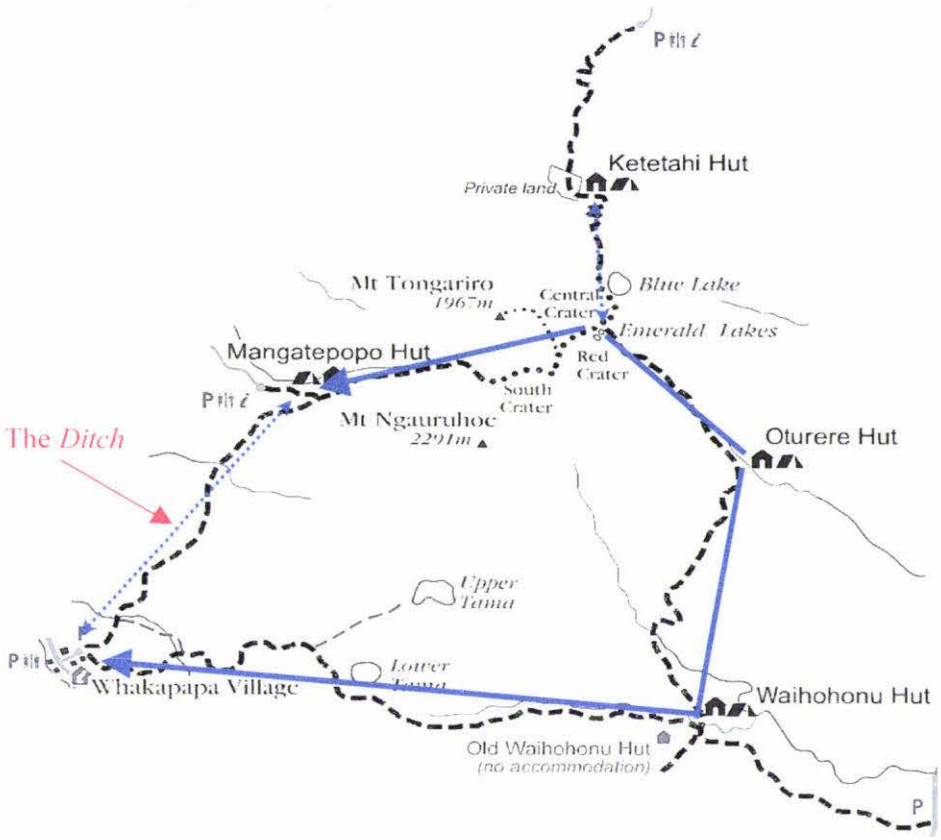


Figure 5-2: *The Circuit*

When including the overnight facilities used by those completing the *Circuit*, 32 trips were recorded by those surveyed. The frequencies of these trips are listed in Table 5-2.

Walking clockwise around the *Circuit* was the most popular direction of travel (87%), and the *Long Circuit* (59%), including the *Ditch*, was preferred. The single most popular trip of all surveyed was the two-night clockwise *Short Circuit*, staying at Ketetahi and Waihohonu. This single trip was completed by 9.8% of all those surveyed and 20% of those completing the *Circuit*.

Table 5-2: *The popularity of different Circuit options*

Direction and Length	Overnight Facilities Used													Total	Per cent of *Circuit* users
	KW	MKW	MOW	OW	MW	MO	O	W	MKOW	KOW	MKO	KO	MK		
Clockwise-Long	30	72	74	12	23	12	11	4	18		7	2	1	266	47%
Clockwise-Short	106	19	5	53	3		12	17		9		2	2	228	40%
Anticlockwise-Long	11	24	2		10	17	4			1				69	12%
Anticlockwise-Short	2	1										1		4	1%
Total	149	116	81	65	36	29	27	21	18	10	7	5	3	567	

		Freq	Per cent
Number of overnight facilities used	1	48	8%
	2	287	51%
	3	214	38%
	4	18	3%
Total number of *Circuit* surveys		567	

Facility used	Freq	Per cent
Waihohonu (W)	496	87%
Ketetahi (K)	308	54%
Mangatepopo (M)	290	51%
Oturere (O)	242	43%
Total number of *Circuit* surveys	567	

Most of those completing the *Circuit* spent either two or three nights and they tended to use a combination of the Waihohonu, Ketetahi and Mangatepopo overnight facilities. Oturere was the least-used of the facilities on the *Circuit*, however it was still well utilised with 43% of those completing the *Circuit* staying there. The average number of nights spent completing the *Circuit* was 2.4 nights—this is the longest of all routes.

The Tongariro Crossing alias the Crossing

The *Crossing* comprises the tracks between the lower Mangatepopo Valley and the Ketetahi car park (Figure 5-3). This is a popular day walk. There are four main trip patterns according to the direction of travel: either Northerly or Southerly and whether one endpoint is the Mangatepopo car park or the Whakapapa Village/Visitor Centre. Starting or finishing from the Mangatepopo car park is called the *Short Crossing*. The *Crossing*, which includes the *Ditch*—that section of track between the Whakapapa Village/Visitor Centre and Mangatepopo Hut—is called a *Long Crossing*.

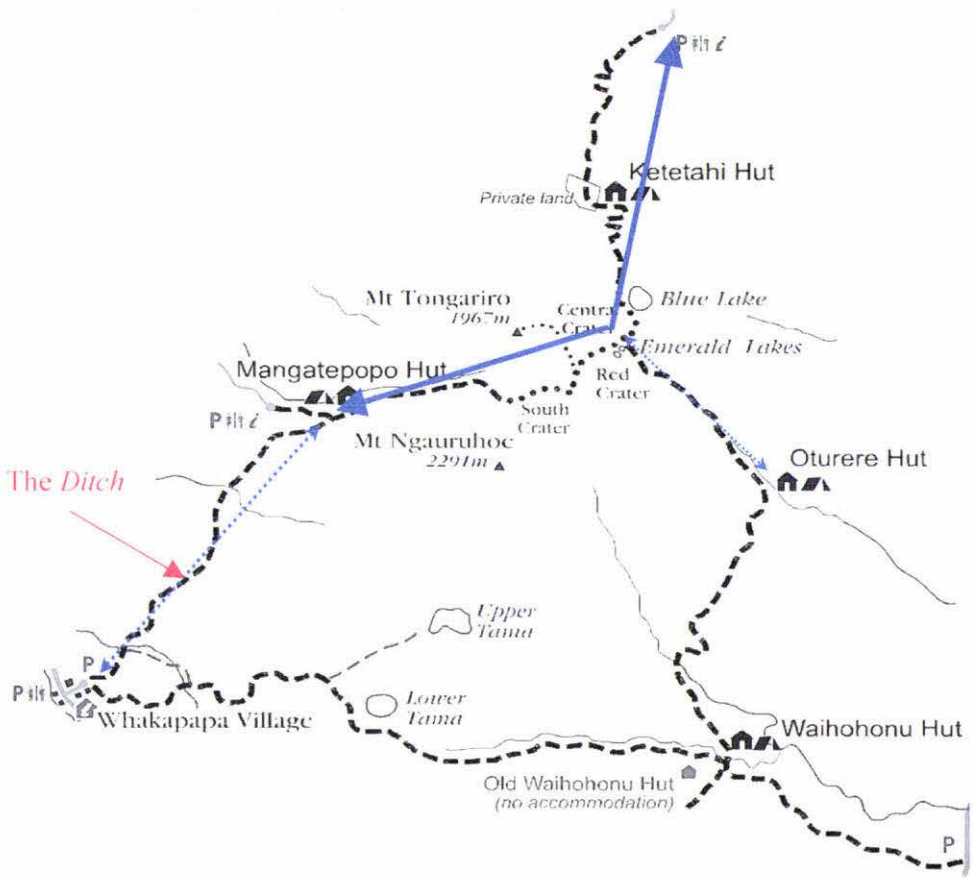


Figure 5-3: *The Crossing*

Of all those completing surveys one quarter (268/1,090) completed the *Crossing*. Of these, 92% were heading in a northerly direction and there was a slight preference for the *Short Crossing* over the *Long Crossing* (53%:47%). The *Short Northerly Crossing*, staying only at Ketetahi, was the second most popular trip making up 9.2% of all surveyed, and accounted for 38% of those completing the *Crossing*.

Ketetahi was used by 82% of those completing the *Crossing* and Mangatepopo by 48%. Most (80%) completing the *Long Crossing* stayed at Mangatepopo.

Table 5-3: *The popularity of different Crossing options*

Direction and Length	Overnight Facilities Used						Total	Percentage of those completing the *Crossing*
	K	MK	M	O	MO	KO		
Northerly-Short	102	20		6		3	131	49%
Northerly-Long	19	64	31	1			115	43%
Southerly-Short	5	4	1		2		12	4%
Southerly-Long	4		5		1		10	4%
Total	130	88	37	7	3	3	268	
Per cent	49%	33%	14%	3%	1%	1%		

		Freq	*Per cent*
Number of overnight facilities used	1	174	65%
	2	94	35%
Total number of *Crossing* surveys		268	

Facility	*Freq*	*Per cent*
Ketetahi (K)	221	82%
Mangatepopo (M)	128	48%
Oturere (O)	13	5%

Most overnight facility users spent only one night completing the *Crossing* (65%). The majority (69%) of those spending two nights were those completing the *Long Crossing*. The mean number of nights for those completing the *Crossing* was 1.35 nights.

One-Hut Return

Of all those completing surveys, 10% completed a *One-Hut Return* trip. This route groups those lesser-used trips where a person or party walks to an overnight facility, stays at least one night and returns the same way. There are four facility sites and most sites are readily accessible from more than one entry point. Eight different trips were recorded in the surveys, with the highest single trip accounting for only 3% of all surveys.

Table 5-4: *The popularity of different One-Hut Return options*

One-Hut Return Trip	Frequency	Percentage of all surveys
Mangatepopo from Whakapapa Village/VC	29	2.7%
Ketetahi from Ketetahi carpark	28	2.6%
Mangatepopo from Mangatepopo carpark	26	2.4%
Waihohonu from Whakapapa Village/VC	16	1.4%
Ketetahi from Mangatepopo carpark	3	0.3%
Oturere from Mangatepopo carpark	3	0.3%
Waihohonu from D. Rd	2	0.2%
Oturere from D. Rd	2	0.2%
Total	109	10%

Mangatepopo (50%) was the most popular destination for those completing a *One-Hut Return*. Ketetahi accounted for 28% of the use in this category with most users arriving from the Ketetahi car park.

The Back Crossing

This route accounted for only 3% of all surveys. The route follows the track around the southern and eastern side of Mt Ngauruhoe running between the Whakapapa Village and the Ketetahi car park. The *Back Crossing* can be completed by walking in either a northerly or southerly direction and five of the seven hut combinations were collected in the surveys.

Table 5-5: *The popularity of different Back Crossing options*

Facilities used	Travelling		Total
	North	South	
KOW	6	3	9
KW	5	4	9
OW	9		9
KO	4		4
O	1	2	3
Total	25	9	34

Relative popularity of facilities used on the Back Crossing		
Site	Use	Per cent users
Mangatepopo	27	79%
Oturere	25	74%
Ketetahi	22	65%

Of those completing the *Back Crossing* 79% spent a night at Waihohonu, with about three quarters (74%) staying at Oturere, and two thirds at Ketetahi.

Desert Road entry/exit

Of all surveys, 5% came from relatively non-standard trips that started and/or finished at the Desert Road. Half of these surveys would appear to be related to a concessionaire who took three groups, two of 10 and one of 11 through during the survey period.

Table 5-6: *The popularity of different Back Crossing options*

Facilities used	Total
O	21
W	15
MO	8
KO	4
MKO	4
MKW	2
MOW	2
OW	2
Total	58

Relative popularity of facilities used on the Back Crossing		
Site	Use	Per cent users
Oturere	42	72%
Waihohonu	21	36%
Mangatepopo	16	28%
Ketetahi	10	17%

Around Ruapehu entry/exit

Three per cent of those surveyed entered or exited the Tongariro Northern Circuit from the *Around Ruapehu* or *Round The Mountain* (RTM) track. Two thirds (22/33) of these stayed only at Waihohonu in completing the *Around Ruapehu* circuit, and one third used a variety of other facilities. The *Around Ruapehu* track is the least-used access point of the Tongariro Northern Circuit.

5.5 Route preferences by nationality

The route preferences of international users differ significantly from those of New Zealanders *(p=0.000)* and this is illustrated in Figure 5-4. The biggest group here is international users completing the *Circuit* which accounts for 42% of all those surveyed. The next most popular group of overnight facility users is international users completing the *Crossing*. New Zealand use follows an almost even three-way split between those completing the *Circuit*, the *Crossing* and the rest.

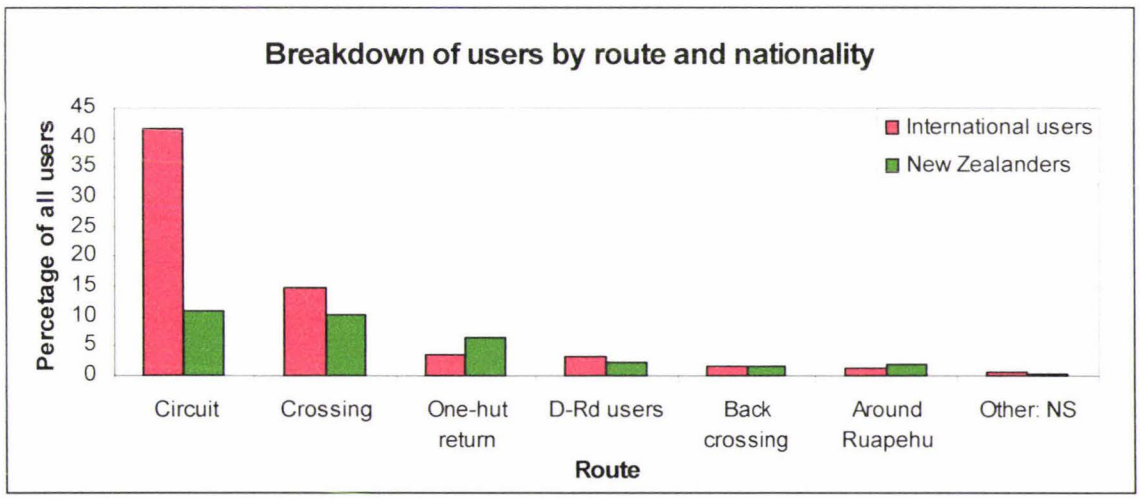


Figure 5-4: *The route preferences of international users compared with those of New Zealanders*

5.6 Summary

Almost two thirds of the total overnight facility use (bed nights) is by those completing the *Circuit* (64%). Even though the circuit users represent just over half of the users, the increased proportion of bed-nights is because the circuit is the longest route, often resulting in users staying another night when compared with other routes. This is reflected in the figures in Table 15-1. Similarly the relative drop for the *Crossing* from 25% of users to 18% of usage is due to the relatively few nights people spend completing it.

Within the Tongariro Northern Circuit, the dominant movement of overnight facility users is up the Mangatepopo Valley as this combines both the northerly direction for the *Crossing* with the clockwise direction for the *Circuit.* These two groups dominate the flow pattern of overnight facility users within the Tongariro Northern Circuit accounting for 78% of the users and 82% of the usage.

6.5 Transportation versus route taken

The charts in Figure 6-4 below demonstrate that the overnight facility users completing the

- ***Circuit*** have a preference to use their own car over the bus/commercial operator services
- ***Crossing*** have a preference to use the bus/commercial operator service as opposed to their own cars
- ***One-Hut Return*** tend to use their own vehicle to arrive at and depart from the Tongariro Northern Circuit.

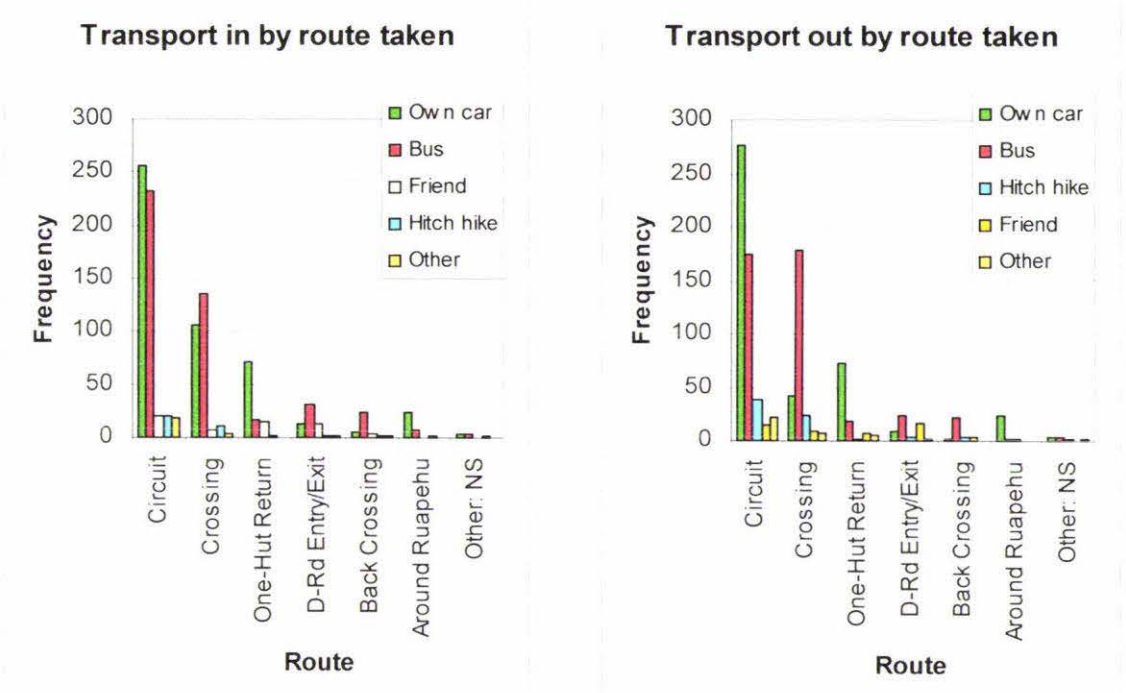


Figure 6-4: *The relationship between transport and route taken*

Chapter 7

The Movement Into and Out of the Tongariro Northern Circuit

7.1 Introduction

This chapter first considers the relationship between entry and exit points (Section 7.2), and then breaks down by access point, both the users' first day movement into the TNC and their final day movement out of the TNC (Sections 7.3–7.6).

7.2 The relationship between the entry and exit points

The access points of the Tongariro Northern Circuit have differing numbers of overnight facility users entering compared with those departing via that point. The crosstab Table 7-1 below shows that less than half (43%) of the overnight facility users enter and exit via the same point. This is largely due to the numbers completing the *Crossing* (25%) and the *Short Circuit* (21%), which have different entry and exit points.

Table 7-1: The relationship between the entry and exit points

		Exit point					
		WVc	KCp	MCp	DRd	RTM	
Entry point	WVc	35%	13%	0%	1%	2%	52%
	MCp	21%	12%	3%			36%
	KCp	2%	3%	1%			6%
	DRd	1%		2%	2%		5%
	RTM	1%					1%
		61%	28%	7%	3%	2%	100%

Key:		
	WVc	Whakapapa Visitor Centre
	MCp	Managatepopo Carpark
	KCp	Ketetahi Carpark
	DRd	Desert Road
	RTM	Round The Mountain track (around Mt Ruapehu)

Table 7-2 gives the breakdown of entry and exit points by the route taken. The main contributors to those entering and exiting via the same point are those completing the *Circuit* who start from the Whakapapa Visitor Centre (31%) and *One-hut return* (10%).

Table 7-2: The relationship between the route taken and the entry/exit points

Route	Entry Points					
	WVc	MCp	KCp	DRd	RTM	
Circuit	31%	21%	0%			53%
Crossing	11%	12%	2%			25%
One-hut return	4%	3%	3%			10%
D-Rd users	1%		0%	4%		5%
All others	4%		1%		1%	7%
	52%	36%	6%	5%	1%	100%

Route	Exit Points					
	WVc	KCp	MCp	DRd	RTM	
Circuit	52%	0%	0%			53%
Crossing	1%	23%	1%			25%
One-hut return	4%	3%	3%			10%
D-Rd users	1%		2%	2%		5%
All others	2%	2%			2%	7%
	61%	28%	7%	3%	2%	100%

7.3 Whakapapa village/visitor centre

Whakapapa is the single most popular entry and exit point for the Tongariro Northern Circuit overnight facility users. This access point accounts for over half (52%) of the overnight facility users entering the Tongariro Northern Circuit and over three fifths (61%) of those departing. The dominant direction into and out of the TNC at Whakapapa follows the clockwise movement around the *Circuit*.

For those entering from Whakapapa, 79% walk the *Ditch*, and almost 80% of these stay their first night at Mangatepopo. For the 21% entering via the *Tama Saddle*, 95% spend their first night at Waihohonu.

Table 7-3: Breakdown of those entering via Whakapapa Visitor Centre

Entering TNC: Destination	Percentage of all overnight facility users	Percentage of those entering using this point
WVc-M	32%	61%
WVc-W	10%	20%
WVc-O	5%	9%
WVc-K	5%	9%
	52%	100%

Route	Per cent of all overnight facility users	Percentage of those entering using this point
Circuit	31%	61%
Crossing	11%	21%
One-hut return	4%	8%
D-Rd users	1%	2%
All others	5%	8%
	52%	100%

Of those leaving the Tongariro Northern Circuit through Whakapapa (Table 7-4), 82% came out via the Tama Saddle, and 74% came directly from a night at Waihohonu. Those completing the *Circuit* made up 86% of those exiting via Whakapapa.

Table 7-4: Breakdown of those exiting via Whakapapa Visitor Centre

Leaving TNC from	Percentage of all overnight facility users	Percentage of those leaving using this point
W-WVc	45%	74%
M-WVc	9%	14%
O-WVc	5%	8%
K-WVc	2%	4%
	61%	100%

Route	Per cent of all overnight facility users	Percentage of those leaving using this point
Circuit	52%	86%
Crossing	1%	2%
One-hut return	4%	7%
D-Rd users	1%	2%
All others	2%	3%
	61%	100%

7.4 Mangatepopo car park

Mangatepopo is the second most popular entry point for overnight facility users on the Tongariro Northern Circuit, accounting for over one third (36%) of all entries, but less than one fourteenth (7%) exit this way. Over 80% of the overnight facility users entering from the Mangatepopo car park head over Red Crater to another facility the same day. The majority of these are heading to Ketetahi for their first night.

Table 7-5: Breakdown of those entering at Mangatepopo car park

Entering TNC: Destination	Percentage of all overnight facility users	Percentage of those entering using this point
MCp-K	21%	56%
MCp-O	7%	20%
MCp-M	7%	19%
MCp-W	2%	4%
	36%	100%

Route	Per cent of all overnight facility users	Percentage of those entering using this point
Circuit	21%	58%
Crossing	12%	33%
One-hut return	3%	8%
D-Rd users	0%	0%
All others	0%	1%
	36%	100%

For the relatively small number exiting via the Mangatepopo car park approximately half are *One-hut return* users (Table 7-4), exiting the way they entered after using only the Mangatepopo overnight facilities.

Table 7-4: Breakdown of those exiting from Mangatepopo car park

Leaving TNC from	Percentage of all overnight facility users	Percentage of those leaving using this point
M-MCp	4%	62%
O-MCp	1%	20%
K-MCp	1%	18%
	7%	100%

Route	Per cent of all overnight facility users	Percentage of those leaving using this point
Circuit	0.5%	6%
Crossing	1%	17%
One-hut return	3%	48%
D-Rd users	2%	28%
All others	0.5%	4%
	7%	100%

7.5 Ketetahi car park

Ketetahi is the second most popular exit point with over a quarter (28%) of all overnight facility users exiting this way. Only about one in sixteen (6%) overnight facility users enter this way.

Most (78%) of the small number of overnight facility users entering the Tongariro Northern Circuit via the Ketetahi car park spend their first night at the Ketetahi overnight facilities. Over half of these are *One-hut return* users, using only the Ketetahi overnight facilities and exiting via the Ketetahi car park.

Table 7-6: *Breakdown of those entering at Ketetahi car park*

Entering TNC: Destination	Percentage of all overnight facility users	Percentage of those entering using this point
KCp-K	4%	78%
KCp-O	1%	11%
KCp-M	1%	10%
KCp-W	0%	2%
	6%	100%

Route	Per cent of all overnight facility users	Percentage of those entering using this point
Crossing	2%	35%
One-hut return	3%	44%
Back crossing	1%	15%
All others	1%	6%
	6%	100%

The majority of the overnight facility users exiting via the Ketetahi car park have spent their final night at Ketetahi (83%). Eighty per cent of overnight users exiting at Ketetahi car park completed the *Crossing*.

Table 7-7: *Breakdown of those exiting from Ketetahi car park*

Leaving TNC from	Percentage of all overnight facility users	Percentage of those leaving using this point
K-KCp	4%	83%
M-KCp	1%	11%
O-KCp	1%	6%
	7%	100%

Route	Per cent of all overnight facility users	Percentage of those leaving using this point
Crossing	23%	80%
One-hut return	3%	9%
Back crossing	2	8%
All others	0%	3%
	28%	100%

7.6 Desert Road and 'Round the Mountain' track

The Desert Road (DRd) and the Round the Mountain Track (RTM) entry/exit points both have relatively low use and the routes using these access points fall into their own low use category. These are *Desert Road* users and *Around Ruapehu*/Round the Mountain users respectively.

The use of these access points is low when compared with the others and both have obtained small sample sizes. The small sample may be cause concern if trying to interpret too much from the data, however almost all (99%) of the entry destinations and exit departure points are either Waihohonu or Oturere. This is to be expected.

Table 7-8: *Breakdown of the use of the Desert Road and Round the Mountain track access points*

Desert Road Entry	Percentage of all overnight facility users
DRd-O	3.2%
DRd-W	1.6%

Round the Mountain Entry	Per cent of all overnight facility users
RTM-W	1.2%
RTM-K	0.1%

Desert Road Exit	Percentage of all overnight facility users
O-DRd	1.5%
W-DRd	1.0%

Round the Mountain Exit	Per cent of all overnight facility users
W-RTM	1.6%
O-RTM	0.2%

Chapter 8

The Movement To and From Each Facility Within the TNC

8.1 Mangatepopo overnight users

Of the 1,079 completed surveys containing trip patterns 502 (47%) stayed overnight at this facility. Table 8-1 indicates that over two thirds (68%) of those staying at Mangatepopo arrived via the *Ditch* (the track between Whakapapa and Mangatepopo). Just over one third (35%) of the Mangatepopo occupants are spending their final night on the Tongariro Northern Circuit. Approximately two thirds (65%) are heading towards another overnight facility in the Tongariro Northern Circuit, and two thirds of these spend their next night at Ketetahi.

Table 8-1: Mangatepopo user breakdown of arrival information, departure destinations, and primary routes travelled

Arrived from	Percentage of those using this facility
WVc-M	68%
MCp-M	15%
O-M	7%
K-M	6%
W-M	3%
KCp-M	1%

Went to	Percentage of those using this facility
M-K	42%
M-WVc	19%
M-O	18%
M-MCp	9%
M-KCp	7%
M-W	5%

Route	Percentage of those using this facility
Circuit	58%
Crossing	25%
One-hut return	11%
All others	6%

Percentage New Zealand use
32%

Over half (58%) of the Mangatepopo overnight facility users were completing the *Circuit*, and one quarter were completing the *Crossing*. Approximately half of those completing a *One-Hut Return* trip stayed at Mangatepopo and they make up 11% of Mangatepopo's total use.

8.2 Ketetahi overnight users

Ketetahi was used by 56% (602/1079), and was the most popular hut of those surveyed. Approximately 80% of those staying at Ketetahi arrive via the Mangatepopo Valley the same day. Just over 50% of Ketetahi's overnight users are spending the next night at

another facility within the TNC, and most of these are completing the *Circuit*. Almost half (48%) of Ketetahi overnight users are on their last night in the park with most of these (88%) departing via the Ketetahi car park.

Table 8-2: *Ketetahi user breakdown of arrival information, departure destinations, and primary routes travelled*

Arrived from	Percentage of those using this facility
MCp-K	37%
M-K	35%
WVc-K	8%
KCp-K	8%
W-K	8%
Other	4%

Went to	Percentage of those using this facility
K-KCp	42%
K-W	39%
K-O	7%
K-M	5%
K-WVc	4%
K-MCp	2%

Route	Percentage of those using this facility
Circuit	51%
Crossing	37%
One-hut return	5%
Back xing	4%
All others	4%

Percentage New Zealand use
30%

Ketetahi has the highest (proportional) use of those completing the *Crossing*, and the lowest proportional use for those completing the *Circuit*.

8.3 Oturere overnight users

With just under one third of all overnight facility users surveyed staying the night at Oturere, this is the least popular overnight destination on the TNC. Over half of those staying here overnight came up the Mangatepopo Valley the same day, with approximately equal numbers (a quarter each) coming directly from Mangatepopo Hut and from the Mangatepopo car park. Over half who stay overnight have a short trip to Waihohonu the next day. Almost three quarters of those staying overnight are completing the *Circuit*.

Table 8-3: *Oturere user breakdown of arrival information, departure destinations, and primary routes travelled*

Arrived from	Percentage of those using this facility
M-O	28%
MCp-O	24%
WVc-O	16%
K-O	14%
DRd-O	11%
W-O	7%
Other	3%

Went to	Percentage of those using this facility
O-W	53%
O-WVc	16%
O-M	10%
O-K	6%
O-KCp	5%
O-Drd	5%
O-MCp	4%

Route	Percentage of those using this facility
Circuit	72%
D.Rd entry and/or exit	12%
Back xing	7%
Crossing	4%
All others	4%

Percentage New Zealand use
32%

Oturere has the highest overall and proportional use of those entering and exiting via the Desert Road.

8.4 Waihohonu overnight users

For overnight facility users completing the *Circuit* 87% spend a night at Waihohonu, and they make up 83% of this facility's total use. Approximately three quarters of those staying here have spent at least one night on the TNC already and for 86% of those staying here, it is their final night on the TNC.

Table 8-4: *Waihohonu user breakdown of arrival information, departure destinations, and primary routes travelled*

Arrived from	Percentage of those using this facility
K-W	39%
O-W	30%
WVc-W	19%
M-W	4%
DRd-W	3%
Other	5%

Went to	Percentage of those using this facility
W-WVc	81%
W-K	8%
W-O	4%
W-RTM	3%
W-M	3%
W-Drd	2%

Route	Percentage of those using this facility
Circuit	83%
Around Ruapehu	5%
Back xing	5%
All others	8%

Percentage New Zealand use
29%

Waihohonu came in a close second in terms of overall hut use from those surveyed (596 of the 1,079 surveys or 55%). Due to the long walk between Waihohonu and Whakapapa, it is no surprise that the majority of those completing the *Circuit* spend a night at Waihohonu. Waihohonu also has the highest use of those heading around Mt Ruapehu and this is to be expected, as Waihohonu is the only facility on the *RTM Circuit*.

Part III

When the Overnight Facilities Are Being Used

Chapter 9

The Great Walks Pass Butts

9.1 Introduction

The Great Walks pass butts comprise the first of two datasets that capture the use of the overnight facilities throughout the season on the Tongariro Northern Circuit. Unlike the hut wardens' observations of use (Chapter 10), the Great Walks pass butts need to be processed before the overnight-use information is extracted from the dataset. The data entry and extraction process are covered in section 9.2.

This is the only data set that captures the overnight use for each nationality and it can also give the overnight use for youth as given in Section 9.3. It also records the hut and camp use of the overnight facility users, so it can be, and is, used to break down hut and camp use by nationality (see DoC annual report of Tongariro Northern Circuit).

The stub of the Great Walks Pass (Figure 9-1) collects five fields of interest in this analysis. These are:

- nationality
- entry/start date
- intended number of nights
- adult or youth
- hut/camp pass (green butts for hut passes and orange for camp passes)

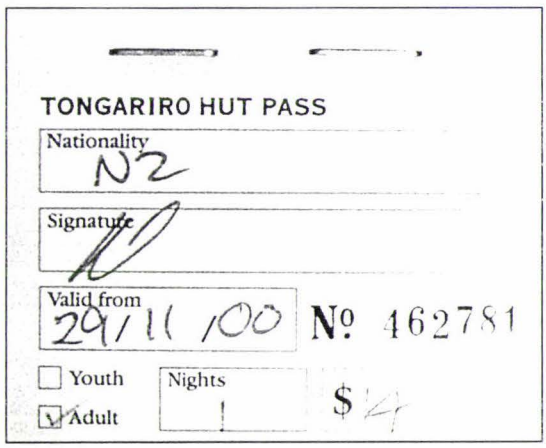


Figure 9-1 The Great Walks pass butt

A sixth field, the pass number, is also recorded for cross referencing/checking purposes.

Two other sources help to improve the accuracy of this information are:

(i) The refunded tickets—these need to be processed to (a) remove those tickets that are returned before the ticket is used, and hence have the original pass removed from the set of users and (b) correct the number of nights stayed by those who leave early.

(ii) Invoices issued by hut wardens to those people who have not pre-purchased tickets and have insufficient funds to pay for lodging on the night. The invoices need to be included as Great Walks passes are not issued.

The accuracy and limitations to this dataset are discussed in Chapter 13.

9.2 Great Walks pass butt entry and processing

Fortunately five of the six original fields of the Great Walks pass butts had been entered into an electronic form in Turangi as the data was used in the annual end-of-season Great Walks report. By obtaining this electronic database the data entry process was cut down to approximately half of the time required for full pass-butt entry. The addition of the date field to the approximately 6,400 pass butt entries and updating the pass butt information with refunds and invoices involved approximately 40 hours of data entry.

Once the all the data had been entered a DBase IV program (Appendix S) was used to extract and tally the individual nightly use. By activating the ***Nationait*** variable in the program it was possible to obtain the breakdowns of use by nationality, as well as hut versus camp use and/or adult versus youth use. The results of the processing are stored in another Dbase IV database file, which was read directly into Excel for further analysis.

9.3 Analysis of Great Walks pass butts

The processing of the Great Walks pass butts allows us to gain a greater understanding of when the facilities are in demand. The total nightly use is illustrated in Figure 9-2. The 7-day average line removes any regular within-week fluctuations and provides a smoother picture of the changing facility use. The seasonal pattern closely follows those from previous years in that there is a steady build up of use prior to Christmas, the use drops to a low on Christmas Day, builds again after Christmas, and tends to remain relatively high until Easter when the highest use of the year is recorded. After Easter, use declines steadily and remains relatively low until the end of the season.

A within-week or weekly pattern is seen clearly in Figure 9-2 (next page) because the majority of the peaks occur on a Saturday:

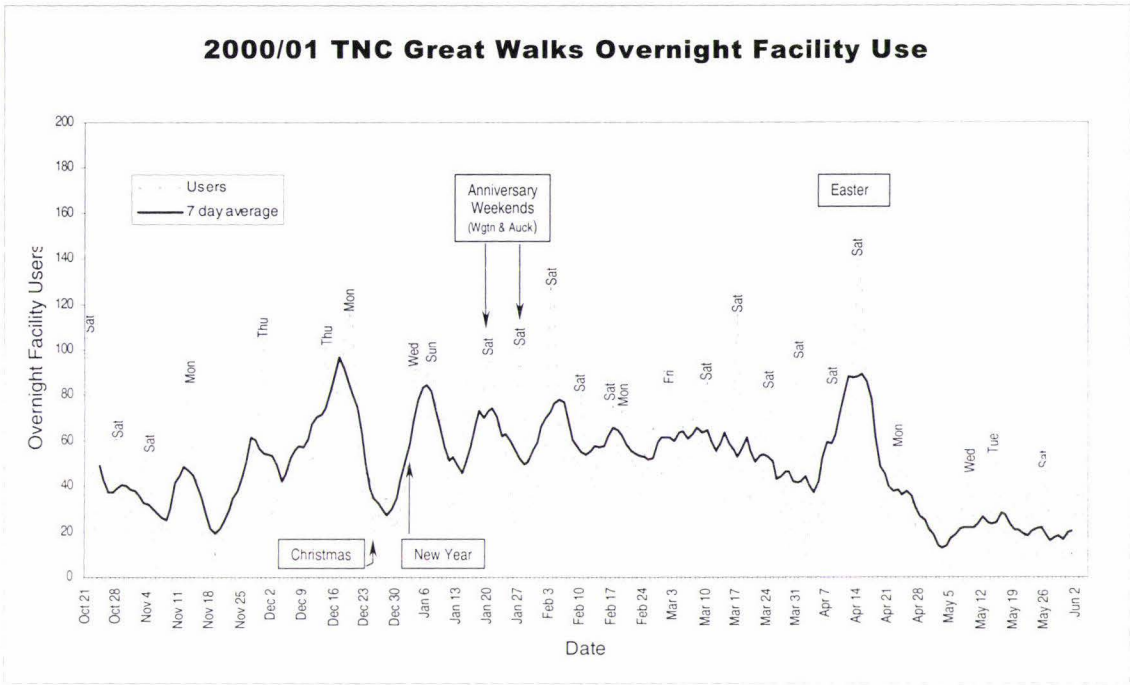


Figure 9-2: *2000/1 summer overnight facility use*

There were two main periods during the last summer season when the combined use was lower than in previous years. The first was between Christmas and the New Year and the second was the Easter break, which historically has a peak of around 200 overnight users. Bad weather during these periods in the 2000/01 summer season is believed to have been the main cause of the reduced use. This is also demonstrated in Figure 12-2 (page 85) when comparing use with seven years ago and in Chapter 15 as models are developed and the influence of weather is estimated.

Initially there appear to be three main factors contributing to the fluctuations in overnight use of the facilities on the Tongariro Northern Circuit. These are:

- the time of year or proximity to holiday periods
- the day of the week, and
- the weather.

The magnitude or influence of these three factors is discussed in more detail in Chapter 15.

On separating the New Zealand overnight facility users from the rest, different overall use patterns emerge. It is interesting to note that generally international users are the main cause of the bulge or basic shape of the general use pattern and New Zealanders cause the spikes,

both at weekly intervals and during main holidays. This is illustrated in both Figure 9-3 and Figure 9-4, comparing international use versus New Zealand use of overnight facilities.

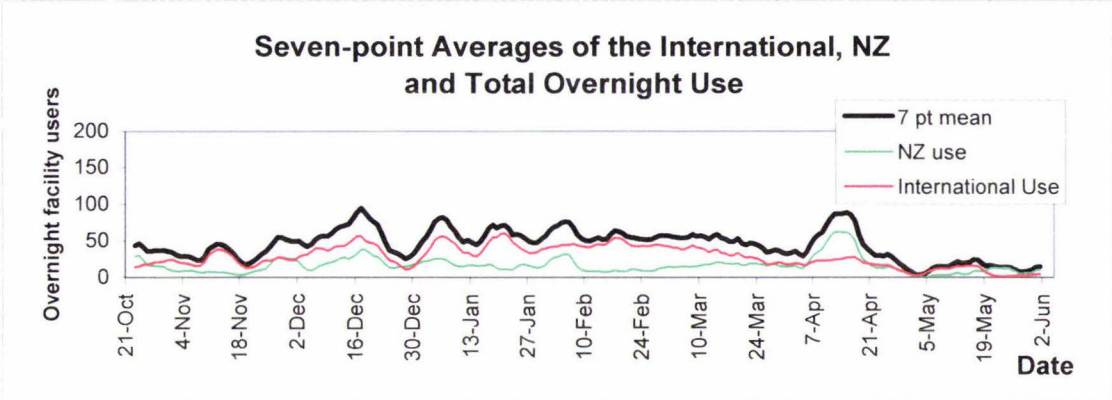


Figure 9-3: *NZ and international use during the 2000/1 summer season*

In Figure 9-3 the number of international overnight facility users exceeds NZ users, throughout most of the summer season. However NZ users are the primary cause of the peak around Easter, and they also contribute to the high use just prior to Christmas and around Waitangi Day. Figure 9-4 below shows that the proportion of New Zealanders on the TNC changes daily. The highly fluctuating nature displays the within-week cycle, and the proportion of New Zealanders, which regularly nears, or exceeds 50%. On closer inspection many of these days with the highest proportion of New Zealanders present on the Tongariro Northern Circuit occur on the weekend, particularly Saturdays.

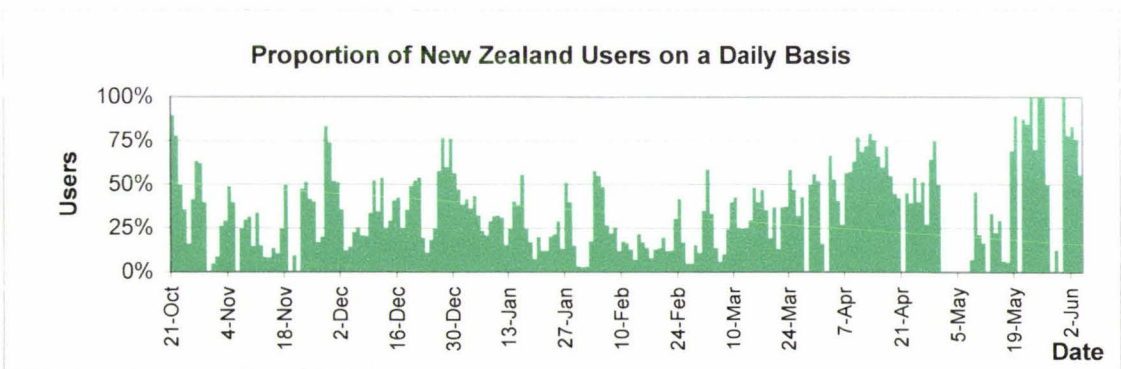


Figure 9-4: *NZ proportional use during the 2000/1 summer season*

Youth use of overnight facilities

The Great Walks pass butts distinguish between adult and youth users. Youth are defined as [High] school-aged children 12 years and older. Children under the age of 12 are missing from the pass butt records as there is no charge for them to use the overnight facilities and they do not require a pass. The use of facilities by children is believed to be less than 1%. *[From personal correspondence with Jimmy Johnson.]*

Over the full season youth make up 7% of the Great Walks passes, and these are almost entirely New Zealanders (96%). The daily youth-use of the facilities follows a different pattern from the adults as illustrated in Figure 9-5 where the youth-use is plotted against the 7–point mean of all users (predominantly adults).

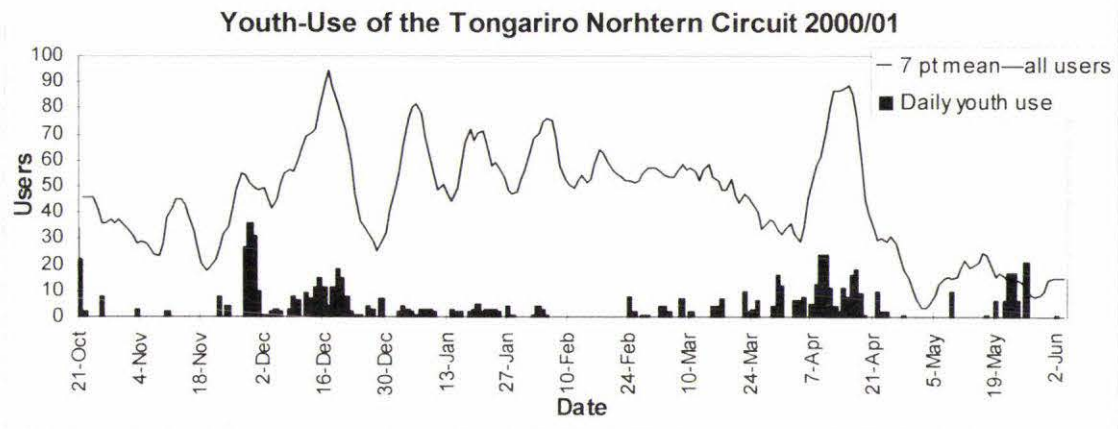


***Figure 9-5**: Youth use of overnight facilities during the 2000/1 summer season*

Most of the youth-use is made up of school and outdoor-guided groups, such as the Outdoor Pursuits Centre groups, which often use the facilities during the week rather than on weekends. The school groups are illustrated well in Figure 9-5 as they tend to be clustered into three main areas:

- the final weeks of the school year and before Christmas
- around Easter
- the closing weeks of the summer season.

Figure 9-5 also shows low youth-use during the summer school holidays where the youth come into the Tongariro Northern Circuit as members of family groups.

The analysis of the Great Walk pass butts indicate that during the summer season, over half of the time (51%) there are no youths using the facilities on the TNC.

9.4 Other Great Walks pass butt information

Without utilising the start-date information on the Great Walks pass butts the two following cross-tab tables, Table 9-1 and Table 9-2, are presented here for completeness and to comment prior to the comparisons made in Chapter 13 with similar information gathered in the 2000/1 summer survey.

The 2000/01 summer season had 5,797 valid, used passes representing 10,178 bed-nights. The nationality breakdown in Table 9-1 shows that New Zealanders make up 40% of passes sold but only 37% of the bed-nights. The 3% drop indicates that New Zealanders tend to have shorter trips than their international counterparts, and this is confirmed in Table 9-2 where it is shown that over half of the New Zealand pass butts were for only one night, thus contributing to New Zealanders having the lowest average trip length.

Table 9-1: *The proportion of Great Walks pass butts collected during the 2000/1 summer season and the associated overnight facility use broken down by nationality*

Nationality	New Zealand	Germany	UK/Ireland	USA	Other European	Netherlands	Israel	Australia	Switzerland	Canada	Sweden	Japan	Other
Passes	40%	13%	10%	7%	7%	5%	4%	4%	4%	3%	2%	1%	1%
Bed-nights	37%	14%	11%	8%	7%	6%	4%	4%	4%	3%	2%	1%	1%

Table 9-2: *The number of Great Walks pass butts issued to the five largest nationality groups broken down by the number of nights they were used for.*

	Length of stay (nights)				Total passes	Average nights
Nationality	**1**	**2**	**3**	**4**		
NZ	1,246	677	345	40	2,308	1.64
Germany	293	311	142	10	756	1.83
UK/Ireland	236	245	111	8	600	1.82
USA	153	162	79	22	416	1.93
Other European	177	138	67	5	387	1.74
The Rest	503	557	254	14	1,328	1.83
Total	2,608	2,090	998	99	5,795	1.76
Per cent of Total	45%	36%	17%	2%		

Chapter 10

Hut Warden Observations of Use

Facility Use Comparisons

10.1 Introduction

The hut wardens' observations of use are recorded as part of the hut wardens' duties: their records are brought out with them at the end of their shift in the Circuit and entered into the computer with related financial information. Unlike the Great Walks pass butts (Chapter 9) these are collected in a form that can readily generate seasonal use charts as in Figure 9-1. The advantages and disadvantages of the data set are discussed in Chapter 13.

These observations of use (Table 10-1) are the only dataset that provides the actual breakdown of what is happening within the TNC. Each night the number of people both in huts and those camping at each facility are recorded. This is also the only data source that includes children under the age of 12.

Table 10-1 *Sample of the hut wardens' observations of use*

	Mangatepopo		Ketetahi		Oturere		Waihohonu		Total
Date	Hut	Camp	Hut	Camp	Hut	Camp	Hut	Camp	
Oct 21	17	2	22	9	24	16	11	5	106
Oct 22	14	10	9	0	15	0	14	6	63
Oct 23	6	0	6	3	2	0	5	0	22
Oct 24	2	1	1	0	4	0	5	0	13

This dataset is currently used to provide information on the relative use of each facility as well as individual camping facility statistics, such as in Table 10-2. The season totals clearly indicate that Waihohonu had the highest use, Oturere the least use and Mangatepopo's use was slightly higher than Ketetahi. However these final figures for the total season's use fail to indicate any fluctuations in use within the season.

Table 10-2: Total of facility use observations from hut wardens

Facility	2000/1 total use nights	Percentage of total use
Mangatepopo	2,697	26%
Ketetahi	2,600	25%
Oturere	2,073	20%
Waihohonu	3,132	30%
Total	10,502	

10.2 The fluctuating nature of individual facility use

The graph below, Figure 10-1, shows the smoothed 7-point average number of overnight facility users for each facility throughout the summer season. The relative popularity of the facilities clearly changes during the season. The use of Waihohonu is regularly higher than the others and Oturere is lower as could be expected. It is interesting to observe that Mangatepopo has the highest use during some of the periods of relatively high New Zealand use, for instance after Christmas and Easter. This would indicate that New Zealanders prefer different facilities; they may have different use patterns to the international users; and/or New Zealand use of facilities changes during the year.

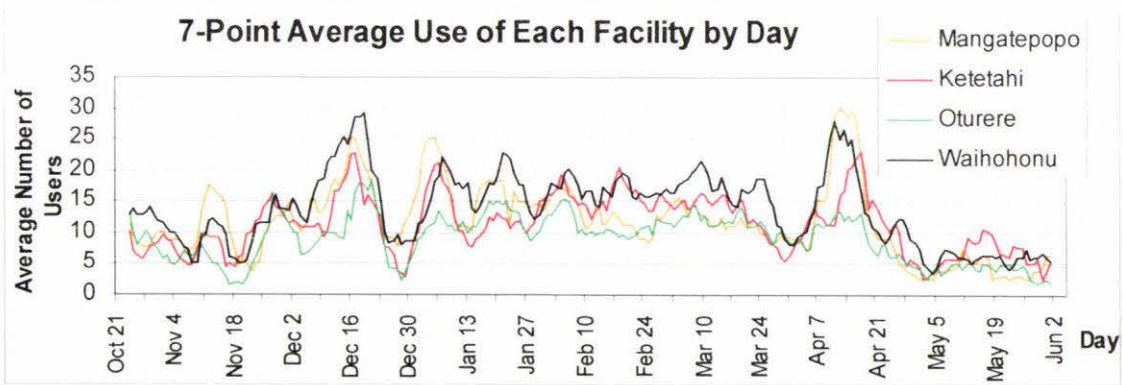


Figure 10-1: The fluctuating nature of individual facility use throughout the season

The graph below, Figure 10-2, shows that the proportional use of facilities fluctuates daily. A relatively regular pattern indicates that there may be a within-week cycle for the use of some facilities and/or groups of people may be moving from one facility to another.

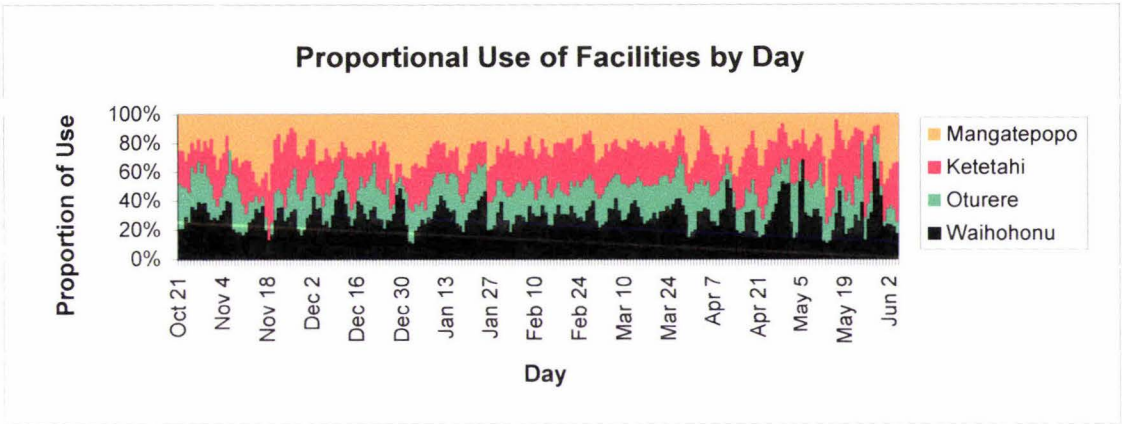


Figure 10-2: *The daily fluctuations in proportional use of overnight facilities*

The charts in Figure 10-3 emphasise the fluctuating nature of the overnight use at each facility. The top line (red) is the maximum-recorded use during the week, and the week is centred around the night of maximum recorded use. The bottom line (green) is the minimum. The difference between the red and the green line represents the change in use during the week (centred on that night). None of the overnight facilities had a regular weekly use cycle as this would have been shown by horizontal lines for the weekly maximum, average and minimum values.

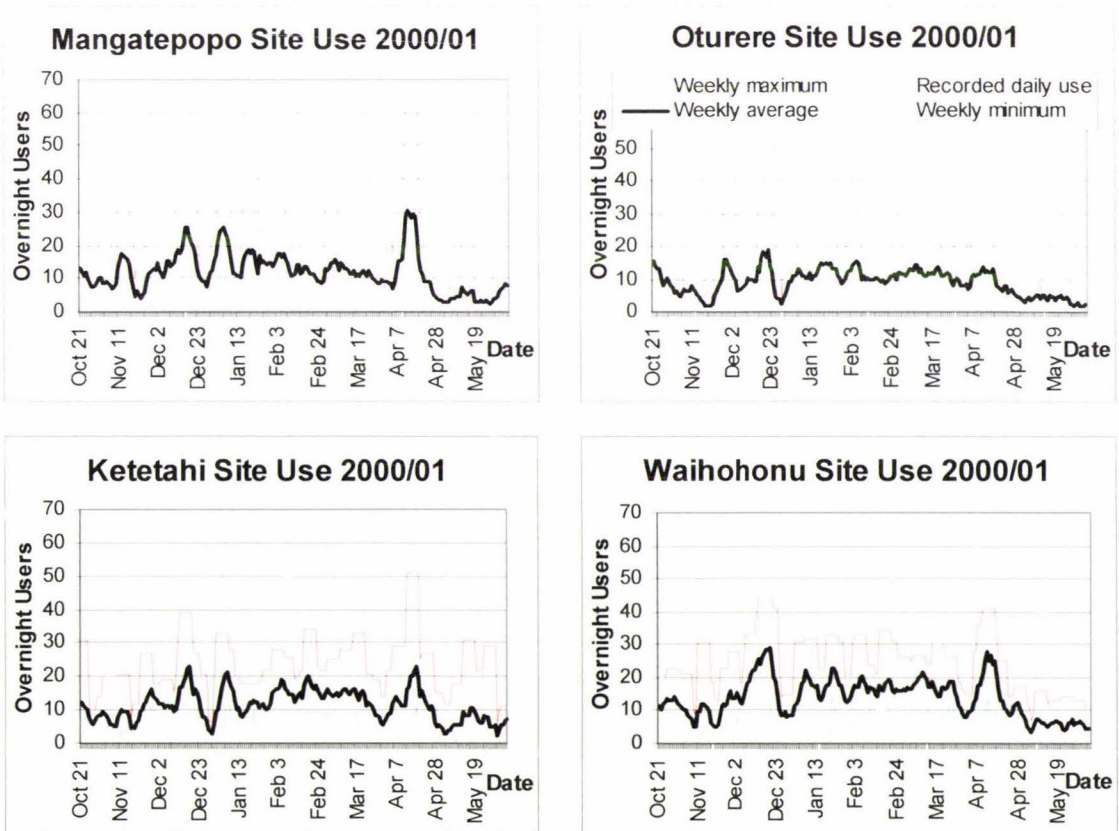


Figure 10-3: *The within-week fluctuations in use of the overnight facilities*

The charts in Figure 10-3 indicate that:

- Mangatepopo had the highest within-week fluctuation, or average difference between the highest and lowest use. The mean difference was 25 users (median 23).

- Oturere did not have any extreme facility overloading last Easter, in fact through the final two thirds of the season the site did not experience any periods of extreme overloading with the maximum site occupancy of, at most, 30 users.

- Waihohonu had a period of the highest consistent use with over a month where the minimum overnight use did not drop below 10 people on any night.

Using a single average to represent the number of overnight facility users per night at any site overlooks the continual fluctuating nature of site occupancies. The fluctuating nature becomes particularly important when considering crowding or overuse issues, which is discussed in Chapter 11. A single average use at an acceptable level will not give any indication that for instance, a facility has high congestion or crowding levels at least once a week, or on over half of all Saturdays.

Each week during the central summer season each facility site use will fluctuate from a typical low of between 4 and 7 users to a typical high of between 26 and 32 users. Oturere tends to be slightly lower than the figures given and Waihohonu at the higher end. The key point is that all facilities, even Oturere, display within-week fluctuations in use where the peak use that week is typically between 19 and 25 above the minimum use that week. The Table 10-3 contains these typical figures:

Table 10-3: *Fluctuating use figures from mid-summer 2000/1*

	Average Use Values		**Hi and Low Medians**		**Typical Within Week Fluctuations**	
Site	Median	Mean	Weekly low	Weekly high	Difference of medians	Mean of all differences
Mangatepopo	11	14.0	4	27	23	24.8
Ketetahi	12	13.1	4	26	22	22.1
Oturere	9	10.7	2	21	19	19.5
Waihohonu	15	16.5	7	28	21	21.3

In all cases in Table 10-3 the median is below the mean. This is due to the shapes of the site use distributions: they are all skewed with a higher concentration of similar values below

the median and a longer tail above the median. The charts in Figure 10-4 below demonstrate the skewed nature even with all observations above 30 users being grouped into the final interval.

The median is likely to be the best average (or measure of central tendency) as it is not subject to the variations caused by a few extreme high use values, for instance Easter use. Again the average should not be used in isolation, as the distributions below do not show the continual fluctuating use.

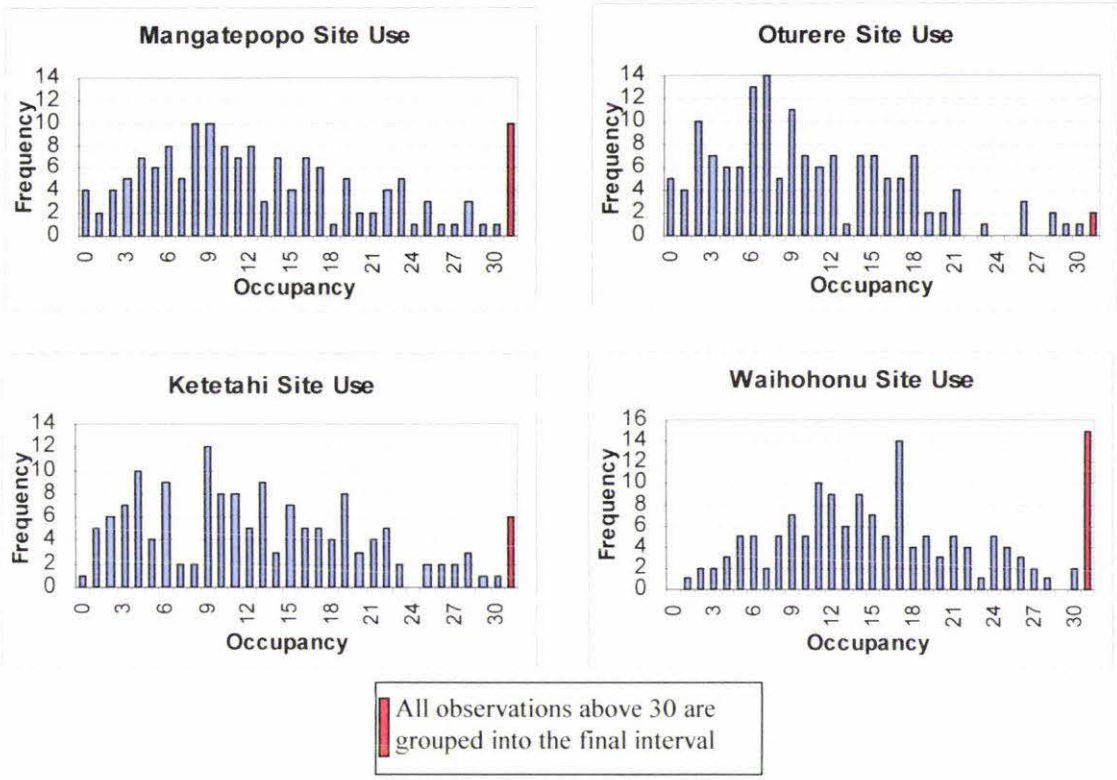


Figure 10-4: *Distribution of Site Use*

10.3 Weekday effects for individual facilities

It is helpful to look at the relative use of each facility on different days of the week to establish the extent of any weekly pattern. The box and whisker graphs below in Figure 10-5 show the distribution of site use during the mid-summer season from 1 December 2000–30 April 2001. The mid summer season has been used due to it being the higher use period of the year. The removal of the shoulder season (with many zero observations) does not reduce the validity of what is under investigation.

It is worth emphasising again that even though the graphs in Figure 10-5 show the distribution within each day, they do not show, or account for, the typical within-week fluctuations of about 20 overnight users at each site. No site indicates a consistent regular within-week cycle meaning that the day of the week alone is insufficient in predicting use. The graphs show large variations on all days of the week at all sites, with no single day taking precedence over others for high or low use.

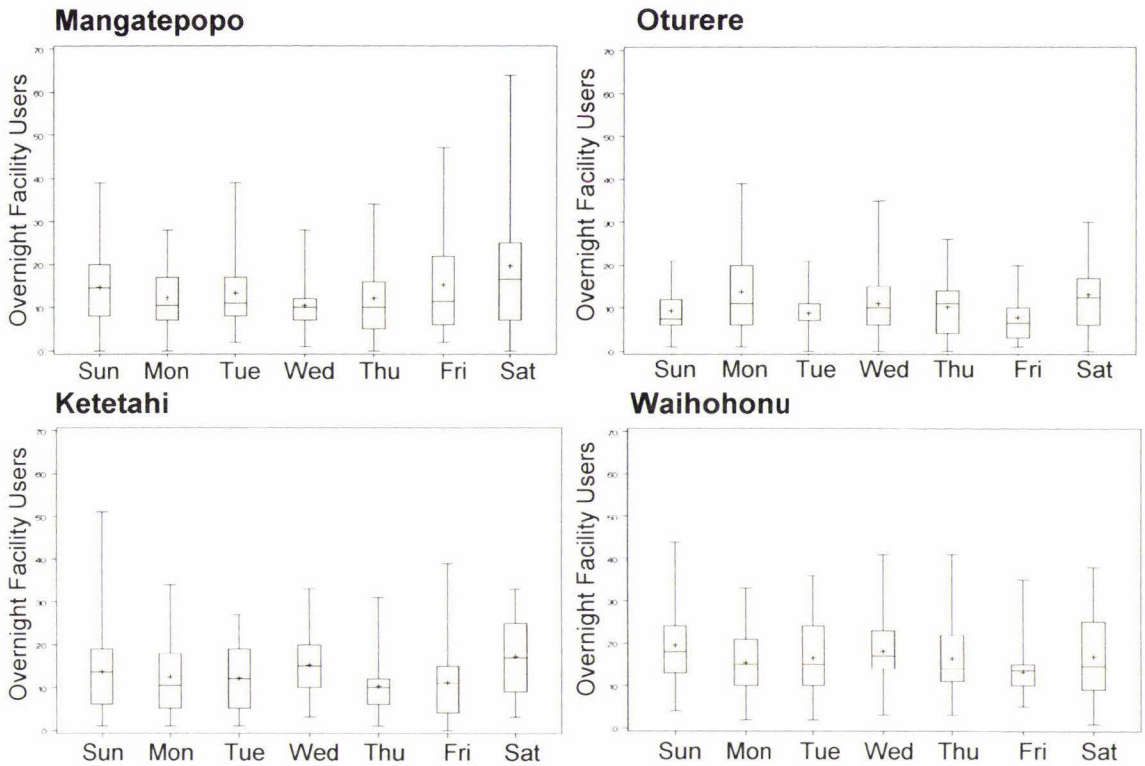


Figure 10-5: *Survey numbers by nationality and length of stay*

With the reservations noted above, the following observations are made about use during the main summer season (1 December 2000–30 April 2001).

- Mangatepopo typically has a low-use day on Wednesday and is high on Saturday. The average variation between these days is approximately 10 users. Overall Mangatepopo displays the greatest variation.

- Ketetahi typically has a low use Thursday and is higher on Saturday. The average variation between these days is approximately eight users.

- Oturere appears to have lower use on Sundays, Tuesdays and especially Fridays, with higher use on Mondays and Saturdays.
- Waihohonu has relatively low use on Fridays, but has the highest overall Sunday use.

- With all individual facility sites, for every day of the week, each weekday experienced both a relatively high and a low (near zero) overnight use. This would indicate that weekday alone is not the primary determinant of individual overnight facility use.

10.4 Individual hut occupancy statistics and the pressure on overnight facilities

The continual fluctuating nature of facility use also means that there is generally a respite during periods of high or extremely high use. This is shown in graphs in Figures 10-3 (page 71). The ideal charts for displaying a summary of use without the fluctuations within a given period are the charts in Figure 10-4 (page 73). When specific hut or total facility occupancy use-levels are set for a specified carrying capacity, tables such as Table 10-4 can be generated as a summary for Management. All of these charts and tables can be set up as templates within *Excel* to provide up-to-date information for Management.

Due to limitations in the design of the facilities (such as limited seating, cooking facilities and general space to move within the huts) on the Tongariro Northern Circuit crowding pressures begin when there are about 12 people present at each site. These crowding impacts are discussed in greater detail in Chapter 11, however it is sufficient to say that it is an area that Management has largely overlooked in the past and little progress has been made to rectify the problem.

Table 10-4: *Levels of crowding impacts*

Use figures from mid season 1 December 2000–30 April 2001									
Site	**Site use**					**Hut use**			
	≥ 12	**≥ 18**	**≥ 24**	**≥ 30**		**≥ 12**	**≥ 18**	**≥ 24**	**≥ 30**
Mangatepopo	50%	26%	14%	7%		34%	17%	9%	3%
Ketetahi	51%	28%	11%	5%		39%	20%	7%	1%
Oturere	38%	17%	6%	2%		33%	8%	4%	-
Waihohonu	69%	36%	21%	11%		50%	22%	9%	1%

Instead of viewing the site-use categories presented in the table as *at least ½ full, at least ¾ full, full to overloaded* and *excessive use*, a scale recognising congestion could be used. For example: *crowding/congestion impacts present, high crowding/congestion impacts, excessive crowding/congestion impacts, and extreme congestion.*

Chapter 11

Crowding and Congestion Issues

11.1 Introduction

The problem of cramped conditions in huts on the TNC has been experienced for well over a decade (personal communication from Neil Small, retired senior Conservation Officer, 9 November 2000) however it remains a relatively contentious issue in DoC. Attempts to work towards defining a threshold carrying capacity for the Tongariro Northern Circuit facilities have largely failed due to three main factors:

- Management has been slow to recognise the problem
- There are no easy or inexpensive solutions, so the problem poses difficulties for Management
- The issue is frequently confused with bunk utilisation and facility overloading. Though bunk utilisation and facility overloading are directly related to the cramped conditions, discussions about available bunks on most nights evade the real issue.

For many without experience, it is inconceivable that a facility is overloaded, or cramped and congested, when there is a bunk or two to spare—hence my change in terminology now, in order to focus on the bottlenecks and congestion areas which have been brought about by the design of the facilities.

This section outlines the problem and presents some current statistics to help establish the degree of the problem and related impacts.

11.2 Background

When the Tongariro Northern Circuit (TNC) huts were built in the late 1960s and early 1970s the present-day demands on the overnight facilities were not predicted. They were not designed to withstand the strain of today's needs.

Over the years, with the steady increase in use, peripheral facilities have been upgraded in an effort to meet the increased demand. These have included the upgrading of:

- The capacity of the water supplies
- The sinks and basins by providing more
- The toilets: in some cases more toilets and in some cases flush toilets
- The type of heating and cooking facilities.

Specific areas for camping for about 20 people have also been developed around the huts. These developments have increased the area's ability to accommodate larger numbers of people, however the steady increase in overnight facility use has put more pressure on the limited hut resources, increasing stress on bottlenecks and congestion areas. This problem needs to be considered both from a physical perspective and a public relations perspective.

In the late 1980s and early 1990s Neil Small, then DoC Senior Conservation Officer responsible for the maintenance and care of the Turangi Field Centre huts, was so concerned about the congestion at Ketetahi Hut during the summer season that he gathered use-data. Unfortunately the data is no longer available as he informed me that it was discarded after his endeavours to have the problems addressed by Management failed. The congestion problems therefore are not new.

11.3 The physical perspective

Most TNC huts have a variety of bunks, equivalent to 24–26 mattresses. Some of the platform bunks can accommodate extra people when required, some huts have spare mattresses under bunks that can be pulled out when the other bunks are full, and most hut wardens' quarters have sleeping mats to provide a few with some padding who would otherwise have to sleep on the floor.

Even though there is sleeping space for 26 or more, the physical space available is not sufficient to comfortably house this number. Hut floor space becomes congested with no storage left for gear, and movement within the hut becomes strictly limited.

The problems include:

(i) **Limited hut floor space and gear storage areas**: When the huts are only half full, most of the remaining bunk space is used for the storage of users' gear. When the huts are more than half full, there are no longer as many bunks available for storage in this way, and the gear needs to be stored on the floor area. This begins to severely

limit movement within the hut. The more bunks being used, the worse the congestion gets. Even if users store packs under bunks, floor space is constantly needed for them to pull out their packs to access their gear.

(ii) **Limited cooking facilities**: During the summer season each hut has only four gas rings to cater for all of the hut and campground users. As there are frequently more than 30, this is clearly inadequate, with groups having to queue to cook their meals.

(iii) **Limited bench space, seating, and table space:** Most huts have only one table and seating for 10 to 14 people. For most facility sites, over half of the time during the main summer season (1 December-30 April) there are more occupants than seated table space allows for, and about 10% of the time there are more than double this number. The table and seating space then, is inadequate.

(iv) **Factors causing further congestion:** *Inclement weather:* Rain can lead to additional pressure on the hut facilities by bringing campers inside to socialise, as well as keeping those users inside who would have otherwise eaten and socialised outside.

Extreme weather: Most of the campsites around the huts are exposed to high winds, and it is not uncommon for campers to be driven to sleep inside under severe conditions. This can lead to excessively cramped huts with little room to move.

On occasions, freedom-camping school parties have been forced to take shelter in the huts as well, making conditions unpleasant.

(v) **Limited clothes' and gear-drying space**: A party of four arriving wet from heavy rain is likely to use the entire clothes drying rack and most of the available coat hooks within the hut. If more people arrive with wet gear, the gear-drying space is immediately inadequate and the increased moisture within the hut becomes a problem in itself, preventing things from drying. Though the veranda areas of most huts possess a number of coat hooks, the area is susceptible to wind-blown rain.

11.4 The public relations' perspective

This section looks beyond the physical discomfort of crowded conditions to the potential for public relations damage.

Management will be concerned about the possibility of tourists being left with unfavourable impressions of facilities and having disappointing experiences. The focus always has been to provide such amenities that the wonderful, outdoor experience of the Tongariro Northern Circuit is not in any way detracted from for any visitor, but the question needs to be asked whether this is being achieved.

In the report *Visitor satisfactions, impact perceptions and attitudes towards management options on the Tongariro Circuit Track* (by Gordon Cessford Nov 1999, based on data obtained during the 1993-4 and 94-5 summer seasons) the nine highest areas of dissatisfaction were as follows:

- Hut lighting (22%)
- Hut cooking and facilities (19%) **
- Hut relaxation space (18%) **
- Drying facilities (14%) **
- Hut washing facilities (14%)
- Hut bunk numbers (14%) **
- Campsite toilets (13%)
- Campsite rain shelters (12%) **
- Hut toilets (12%)

Since the 1993/94 Great Walks Survey most TNC hut sites have had toilet and washing facilities improved. However, the five physical conditions ** continue to be a major issue and no improvements have been made in this area. Yet hut and site usage continue to increase.

The two physical space problems—drying facilities and campsite rain shelter, with dissatisfaction levels of 14% and 12% respectively—are from those experiencing inclement weather while in the Tongariro Northern Circuit. The reason for singling these out is that the NIWA records for the Chateau indicate that there was no rain on at least two thirds of the days during the 1993/4 survey period. Essentially this elevates the proportion of those dissatisfied with *drying facilities* to over 50% of those who experienced rain and dissatisfaction for the *campsite rain shelters* to 170% of those camping who experienced rain. This last percentage of campers has come about because some hut users must have also indicated dissatisfaction with campsite rain shelters, as the lack of outside sheltered space must have impacted on their in-hut experience with campers needing to share their 'dry' hut space in the evenings.

11.5 Crowding levels and booking systems

Related to the issue of congestion in facilities on the Tongariro Northern Circuit is the possibility of using a booking system. It is interesting to note that the Tongariro Northern Circuit was ranked third highest on the crowding levels of the 11 Great Walks surveyed in the 1993/94 summer season. The two Great Walks carrying higher perceptions of crowding (the *Routeburn* and the *Able Tasman*) have since developed and implemented hut booking systems. This would suggest it is time that Management began to consider this option for Tongariro Northern Circuit, or at the very least consider other measures to reduce the congestion.

Though proposals are afoot for the replacement of, or development of, two new 40-bunk facilities on the Tongariro Northern Circuit, the congestion issues brought about by the basic design flaw in the current facilities will not be solved. A threshold carrying-capacity must be determined for the existing facilities, so that Management can ascertain the size of the real problem and begin to develop plans to deal with it.

11.6 Summary

With hardened campsites and huts with 24–26 bunks, an imbalance in sleeping space versus living space has been created. It is physically possible to sleep about 46 people but there is insufficient living space or gear storage space for this number. Hut congestion increases discomfort levels and visitor dissatisfaction. This must be addressed.

Building larger, sheltered areas for overnight facility users to sit, eat and socialise, would alleviate the immediate problem, however, Management will still need to identify a threshold level of use for the facilities. The building of additional facilities for campers does not fit within the current management plan, nor are there funds readily available for such a development, however it must remain a possible option.

Comfort level is paramount in determining a satisfactory level of use. Beyond this comfort level, use becomes overuse and comfortable becomes cramped.

Part IV

Comparisons Between Datasets and Sources of Bias

Chapter 12

How Use Has Changed:
A Comparison with Seven Years Ago

12.1 Introduction

Most of the details captured in the 2000/1 summer survey were also captured during the 1993/4 Great Walks surveying process in the Tongariro Northern Circuit. This chapter compares and discusses the changes in three main areas:

(i) Seasonal use of the overnight facilities—12.2

(ii) The flow of overnight facility users within the Tongariro Northern Circuit and their use of facilities—12.3

(iii) The characteristics of user groups—12.4.

12.2 Changes in the seasonal use of the overnight facilities

The following two graphs show the combined facility use pattern for the 1993/4 summer season and the 2000/1 summer season. The first graph shows the high daily fluctuations, the second is the 7-point smoothed moving average of the same data allowing a clearer picture by removing the within-week fluctuations.

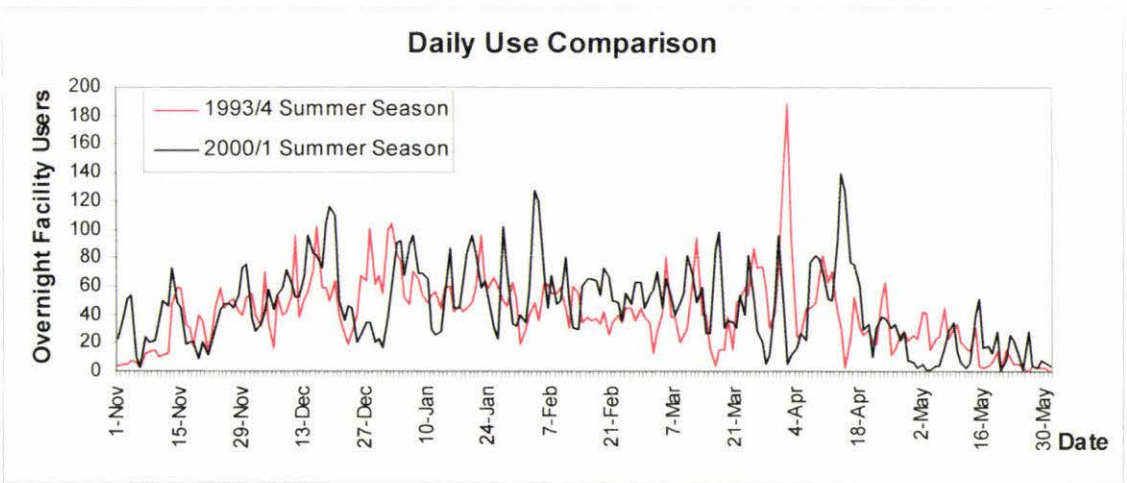


Figure 12-1: *Comparing the number of overnight facility users in the Tongariro Northern Circuit*

Most of the local peaks in Figure 12-1 do not coincide with the other seasons' local peaks. This is because the graphs are plotted against date, not day of week. Saturdays occur two days later in the red 1993/4 season when compared with the 2000/1 season.

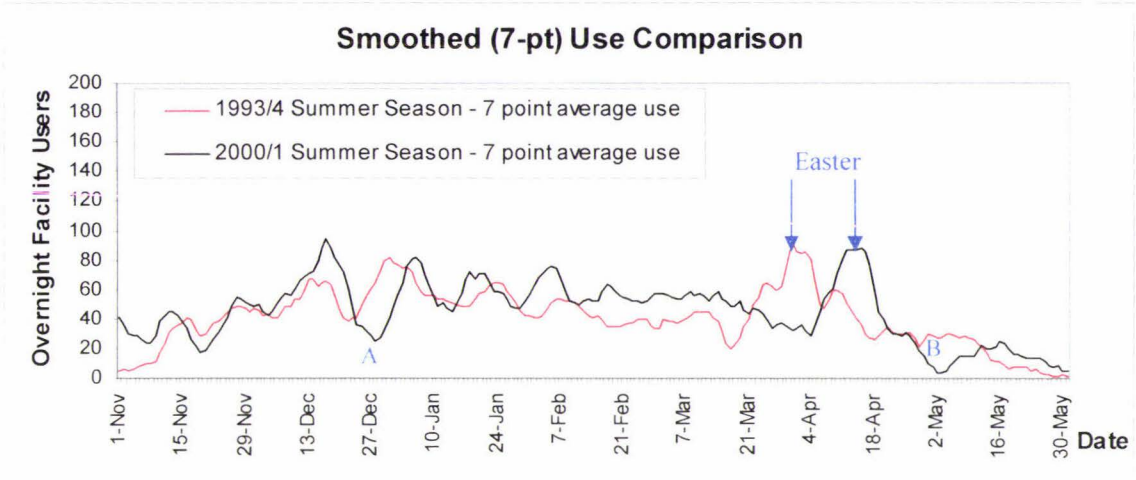


Figure 12-2: *Comparing the smoothed seasonal use pattern*

Apart from the shift in Easter there are two places, marked A and B, where the 2000/1 summer use falls well below that recorded during the 1993/4 summer season. These two reduced use periods are due to prolonged bad weather, and combined, they reduced the potential use by approximately 500 bed-nights. Even with these two periods of reduced use the 2000/1 summer season use was up by about 20%—1,800 bed-nights—on that recorded during the 1993/4 summer season. The overall increase in use seems to be due to increased use throughout the season as shown in Figure 12-2.

12.3 Changes in flow

The map below shows the figures for the flow of overnight facility users for the 2000/1 summer season and for the 1993/4 summer season:

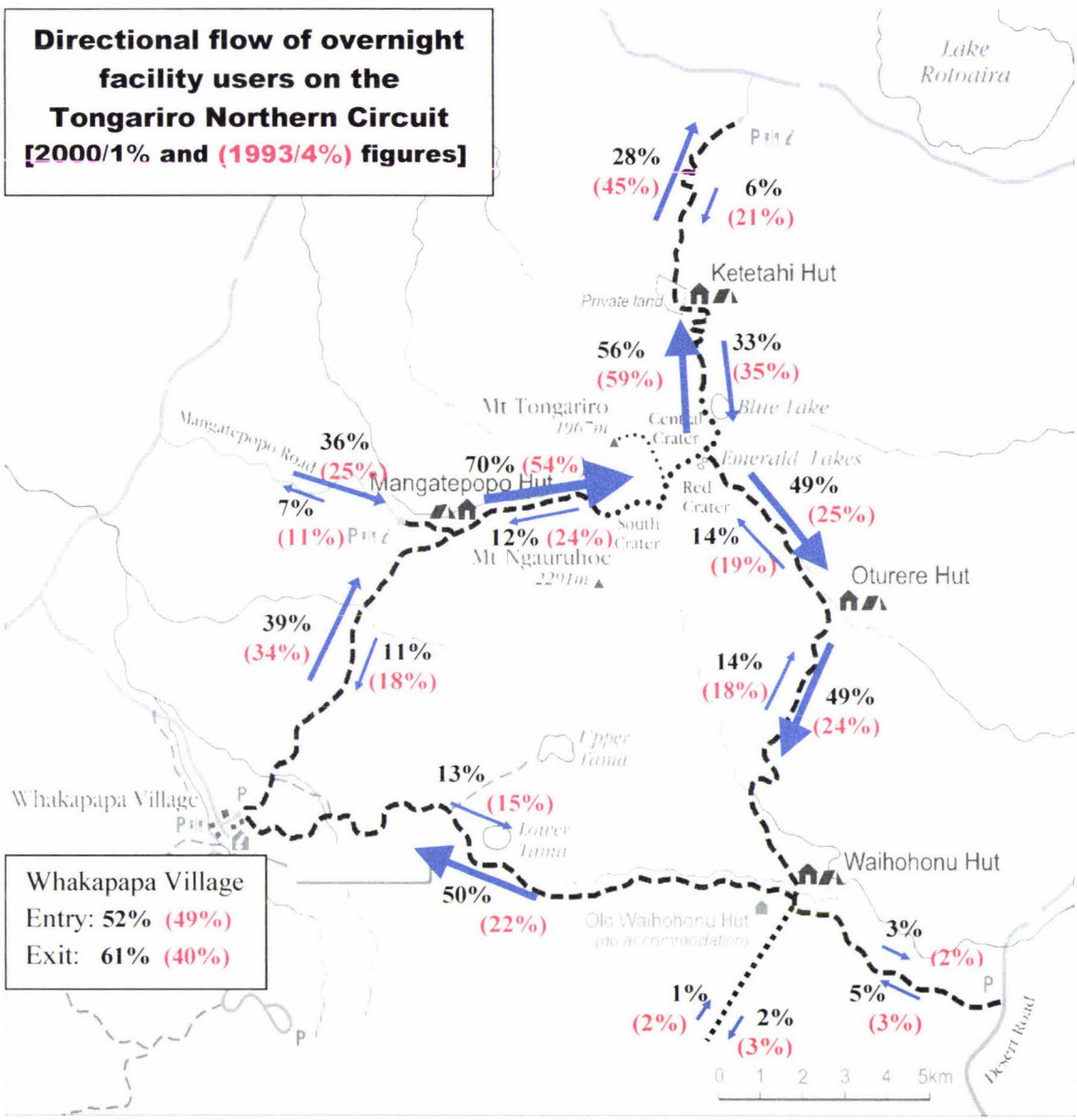


Figure 12-3: *Comparing the overall flow of overnight facility users within the Tongariro Northern Circuit*

There are three changes in the trip patterns of overnight facility users that explain the transformation in the flow within the Tongariro Northern Circuit. These three changes are:

1 **A move from the *Crossing* to the *Circuit* as the most preferred route**. This increased the use of the track and facilities on the eastern and southern sides of Mt Ngauruhoe by between 40% and 70%. A direct result of this was that the largest

overnight facility user group stayed longer than they did seven years earlier as the *Circuit* typically takes one more day to complete than the *Crossing*.

2 **A reduced use of the Ketetahi facilities by overnight facility users, dropping overall use by approximately 24%.** This reduction is most likely a direct result of the tangata whenua closing the access to the hot springs, thus reducing the appeal of the Ketetahi facilities. The numbers of Ketetahi *One-Hut Return* overnight users has dropped to about 40% of the former value. There are now fewer people entering from the Ketetahi car park.

3 **An increased conformity to the main direction of flow.** The main flow is clockwise around the *Circuit* and completing the *Crossing* by walking in a northerly direction. Having less people moving against the main flow helps decrease the perception of crowding on the tracks.

With these three primary changes to the flow of overnight facility users within the Tongariro Northern Circuit, there has also been a change in the facilities used for first and final nights. During the 1993/4 summer season both the Mangatepopo and Ketetahi facilities received about 40% of the overnight facility users each for their first night on the *Circuit* (see Table 11-1). In 2000/1 Mangatepopo retained its high first-night use, but Ketetahi's dropped by almost 10%. Most of this transferred over to Oturere, whose first-night use doubled.

The final overnight facility used showed the effects of all three changes in overnight facility users' trip patterns as:

1 the move from the *Crossing* to the *Circuit* has brought about a doubling in final-night use of Waihohonu, and is partially responsible for the reduction in use of Ketetahi

2 the reduced *One-Hut Return* use of Ketetahi has also reduced its final-night use

3 the increased conformity in direction of travel has caused a reduction in Mangatepopo's final night use: Mangatepopo being the final facility on the southbound *Crossing* and anticlockwise *Circuit* routes, which are now no longer as popular.

Table 12-1: The changes in the location of facility users' first and final nights

Start: first overnight facility		
Site	**1993/4**	**2000/1**
Mangatepopo	38%	39%
Ketetahi	39%	30%
Oturere	8%	16%
Waihohonu	15%	15%

End: final overnight facility		
Site	**1993/4**	**2000/1**
Mangatepopo	20%	16%
Ketetahi	53%	27%
Oturere	7%	9%
Waihohonu	20%	48%

Ketetahi is the only facility that has experienced a decline in use (Table 12-2). During the 1993/4 summer season over one quarter (27%) of all the overnight facility users stayed only at Ketetahi while on the Tongariro Northern Circuit. During the 2000/01 summer season this dropped to only 15%, just over half (56%) of the previous proportion.

Table 12-2: The changes in where overnight facility users stay

Proportion of overnight facility users staying at:			
Site	**1993/94**	**2000/01**	**Percentage change**
Mangatepopo	47%	47%	No change
Ketetahi	73%	56%	Decrease by 24%
Oturere	18%	31%	Increase by 72%
Waihohonu	35%	55%	Increase by 57%
Total number of facilities used per hundred overnight facility users	173	189	Increase by 9%

The overall changes in route between 1993/4 and 2000/1 are highly significant (p=0.000) and the proportions are summarised in Table 12-3.

Table 12-3: The changes in the popularity of different routes

Trip patters/route taken by overnight facility users			
Route	**1993/4**	**2000/1**	**Percentage change relative to 1993/4 value**
Circuit	28%	53%	Increase by 89%
Crossing	40%	25%	Decrease by 37%
One-hut return	13%	10%	Decrease by 23%
Desert Road entry/exit	4%	5%	* Increase by 25%
Back Crossing	5%	3%	* Decrease by 40%
Around Ruapehu entry/exit	5%	3%	* Decrease by 40%
Other: non standard	4%	1%	* Decrease by 75%

* Sample sizes are relatively small

The 'route by nationality' graphs below (Figure 12-4) clearly reveal two things:

- Firstly, the increase in *Circuit* use and the swing from the *Crossing* to the *Circuit* as the most popular route has been caused by international users alone
- Secondly, the split of New Zealand users by route has not changed a great deal when compared with seven years ago.

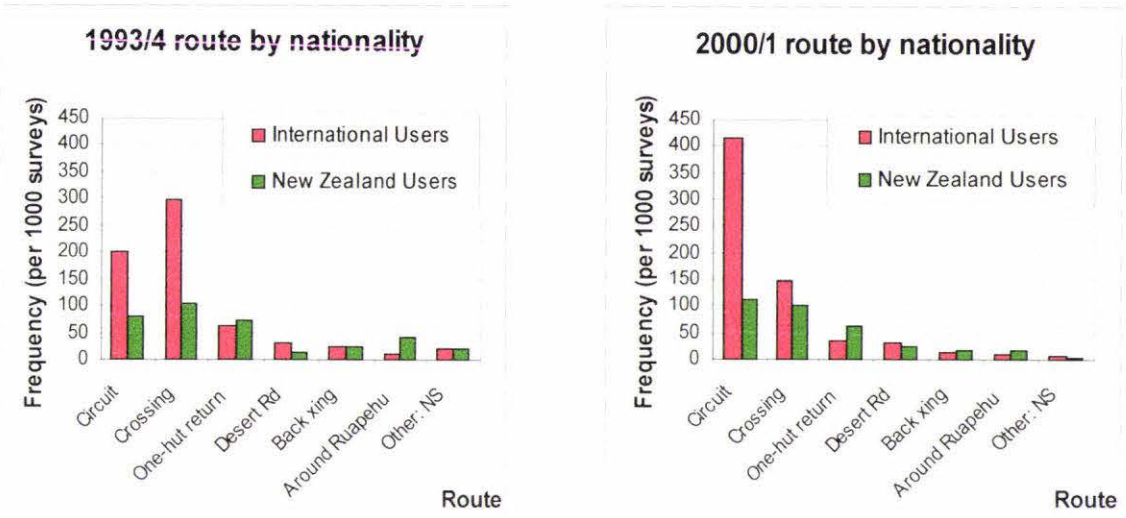


Figure 12-4: *Comparing the changes in the route taken by nationality groups*

The chart in Figure 11-4 shows that in 2000/1 41% of all users were the international users completing the *Circuit* compared with only 20% in 1993/4. International overnight use has changed significantly *(p=0.000)*. For New Zealand users there is an approximately equal three-way split between those completing the *Circuit*, the *Crossing*, and the rest. The change in New Zealand use borders on being significant *(p=0.051)* but given the collection site bias (Section 13.2 page 98) the actual change is probably not significant at all.

12.4 Changes in characteristics (of overnight facility users)

Gender

There has been a significant change *(p=0.000)* in the gender balance of overnight facility users from seven years ago (see Table 12-4). Overall the proportion of males completing surveys has fallen from 62% in the 1993/4 survey to 54% in the 2000/1 survey. The largest change occurred within the New Zealand user group where the proportion of males completing surveys dropped from 67% in the 1993/4 survey to 54% in the 2000/1 survey.

Table 12-4: *The changes in the proportion of males staying overnight on the Tongariro Northern Circuit*

The changing proportion of male overnight facility users		
	1993/4	2000/1
International users	60%	55%
New Zealand users	67%	54%
Overall/combined	62%	54%

Nationality

The proportion of New Zealanders completing surveys has not changed significantly *(p=0.545)*. In the 1993/4 survey 35% were New Zealanders compared with 34% in the 2000/1 survey.

The single biggest nationality change (Table 12-5) has been the reduction in the proportion of Germans using the overnight facilities. In 1993/4 Germans accounted for almost one in every four (23%) overnight facility users whereas in 2000/1 the ratio had dropped to one in seven (14%). The proportion of those visiting from other European countries: the Netherlands, Canada, Israel and Sweden have all increased.

Table 12-5: *The change in the proportion of surveys collected from different nationality groups*

	Country of Origin	New Zealand	Germany	UK/Ireland	Other European	Australia	Netherlands	USA	Canada	Israel	Switzerland	Sweden	Japan	Other
1993/4 Survey	Surveys	35%	23%	11%	3%	6%	3%	8%	2%	1%	5%	0%	2%	1%
	Bednights	36%	22%	10%	3%	5%	3%	8%	2%	1%	4%	0%	1%	1%
2000/1 Survey	Surveys	34%	14%	13%	7%	6%	6%	5%	4%	4%	4%	3%	1%	0%
	Bed-nights	31%	14%	12%	7%	7%	7%	6%	4%	3%	4%	3%	1%	1%

For a detailed breakdown of the changing annual use by nationality see the *2000/2001 Great Walk Season Tongariro National Park* report by Jimmy Johnson.

Age distribution

The age distribution of respondents has shown a slight increase in spread (Figure 11-5). The youngest age group, under 20 years of age, has shown a small increase from 9% to 10%, while those over 40 years of age have increased from 14% to 18%. Overall this change in distribution borders on being significant *(p=0.052)*. When considering New Zealand and international users independently they both demonstrate the same increase in spread and neither change in distribution is significant *(p=0.143 and p=0.154 respectively)*.

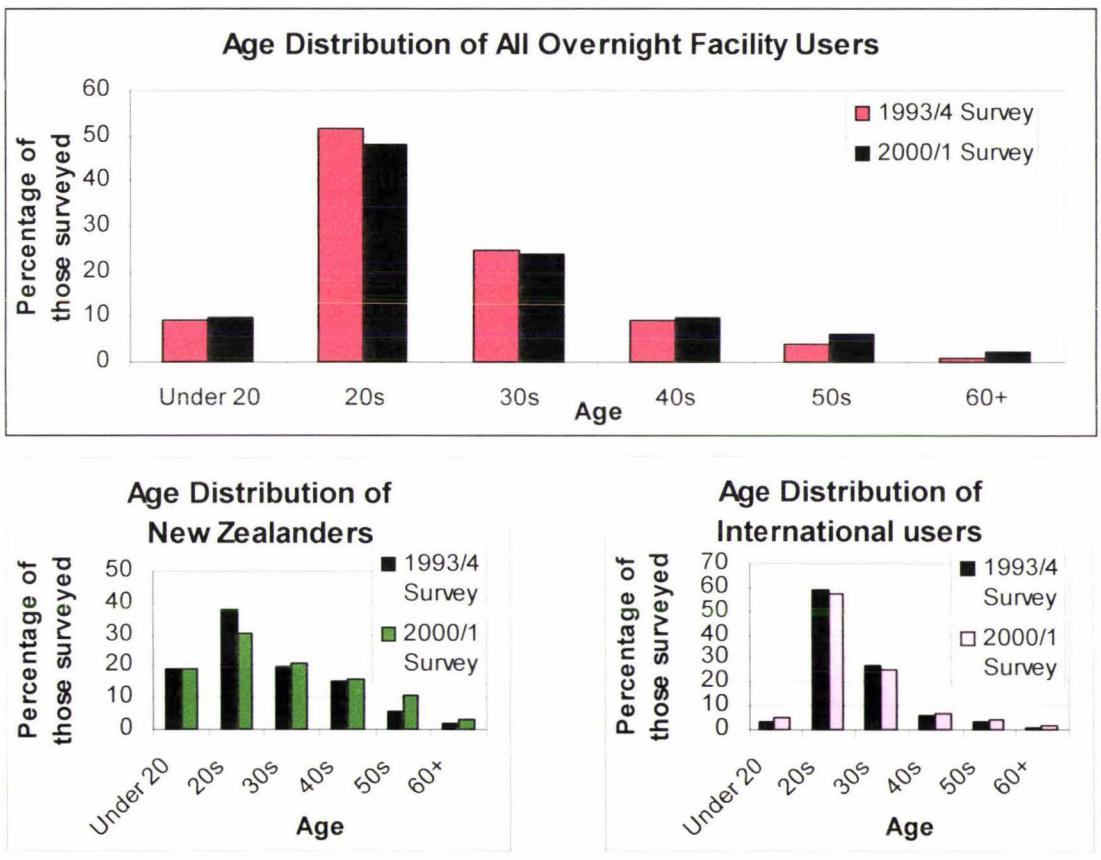


Figure 12-5: *Comparing the age distribution of overnight facility users*

Experience

The proportion of overnight facility users returning to the Circuit has decreased slightly from 16% in the 1993/4 survey to 13% in the 2000/1 survey. This change is not significant *(p=0.065)* until broken down for a more detailed analysis. The proportion of New Zealanders returning has remained relatively consistent at around 30%, whereas the proportion of international users has dropped significantly from 8% in 1993/4 to 5% in 2000/1 *(p=0.012)*.

The distribution of overnight backcountry experience remains relatively constant with half of those responding having had no more than five previous similar trips.

Perceptions of crowding

When comparing the two surveys, the proportion of those experiencing crowding (responding with a '3' or more) has risen from 68% to 71%. This is not significant *(p=0.284)*. The proportion of those experiencing extreme crowding has more than doubled, increasing from 6% to 15%, as seen in Figure 12-6. This increase contributes to the high significance in the change in the distribution of responses *(p=0.000)*.

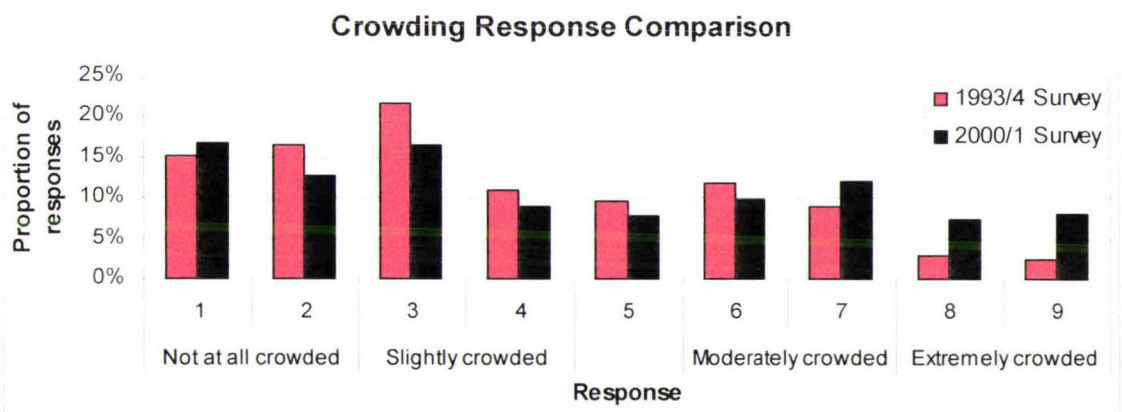


Figure 12-6: *Comparing the impressions of crowding while in the Tongariro Northern Circuit*

With regard to the number of people those surveyed expected to see, there has been an increase in the extreme values (Figure 12-7), which has caused a significant change *(p=0.014)* to the distribution.

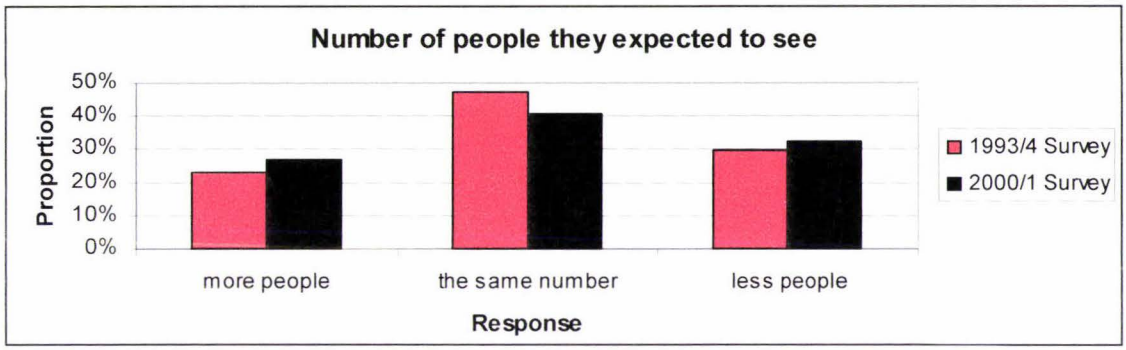


Figure 12-7: *Comparing the numbers of people overnight facility users expected to see*

Expectations of trip

The distribution of how closely overnight facility users' expectations matched their experience was similar when comparing the two surveys and looking at all nationality groups together *(p=0.272)*. This could be expected to remain fairly consistent due to visitor coping strategies such as *Rationalisation, Displacement, Product-Shift* and *Substitution/Self Selection* (Sharp, Druce), however a greater proportion of New Zealanders reported their experience was much worse than expected.

Group/party size

When grouping the parties of five-or-more into one group there was no significant change in the shape of the distribution *(p=0.584)*. However when breaking down the party sizes into nine groups from *1–8* and *9 or more*, as in Figure 12-8, the differences between the 1993/4 and 2000/1 surveys were highly significant *(p=0.001)*. This is due to relatively big fluctuations in the larger party sizes with smaller frequencies. Overall the distribution of party sizes remains much the same.

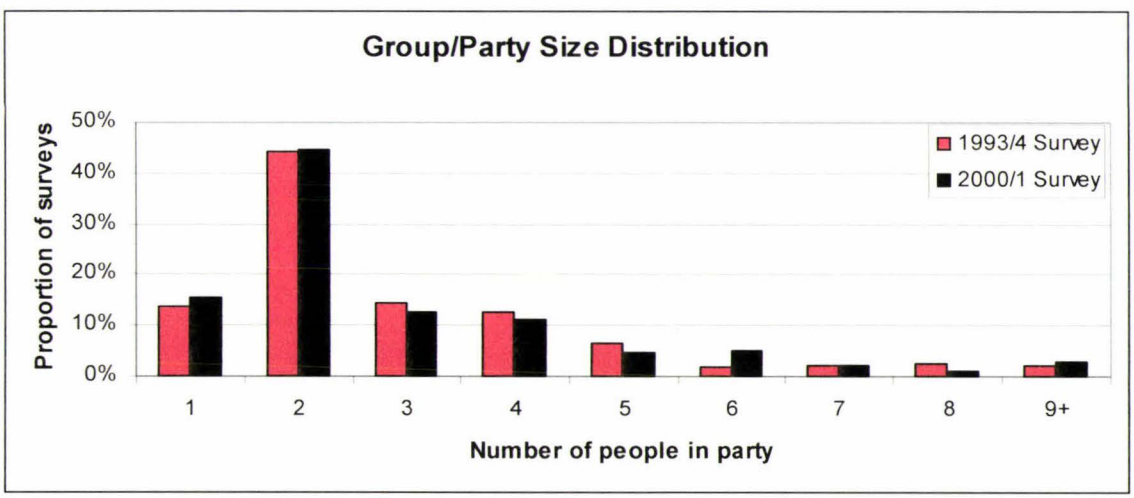


Figure 12-8: *Comparing party size*

Trip lengths

There are highly significant changes between the 1993/4 and the 2000/1 surveys when comparing the trip lengths (number of nights stayed) of overnight facility users on the Tongariro Northern Circuit *(p=0.000)*. Overall the proportion staying both one night and three nights has increased, with a decrease in those staying two and four nights. When breaking down all users into New Zealanders and international users, both groups display significant changes to trip lengths between surveys *(p=0.001 and p=0.000 respectively)*. As displayed in Figure 12-9 the proportion of New Zealanders spending only one night has increased at the expense of all other trip lengths, whereas for international users the proportion of those staying three nights has increased at the expense of the others.

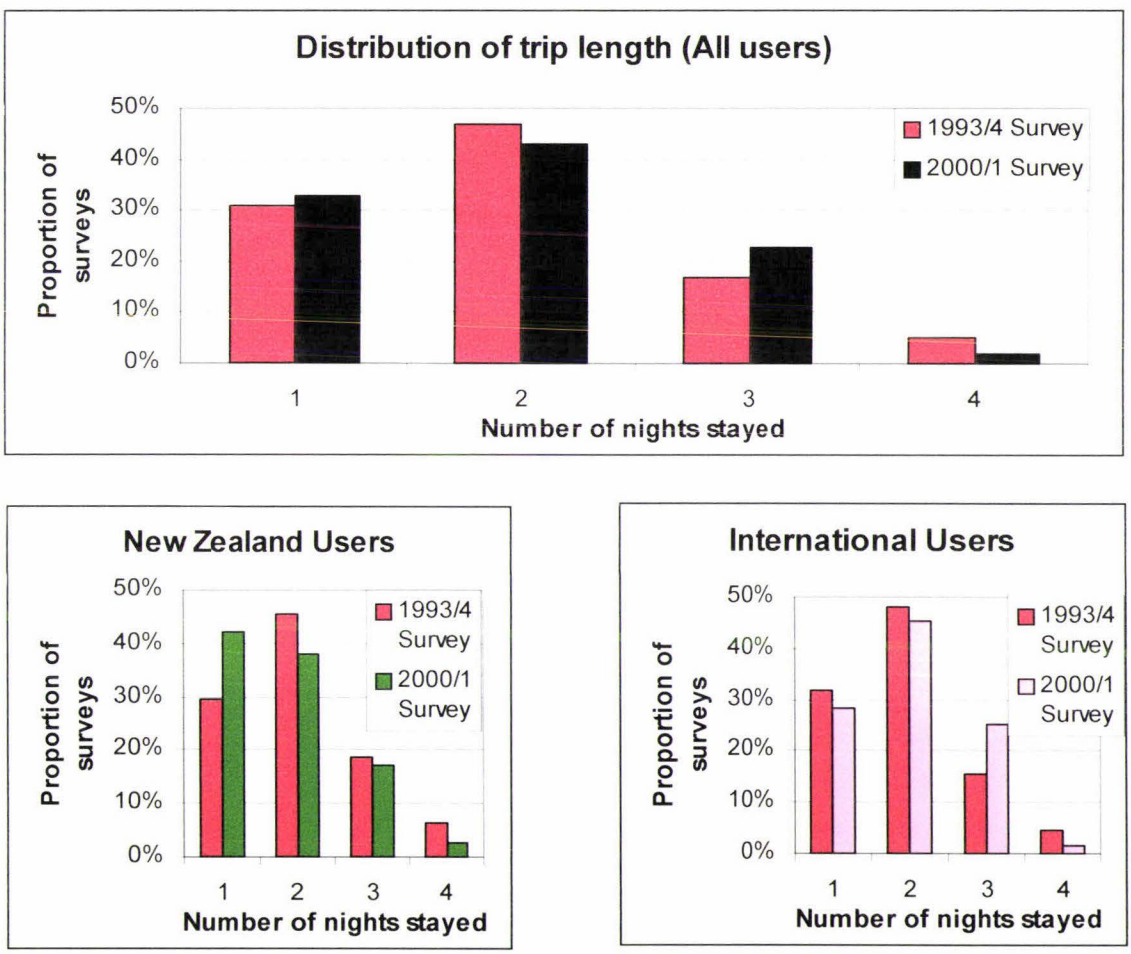


Figure 12-9: *Comparing the length of stay*

In 1993/4 the New Zealanders' average trip length was longer than international users' (2.03 cf 1.93 nights), whereas the reverse is true in the 2000/1 survey (1.80 cf 2.00 nights). The decrease in New Zealanders' trip lengths may be a result of increased overnight charges, whereas for international users, it is probably the result of the change in the most preferred route from the *Crossing* to the *Circuit*.

12.5 Summary

When comparing survey results from 1993/4 and 2000/1, there has been no significant change in the proportion of New Zealanders using the facilities, or the trips undertaken by New Zealanders. Party sizes, the experience of overnight facility users, the proportion of those experiencing crowding, and overnight facility users' view of their trip versus their expectations, are also similar to those of seven years ago.

The changes of greatest significance are:

- The gender balance, with the proportion of males surveyed dropping from 62% to 54%. There are still significantly more males than females using the overnight facilities.
- The swing of international users choosing the *Circuit* rather than the *Crossing* as their most preferred route.

Other significant changes include:

- A greater spread in the age-distribution of users, particularly the increase in the proportion of users over 40 years of age.
- The proportion of international users returning to the park has dropped from 8% to 5%.
- The proportion of those experiencing extreme crowding has increased from 5% to 10%.

There have also been changes to the number of nights stayed—a drop for New Zealand users but a slight increase for international users.

Chapter 13

Bias and the Accuracy of Data Collected

13.1 Introduction

This chapter first discusses the main sources of bias and inaccuracies inherent in the data used in this thesis. Suggestions are made that may improve the quality of data being collected in the ongoing data source. Section 13.5 compares and discusses the differences evident between the sources of data that collect similar information and this includes tests of how representative the survey was.

I use the simple definition of bias from Barton (p 130):

"**Bias** occurs when one member of the population is more likely to be chosen than others."

Thus the survey contains many sources of bias resulting from the sampling process whereas the other two datasets—the Great Walks pass butts and the hut wardens' observations of use—contain inaccuracies rather than bias, however care may also be needed in interpreting the data in the later datasets due to the unknown accuracy of the data collected.

A technical point regarding bias is that some more advanced methods of sampling, such as stratified sampling, may use different sampling probabilities for each section of the population. Unbiased results can then be estimated by adjusting for the different selection probabilities. No attempts have been made in this thesis to adjust for possible sources of bias.

Table 13-1 (next page) contains a summary of the three main datasets: the advantages, disadvantages and the information collected as well as identifying where comparisons are made.

Table 13-1: Summary of main dataset

	Survey	Pass butts	Hutt warden observations
Advantages	Sample with more detailed information being collected *(see below)*	(Full season)	(Full season)
		Most of the data is already inputted for annual reports, checks on concessionaire sales etc	Captures children under 12
			Collected as routine checks etc
			Provide breakdown by site
Disadvantages	**Bias:** • Site selection (hut wardens present) • Self selection (non-response errors) • Central season only • Early departures • Some missing information	Need to process refunds	Many estimates - for missing information
		Need to include invoices	Some sites more accurate than others
		No children under 12	
		Buying single tickets	
		Some problems with hut/camp breakdown due to upgrades	
		Some missing information	
Information collected	Nationality	Nationality	
	Age group	Adult and youth	Number camping and in hut
	Gender	Number of nights (trip length)	Daily breakdown of each huts use
	Been before	Hut and camping passes	
	Previous tramping experience	Start date	
	Crowding		
	Expected no. of people seen		
	Better or worse		
	Party size		
	Number of nights		
	Trip details including: • Entry and exit point • Route • Huts used • Direction • Transport used		
Comparisons	Nationality	Nationality	
	Trip lengths	Trip lengths	
	Facility use breakdown (total)		Facility use breakdown (total)
		Seasonal use pattern	Seasonal use pattern
		Total use	Total use
	Past surveys collection sites/number of surveys		

13.2 Survey bias

The 2000/01 summer survey (see Appendix A) gathered much more information about the Tongariro Northern Circuit overnight facility users than the other two data sources (see Table 13-1). In all 1,090 surveys were collected on the Tongariro Northern Circuit between 22 December 2000 and 16 April 2001. These account for approximately 33% of the users (compared with numbers of Great Walks pass butts issue) and 36% of the overnight facility bednights during the survey period (compared with hut warden observations). This is comparable with the 1993/4 Great Walks survey. The surveys collected represent approximately 19% of users and 21% of the overnight facility use when comparing with the full summer season.

Due to the nature of the survey there were various forms of bias and these are:

Time frame for data collection: The survey is assumed to reflect the overnight facility users over the full summer season. As it did not sample from the full summer season, it is really only a reflection of those during the survey period running from 22 December 2000–16 April 2001. This is a problem inherent in the survey methodology, but as comparisons are made with the 1993/4 Great Walks survey, using the same sampling time should make the comparison more representative. No attempt has been made to sample from the shoulder season for comparisons with the midsummer season, however in Section 13.5 comparisons are made with other datasets to examine differences between the survey and non-survey periods.

Survey sites—selection bias: The original Great Walks survey methodology was based on one full-time surveyor, and sampling sites and locations within the Tongariro Northern Circuit were pre-selected with each facility being equally represented. However when the surveying started, with the desire to gather as many surveys as possible, all sites (or as many as possible) were surveyed continuously from 22 December 1993–13 March 1994 and over Easter when the hut wardens were present.

During the 1993/4 survey period Ketetahi was the hut of highest use, and this was where the paid surveyor was based. When he was out of the park, Ketetahi was wardened by other staff for compliance reasons and the surveying at this site was almost continuous. Initially *human error* occurred when the surveyor selected all hut occupants, however the surveying settled down to selecting only those on their final night.

Insufficient staffing levels in the 1993/4 summer season meant that some huts were not fully staffed, thus creating a selection bias. For compliance (Great Walks passes) reasons, the priority for hut wardens was to be at the sites of highest use. On some occasions the hut wardens would check Great Walks passes at more than one hut on an evening, and as a result they would often fail to survey at one or both huts.

During the 2000/1 survey period, despite being assured that there would be sufficient staff throughout the survey period, there was not and this was unavoidable. Table 13-2 is indicative of the site selection bias. There are no estimates available for the number of times that there were no people in the hut on their final night and hence not eligible for surveying. This may have been relatively common at Oturere due to lower use and being an internal hut.

Table 13-2: Estimates of site survey

	Proportion of days each site had surveys collected during survey period		Proportions of surveys collected		Mean (average) number of surveys collected per night	
Site	**1993/4**	**2000/1**	**1993/4**	**2000/1**	**1993/4**	**2000/1**
Mangatepopo	45%	45%	47%	47%	4	3
Ketetahi	70%	55%	73%	56%	7.5	4
Oturere	19%	21%	18%	31%	2	3
Waihohonu	39%	68%	35%	55%	5	6

Non-selection bias: Many people did not complete surveys during the survey period. Though this was to be expected, and it would have been possible to gather information on those refusing to complete surveys, with me having to communicate second-hand with those surveying, and goodwill already being stretched, the process was not considered worthwhile.

Not all people answered the surveys who were eligible to. Those not filling in the survey:

- May have been unwilling. Based on a sample of 100 completed surveys, approximately one in six groups contained incomplete sets of surveys, and these represent an approximate 20% loss. This was more noticeable with larger groups. It would have been possible to include the extra information for flow, group-size and transportation calculations to improve the final estimates, however this was not done.

- May have had no hut warden present on their last night
- May have decided en route not to stay for their planned last night and left earlier than anticipated.

Non-selection bias can cause the results to be non-representative if the proportions of those refusing to complete surveys are from one portion of the population (eg one gender or a certain nationality).

Non-completion errors: The surveys contained unanswered questions. The omission or non-completion rate for each of the individual questions is listed in Table 13-3 below and these were not considered to be a problem.

This is similar to the non-selection bias, where one group of the population may refuse to complete a particular question. This is not considered to be a problem here with no controversial questions being asked and the average non-completion rate was approximately one per cent for each question.

Table 13-3: Question non completion rates for 2000/1 survey (n=1,090)

Question	Gender	Nationality	Age	Visited before	Experience	Crowding	People seen	Trip experience	Group size	Nights	Transport in	Transport out	Map question
Number of non-responses	4	6	4	22	13	11	64	13	4	4	35	75	11

Table 13-3 indicates that the question with highest non-completion rate (6.8%) was to do with transport away from the Tongariro Northern Circuit. This is probably due to user uncertainty and no "don't know" option being offered. Next highest (5.8%) was the question below the crowding options asking if they expected to see: more, the same number or fewer people and was most likely to be overlooked.

13.3 Great Walks pass butts

The Great Walks pass butts provide the most accurate information available for the breakdown of total use (bednights) by nationality; they also provide estimates for the

number of nights people stay in the Circuit and estimates for the total number of users, subject to the four limitations below:

- They do not capture the use of children under the age of 12, meaning figures may underestimate total use.

- Some people may leave early without claiming a refund, hence overestimating total use, and a few of these may cause a slight increase in the length of time people stay in the Circuit.

- Some people may be recorded more than once due to purchasing passes nightly from hut wardens during their trip, thus increasing the number of passes issued relative to the number of people using the facilities. Another result of this is that it will decrease the estimate of people's average length of stay in the park.

- Non-completion rates also bring about inaccuracies in the interpretation of the data, and at times it appears that the data has been entered onto the pass butts well after the tickets were issued. This brings into question the validity and accuracy of the whole dataset, and for statistical purposes it would be better to process the pass butt data with blank fields and get an estimate of the omission rates and related errors. For this reason I have not tried to establish omission rates.

Suggested improvements and opportunities

During previous seasons many Great Walks pass butts had either the start date and/or nationality fields missing. The proportion of passes with all the relevant details included was very high for the 2000/1 summer season with the exception of OPC pass butt returns.

The two related processes that now hold the key to improving the value of this dataset are:

Invoicing processes: If Great Walks passes were written for all those who were invoiced there would be no need to include those invoiced when processing pass butts. To remove the possibility of a person or group claiming a refund on an invoiced ticket, the ticket could be marked as non-refundable, or not issued.

Refunding tickets: It would be possible to record a reason for overnight facility users' early exit on the refunded ticket. At present full refunds are frequently marked as VOID. Here an opportunity exists to obtain information on why overnight facility users leave

earlier than first expected. A simple letter code, or common numeric code could be placed on the refunded ticket for later analysis. A suggestion is provided here:

Suggested codes for partial refunds on passes

Wx:	Bad weather or weather deteriorating
HTF:	Huts too full
TMP:	Too many people on tracks or using facilities
FE:	Finished earlier than expected
UF:	Uncomfortable facilities/too noisy
MED:	Medical/sprained ankle or not fit

The entry of refunded ticket details is relatively time-consuming to process, but is necessary to improve the accuracy of the pass butt information.

13.4 Hut warden observations of use

The hut warden observations of use provide the only breakdown of use within the Circuit. The figures provide an accurate and ongoing record of facility use subject to the following limitation:

Every year situations occur when it is not possible to have all facilities staffed throughout the summer season. When this happens efforts are made to talk with people coming from the unstaffed facilities in order to ascertain use level. When this is not possible estimates can be obtained by utilising hut book records (which are often incomplete) and multiplying by some factor. From a statistical viewpoint, it is worth recording these estimates in order not to bring into question the accuracy of the actual observations.

Suggested improvements and opportunities

The hut wardens' observations provide the exact numbers of overnight facility users at the facilities on a given night, with a breakdown by camp and hut use. However when there is no hut warden present an estimate has been provided and the degree of accuracy in the estimate may be in question. It would be useful if the method of estimation was somehow recorded so that the relative accuracy of the whole database could be maintained.

Different shading colours could represent different methods of estimation eg light blue for a reliable observation from someone who stayed there; light green for an estimate from someone who stayed there; light yellow for an estimate based on the hut book etc. It would be possible to change the cell shading in Microsoft Excel® without interfering with any related formula. In this way the database would also record the number of staff in the Circuit on any given night including the huts they were at. Some of this information may be

useful in years to come, or had it been available this year, a more accurate assessment would have been possible by comparing the number of surveys returned from each site against the staffing levels of that site. During the processing of the surveys it was not possible to distinguish between a zero site return on a given night that had no warden present, or no overnight facility users staying that were on the last night of their trip. Such information may have been useful in establishing how representative the survey was.

13.5 Comments on comparative data

There are five areas below where similar data has been gathered by two different datasets. The results are compared and discussed:

Nationality: survey versus Great Walks pass butt data

The nationality figures are quite comparable between the Great Walks pass butts and the 2000/1 survey except for the New Zealanders, see Table 13-4. The chi-square test indicates a highly significant difference for New Zealand and international use *(p=0.000)* comparing the numbers inside and outside the survey period. This is not due to increased New Zealand use outside the survey period, but due to the high international use during the survey. This can be observed in Figure 9-3 (page 66) where the main cause of the peak use season (and the survey period) is attributed to international users.

Table 13-4: *2000/1 nationality comparisons between Great Walks pass butts and survey*

	Country of Origin	New Zealand	Germany	UK/Ireland	Other European	Australia	Netherlands	USA	Canada	Israel	Switzerland	Sweden	Japan	Other
GW pass butts	Number	40%	13%	10%	7%	4%	5%	7%	3%	4%	4%	2%	1%	1%
	Bed-nights	37%	14%	11%	7%	4%	6%	8%	3%	4%	4%	2%	1%	1%
2000/1 Survey	Surveys	34%	14%	13%	7%	6%	6%	5%	4%	4%	4%	3%	1%	0%
	Bed-nights	31%	14%	12%	7%	7%	7%	6%	4%	3%	4%	3%	1%	1%

An analysis of the Great Walks pass butts during the survey period results in the proportion of New Zealand bednights of 33%, and the results are comparable to those of the survey *(p=0.291)*. This is encouraging as it is the first indication that the survey is representative of the users during the survey period.

Number of nights stayed: survey versus Great Walks pass butt data

The two tables presented already are those showing the lengths of stay for those surveyed—Table 4-1 (page 31) and the average number of nights on Great Walks pass butts—Table 9-2 (page 68). These tables show the average number of nights on the pass-butts (1.76 nights) is on average 0.17 nights (9%) shorter than the average length of stay for those surveyed (1.93 nights). The distributions are significantly different *(p=0.000)*. Amongst other reasons this could again be due to differences between the surveyed peak season use and non-surveyed period, or it could be that some users purchased passes nightly for their trip within the Tongariro Northern Circuit and thus brought down the average number of nights for pass purchases when compared with length of stay.

An analysis of the number of nights on the pass butts indicates a significant difference *(p=0.002)* between those inside and outside the survey period. Those inside the survey period have a greater average length of stay (1.79 nights) as compared with those outside the survey period (1.71 nights).

Comparing the nights stayed by those surveyed to the pass butts used during the survey period remains highly significant *(p=0.000)*. There may be a higher proportion of those staying for shorter periods refusing to complete the surveys, however the data is inconclusive as the two datasets indeed measure different things.

Facility use breakdowns (annual total): survey versus hut warden observations

The hut wardens' observations provide the most accurate figures for the distribution of facility use within the Tongariro Northern Circuit. Table 13-5 shows that the use of Ketetahi was higher and Oturere lower in the survey than the observed use by hut wardens. The differences are significantly different when comparing the survey results to both full season *(p=0.000)* and the observed use during the survey period *(p=0.000)*.

Comparing the overall use of facilities inside and outside the survey period there was no significant difference between them *(p=0.148)*.

Table 13-5: Comparing the proportional use of overnight facilities

	Survey	Hut warden observations	
Facility	Percentage of surveyed use	Percentage of total use	Percentage of use during the survey period
Mangatepopo	25%	26%	26%
Ketetahi	30%	25%	24%
Oturere	16%	20%	20%
Waihohonu	29%	30%	29%

The recorded hut warden observations for Oturere are likely to be the least accurate. This is due to its lowest overall use, making it the hut least likely to be staffed when there is a staffing shortage, and hence it is likely to have more estimates of use. However this in itself is not a reason for the significant difference in use.

The reduced survey coverage at Oturere, which is evident in Table 13.2 (page 99) may be the primary reason for total use estimates (from the survey) being lower than the annual use figures. The bias was caused by survey site selection, where the figures indicate that Oturere received less than half the survey time that the other huts received. Table 8-3 (page 60) indicates that 30% of those surveyed using Oturere stayed there on their final night. This proportion may well have been higher had it been surveyed more often, and thus would have made the survey results more comparable with the hut warden observations.

Total use: Great Walks pass butt data versus hut warden observations

The annual use from the hut warden observations is 3% higher that that from the Great Walks pass butts (Table 13-6).

Table 13-6: Total recorded overnight use

	Hut warden observations	Great Walks pass butts	Difference
Total use	10,502	10,189	313 (3%)

The pass butt use may be lower due to failure to record and process invoices; failure to capture children under the age of 12 and/or some undated pass butts being left out of the total. The observed use figures may be higher due to higher estimates of use when there were no staff present. The day-by-day analysis of the use recorded by these two datasets follows.

Daily facility use: Great Walks pass butt data versus hut warden observations

Figure 13-1 demonstrates that there is a fairly close match between the hut wardens' observations of use and the use captured on the Great Walks pass butts.

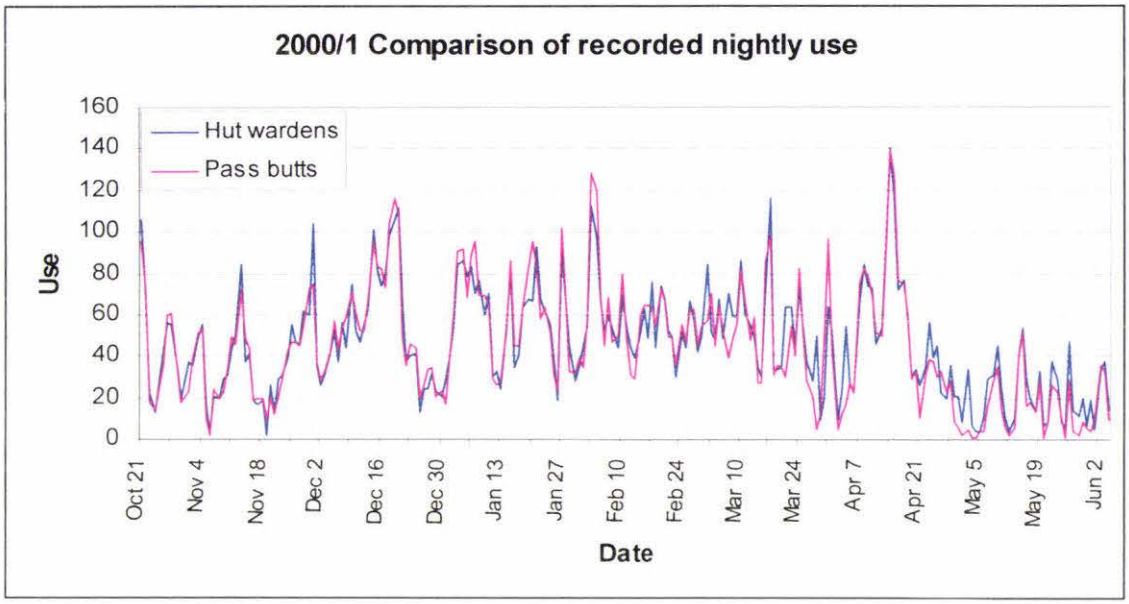


Figure 13-1: *Comparing use from pass butts and hut warden observations*

Figure 13-2 displays the daily difference between the hut warden observations of use and the use recorded on the Great Walks pass butts. The absolute difference in these is summarised in Table 13-7. Only five per cent of the time did the two datasets match exactly. Over half of the time they were within five overnight users of each other and over three quarters of the time they were within ten.

A fluctuation of, for instance, ten users above the hut warden observations one day, to ten below the next, could have been caused by a large party with the wrong date being entered on the Great Walks pass butt.

Table 13-7: *Nightly difference between the recorded use of facilities of that of Great Walks pass butts and hut warden observations*

Absolute difference	<5	<10	<15	<20	<25	<30
Proportion of nights	53%	81%	90%	95%	96%	98%

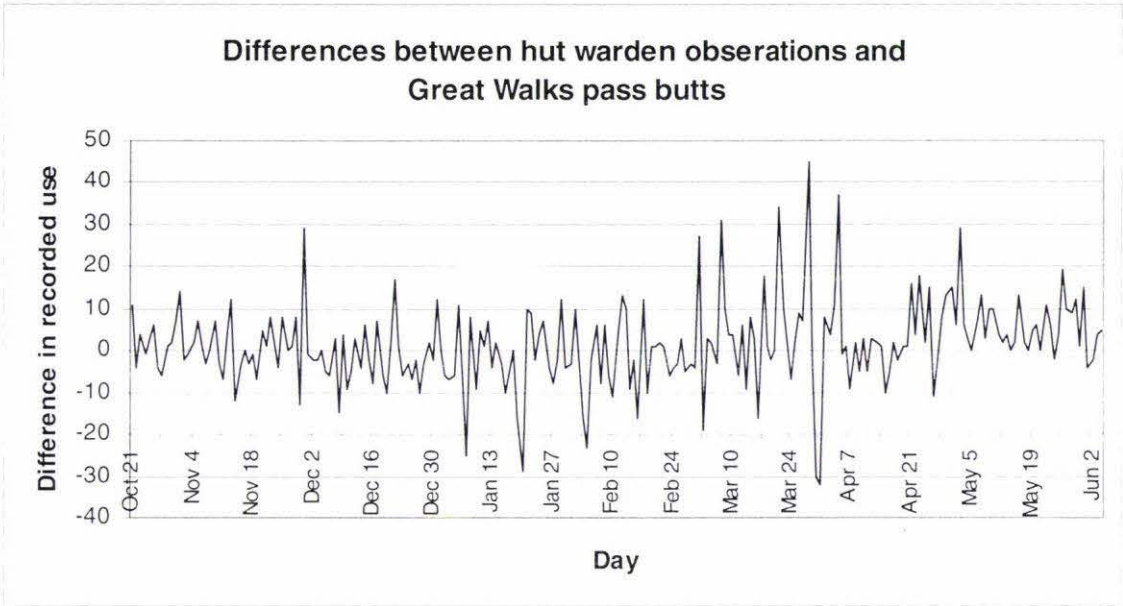


Figure 13-2: Daily difference in recorded overnight facility use

Part V

Model Development

Chapter 14

The Weather

14.1 Introduction

This chapter provides the background for the inclusion of weather effects for modelling overnight facility use within the Tongariro Northern Circuit. It introduces the three sources of weather data that have been used in the modelling in Chapter 15. Two of these sets of data were collected specifically for this research following the failure of the NIWA database to provide suitable weather records.

14.2 Background—the influence of weather

Many people cancel or postpone planned trips into the backcountry due to bad weather. Once in the backcountry, bad weather may cause people to shorten their trip, and at times, it can prevent them from completing their trip as intended. There is little doubt that the weather affects whether or not people enter the Circuit on overnight trips, or that people in the Circuit alter their trip plans if the weather deteriorates. The task undertaken in this thesis is to determine how significant a factor the weather is in overnight facility use on the TNC, and if significant, then to build this into models that reflect the changing use of overnight facilities, essentially quantifying the effects of the weather. If these effects are indeed important, then it follows that all models trying to accurately explain or predict overnight facility use must incorporate them.

My preliminary investigations into the effects of weather on overnight facility use occurred during an extramural paper undertaken in 2000: *161.774 Time Series for Researcher*. My project for this paper *Overnight facility Use on the Tongariro Northern Circuit* (November 2000, unpublished, 26 pages) found shortcomings in the available NIWA datasets. These included the discovery that many of the recorded variables contained incomplete sets of data and that many of the recorded variables were related (not independent) to the others. Despite the difficulties in dealing with correlated variables in multiple regression, the results were encouraging and procedures were set in place to gather more suitable weather data for the 2000/1 summer season in the Tongariro Northern Circuit.

14.3 The components of bad weather

These would consist of any combination of freezing or sub-zero temperatures; gale-force winds and heavy rain, sleet or snow. When contrasting this with good weather—warm temperatures, sun, clear skies and no wind, four components surface:

1. Temperature
2. Wind
3. Cloud cover
4. Precipitation as in rain or snow

It may be possible to grade the severity of the weather by considering various combinations of these components. As well as this, the individual components can be analysed against the use patterns to see which contribute most to changes in use.

It is not only the weather on the day that affects use, but also the perception of what the weather will be like during the trip. A person's perception of the developing weather pattern is also paramount in determining whether they proceed with a planned trip or not, so that weather forecasts become important too.

Throughout the 2000/1 summer season the mountain weather forecasts were collected, and observations of local weather were collected from both Ketetahi and Mangatepopo huts.

14.4 Sources of weather data

Three sources of weather data have been obtained for this research. To overcome the shortage of pertinent local information there were two sources collected during the 2000/1 summer season. They were:

(i) Hut warden morning observations of weather conditions in the Circuit (Section 14.5)

(ii) The local mountain weather forecasts faxed daily from the Meteorological Service (Section 14.6).

The third set of data was obtained from NIWA, and contained many years of weather records. However, my previous investigations (*161.774 project*) indicated that this dataset was incomplete, with many fields containing a large number of missing values. The most complete and useable dataset was from Turangi with many of these fields highly correlated.

Subsequently this historical dataset has been considered unsuitable for longer term modelling due to the limited range of complete data fields. Fortunately more comprehensive data was obtained throughout the 2000/1 summer season from the Chateau site and this dataset is described in Section 14.7.

14.5 Hut warden observations

For the hut warden observations it was necessary to develop a method for observing and recording weather conditions that did not rely on instruments (as none were available), and they needed to be presented in such a way that they could be understood and remain reasonably consistent when interpreted by different people. The result was Table 14-1. The four variables were recorded as two two-digit numbers and therefore coding for both *Temperature* and *Cloud Cover* did not include zero.

The weather observations were completed each morning at 0800 hours (see form in Appendix T) for two reasons: the hut wardens had to be around as at 0815 hours they received the new mountain weather forecast over the radio and needed to pass this on to overnight facility users; it was also the time that trampers' own observations of morning weather conditions decided them on whether to proceed with their planned trips or not.

Table 14-1: Weather observation codes for hut wardens

Coding for hut warden weather observations				
Temperature	**Wind**	**Cloud Cover**	**Rain/Snow**	
1 **hot:** sun bathing	0 calm	1 clear	0 none	
2 **warm:** light clothes needed	1 light 2 moderate	2 clearing (mist/cloud burning off)	1 light 2 moderate	*intermittent showers*
3 **cool:** jersey required	3 strong	3 up to 1/4 cloud cover	3 heavy	
4 **cold:** jacket & hat	4 gale	4 up to 1/2 cloud cover	4 light	*rain/sleet*
5 **freezing:** above + mittens and scarf	5 impossible to move	5 up to 3/4 cloud cover	5 moderate	
		6 overcast	6 heavy	
		7 in mist/cloud	7 light	*snow*
			8 moderate	
			9 heavy	

The hut warden weather observations were collected from both Ketetahi and Mangatepopo throughout most of the 2000/1 summer season. Missing observations were estimated using information from the mountain weather forecasts.

Though the codes are arranged almost entirely to go from the best to the worst conditions in each category, there was no implication that a difference of one or two on any scale would be equivalent. Of primary importance was the gathering of the information as the numbers could be transformed or combined in appropriate ways during the analysis process.

Preliminary investigations where a single value for the *State of the weather* using the raw hut warden observations combined as

State of the weather = Temp + 2 × Wind + Cloud + 2 × Rain.

The justification for the scaling was that both wind and rain have a greater tendency to make travel within the Tongariro Northern Circuit more unpleasant than temperature and cloud cover. So the effects of these two components were doubled when combining the four factors to provide an indicative number describing the severity of the weather *(State of the weather).*

Later, after some thought, the steps between the divisions of the original observations were modified to those in Table 14-2, and with the new *State of weather* being

State of the weather = Temp + Wind + Cloud + Rain

and an improvement was noticed in the fit of the model. The doubling of *Wind* and *Rain* had been taken into account in the values given in Table 14.2.

Table 14-2: Altered scale for hut warden weather observations

Transformed codes for the calculation of the *state of the weather*							
Temperature		**Wind**		**Cloud Cover**		**Rain/Snow**		
0	hot: sun bathing	0	calm	0	clear	0	none	
0	warm: light clothes needed	2	light	0.5	clearing (mist/cloud burning off)	6	light	*intermittent showers*
		6	moderate			8	moderate	
2	cool: jersey required	10	strong	1	up to 1/4 cloud cover	10	heavy	
4	cold: jacket & hat	14	gale	1.5	up to 1/2 cloud cover	8	light	*rain/sleet*
6	freezing: above + mittens and scarf	14	impossible to move	2	up to 3/4 cloud cover	10	moderate	
				4	overcast	12	heavy	
				6	in mist/cloud	6	light	*snow*
						8	moderate	
						10	heavy	

This *State of the weather* can theoretically range from 0–38. It is more realistic to place the weather into categories rather than distinguishing between very good weather observations

such as 0 or 2, or very bad weather such as a 30 or 32. Five categories were selected and the ranges are indicated in the Table 14-3.

Table 14-3: *Weather categories based on hut warden weather observations*

Category:	State of the weather range:
Good	0–5
Fair	5.5–10
Inclement	10.5–17.5
Bad	18–21.5
Very bad	22–38

The differences between the base-model and the actual use observation were calculated, then grouped into the *State of the weather* categories. The median value within each category was selected to be the most representative and to be used as the *Weather* factor for modelling, see Section 15.2.

When introducing the weather category to the base model a relatively good match is obtained (see Section 15.2). The correlation coefficient leapt from 42% to 75%, indicating that this model now explains three quarters of the variation.

14.6 METSERVICE Tongariro [mountain] forecasts

Mountain weather forecasts are faxed through twice daily to the Whakapapa visitor centre, and copies distributed to the Information Centres. As much of the information is similar for the morning and afternoon forecasts, only information from the morning forecasts was entered for analysis. The format of the forecasts changed frequently and many forecasts did not provide the complete set of information required, however information was collected along with the date of the forecast, and fell into 30 categories as indicated in Table 14-4.

Table 14-4: *Details recorded from weather forecast information*

			Weather forecast				
			Today	Tomorrow	Day 3	Day 4	Day 5
	Cloud Cover		✓	✓	✓	✓	✓
	Rain		✓	✓	✓	✓	✓
Wind	1,500m	Direction	✓	✓	✓		
		Speed	✓	✓	✓		
	3,000m	Direction	✓	✓	✓		
		Speed	✓	✓	✓		
	Freezing Level		✓	✓	✓	✓	
General Wind		Direction				✓	✓
		Speed				✓	✓

Many of the categories needed to be estimated and they were entered using the scales from the hut warden observation sheets (Table 14-1). Initially all the wind speeds were entered that were provided on the forecasts, however these were later converted to the hut warden scale.

With the masses of information available on the forecasts' database, the problem became one of how to make use of it. One answer was to categorise the forecasts. This was done by determining the *State of the Weather* on the forecasted days, then forming categories based on the number of good or bad days until the weather changed, see Table 14-5.

Weather for the forecasted day was classified as bad if the combination of *rain*, *wind* (at 1500m), *temperature* (based on freezing level) and *Cloud cover* exceeded 20. The calculations for the *forecasted state of the weather* are similar to the *State of the weather* in Section 14.5. The *forecasted state of the weather* coding is in Appendix W.

Table 14-5: *Weather forecast categories*

Three day weather forecast category	
B1	Bad weather for one day before improving
B2	Bad weather for two days before improving
B3	Bad weather for the full three days
G1	Good weather for one day before deteriorating
G2	Good weather for two days before deteriorating
G3	Good weather for the full three days

14.7 NIWA climate data

Prior to the 2000/1 summer season the Turangi and Chateau climatic datasets were obtained from NIWA. The Turangi dataset contained eight fields with complete sets of readings that were used for initial investigations, however Turangi is at a lower altitude, at least ten kilometres from the nearest point to Tongariro Northern Circuit (TNC) and on the other side of Mt Pihanga, which made relevance for the TNC doubtful. The Chateau dataset contained too many missing values to be directly usable. The initial shortcomings in the NIWA datasets prompted the collection of both the hut warden observations from within the Tongariro Northern Circuit, and the weather forecasts.

The advantage of the historical NIWA data is that it covers the previous seven summer seasons when overnight facility use observations were collected. If the fields contained sufficient information they could have been used to develop and test a model over a longer

time-span, thus providing an opportunity for greater accuracy. Unfortunately this has not been the case.

The eight fields containing complete information were:

- Rain: mm/day
- Evaporation: mm/day
- Maximum Temperature: ^{0}C
- Minimum Temperature: ^{0}C
- Grass Temperature: ^{0}C
- 0900hr Humidity: %
- 1400hr Humidity: %
- Solar Radiation: Mj/m^2

They lacked a wind component, considered essential as high wind can prevent overnight facility users moving over the tops and within the TNC. This meant that the earlier years of historical data from NIWA were of no benefit in this research.

The data obtained from NIWA for the 2000/1 summer season contained a complete and more comprehensive dataset from the Chateau site with six additional fields to those listed above. The additional fields were: possibility of snow, wind direction, wind speed, wind run, maximum wind gust direction and speed. The 14 fields have been used during GAM model investigations.

Chapter 15

Model Development

15.1 Introduction

Two suitable models for predicting overnight facility use in the Tongariro Northern Circuit are presented in this section, and two other models are discussed that produced unsatisfactory results. The first model works through the inclusion of successive factors that are believed to be the primary determinants of overnight facility use. This is the *Piecewise model development* in Section 15.2. The second model, the *GAM model*, uses the SPlus gam function to do the modelling calculations. The GAM results, as well as explanations of significant terms are presented in Section 15.3. These two models are compared in Section 15.4, and then the two unsatisfactory models (time-series and regression models) are discussed briefly in Section 15.5.

15.2 Piecewise model development

This first approach describes the development of the overnight facility use model, progressively adding components to improve it. This has been achieved using four steps. An iterative process—Step (v)—could be used to make minor improvements to this model.

(i) The trend or underlying use pattern is obtained by averaging daily facility use from previous years. This average use is simplified into a series of lines, then the fixed and moving holidays are added to give the **base model**.

(ii) **Within-week variations** are estimated and incorporated into the base model.

(iii) The observed **daily weather conditions** are compared with the model; the average proportional change is estimated for the different weather categories and applied to the model.

(iv) The **weather forecasts** are compared with the model; the average proportional change is estimated for the different weather categories and applied.

(v) Steps (ii)– (iv) could be repeated iteratively to obtain better estimates for the model, however this has not been demonstrated due to its unlikely improvement to the model with other influences not taken into account.

The first four steps are explained in greater detail and graphs included to demonstrate the model development.

The model used is a multiplicative model rather than an additive model, as initial investigations indicated that it was more appropriate to change the use proportionally due to weekday and weather effects, rather than adding or subtracting the same amount throughout the season.

How well this model fits the data is discussed in Section 15.4.

The base model

The orange line in Figure 15-1 is the average daily use obtained from the last eight years use figures. The yearly Easter peaks were removed prior to averaging as these peaks are extreme and the Easter influences would be visible even after combining with other years.

The average daily use for the past eight years was first generalised by a series of lines to give the yearly trend. The trend increases steadily to a peak just prior to Christmas, drops sharply to a low on Christmas Day, increases steadily after Christmas and remains high until the end of the statutory holiday period (when many government departments are closed). Use then drops steadily until meeting the general trend covering most of the central season. After Easter there is a steady decline in use before levelling out, and it remains low for the rest of the season.

The lump prior to the Christmas decline in use (Figure 15-1) is something that has been observed in more recent years and has been included in this initial model.

Holiday effects have been added to establish the **base model** (the black line in Figure 15-1). The holidays include the increased use for the Auckland and Wellington Anniversary weekends, the weekend before Easter, Easter, and the decreased use over the Christmas period.

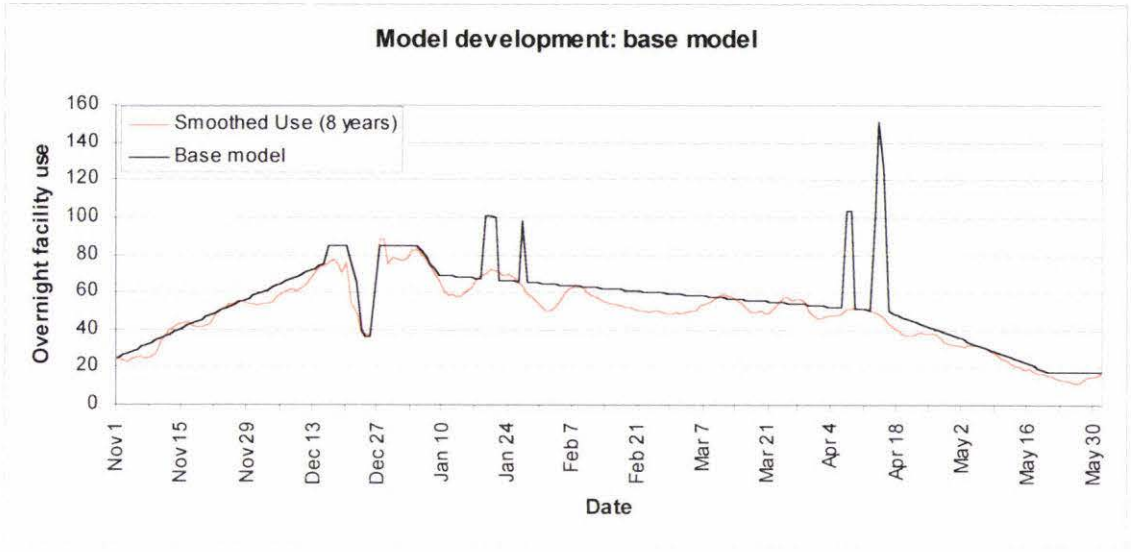


Figure 15-1: *The base model*

Within-week variations

The initial estimate of the within-week variations have been obtained by:

(i) Finding the proportional difference from actual use to the base model for every day in the season

(ii) Sorting these by day and obtaining the median proportional use for each day of the week. The results are summarised in Table 15-1. The median is used as the most appropriate average as this is not subject to extremes

(iii) The median proportional deviation *(Weekday multiplier)* is applied to the base model for every weekday (Figure 15-1).

Table 15-1: *Median proportional deviation based on day of week*

Day of week	Number of days	Week-day multiplier
Monday	29	0.949
Tuesday	30	0.907
Wednesday	31	1.000
Thursday	30	0.844
Friday	27	0.767
Saturday	25	1.132
Sunday	26	0.806

The base model is multiplied by the week-day multipliers (week-day effects) for all days that are not designated holidays. The model development is displayed on the graph below along with the 2000/1 summer seasons' overnight facility use for comparison.

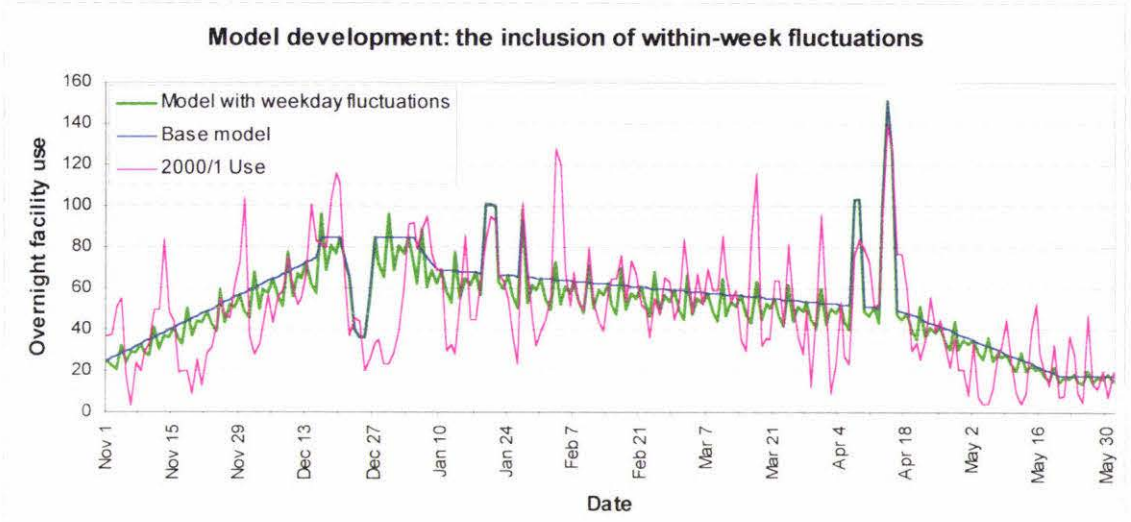


Figure 15-2: *Model incorporating within-week fluctuations*

It is worth noting at this stage that many of the peaks before Christmas and towards the end of the season do not occur on weekends and hence do not fit the developing model very well. These peaks are often the result of youth groups and an improved within-week model may result from applying different weekday proportions to the beginning and end of season. Alternatively youth could be included as a separate sequence and then added.

Daily weather conditions

The observed weather conditions at Ketetahi have been combined to represent the *State of the weather* (Table 14-3). This procedure has taken several steps and is outlined in Section 14.5. The results are summarised in Table 15-2. The median proportional deviation *(Weather multiplier)* is applied to the intermediate model containing within-week fluctuations to incorporate the weather on that day (Figure 15-3).

Table 15-2: The average proportional influence based on the morning weather observations

Category	State of weather range	Number of observations	Weather multiplier
Good	0–5	66	1.098
Fair	5.5–10	49	1.008
Inclement	10.5–17.5	41	0.973
Bad	18–21.5	21	0.732
Very Bad	22-38	35	0.588

A significant improvement is visible in Figure 15-3, particularly with the period of bad weather that occurred just after Christmas. The correlation coefficient moved from 67% to 77% (Table 15-4) indicating that this model now explains over three quarters of the variation, and the inclusion of the morning weather observations reduced the previous unexplained variation by almost one third.

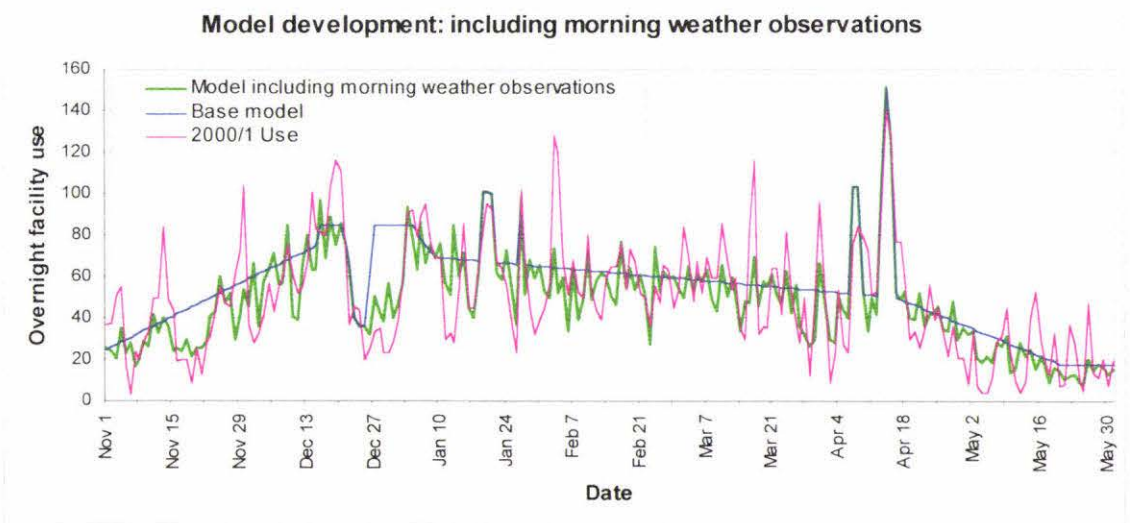


***Figure 15-3:** Model incorporating the morning weather observations*

Weather forecasts

The same procedure is applied to the use of three-day weather forecasts to improve the model. Firstly the proportional deviation is calculated for each day of the summer season (observed use divided by weather model), then the median for each forecast category is found and applied to the previous model. The results are displayed in Figure 15-4.

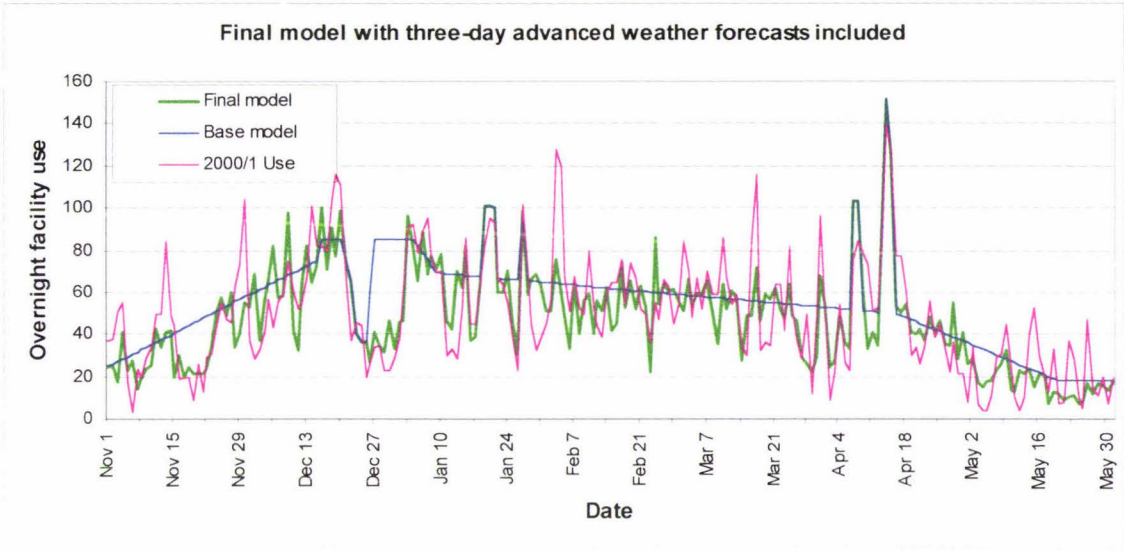


Figure 15-4: *'Final' model which incorporates the projected three-day weather forecast*

The calculations of the weather forecasts produced some interesting results (Table 15-3). Using the three-day advanced forecast suggests that two days of bad weather is more of a deterrent than three days of bad weather. I assume this is due to international users who are prepared to delay their entry for one or two days to complete a trip in the TNC, but they are not prepared to wait three days (due to their own time/travel constraints in seeing other parts of NZ). Some of these enter the Circuit to complete the trip in bad weather knowing it is unlikely that the weather will improve while they are in there, but they want to complete the trip anyway. This also provides an explanation of why use does not drop to zero during the peak use season, even in the most extreme conditions.

Table 15-3: *The average proportional influence based on the three-day forecast*

Three day weather forecast (see Section 14.6)	**Number of observations**	**Forecast multiplier**
B1	44	0.970
B2	51	0.755
B3	14	1.135
G1	26	1.154
G2	6	1.381
G3	71	1.024

Further iterations and improvements

It is likely that the model would be improved slightly by repeating the three steps—within-week variations; daily weather and weather forecasts—however significant improvements are unlikely due to the limitations in the model. These limitations include:

- The failure to incorporate midweek youth-use near the beginning and end of the summer season
- The higher use period on weekends such as the weekend nearest Waitangi Day. This is not evident in all past years and may be related to Waitangi Day's proximity to the weekend and/or weather conditions on that day
- 'Unusual' events such as the very high use during the bad weather just after 29 November (Figure 15-3). Preliminary investigations indicate that this was a school party that had intended to camp away from the facilities, but due to the conditions sought the shelter of the TNC huts.

Model improvements in correlation coefficient

To indicate the changes in the significance of each successive term included in the model the correlation coefficients are provided in Table 15-4.

Table 15-4: Correlation coefficients indicating the improving model

Model comparison with the observed use	Correlation coefficient
Past seven-year averaged use	0.537
Base model	0.659
Weekday included	0.674
Morning weather observations included	0.767
Three-day forecast included	0.793

Model application

To apply this model:

(i) Read the averaged use from the base model for that day

(ii) Next multiply by the weekday factor (Table 15.1)

(iii) Then multiply by the observed weather factor for that morning (Table 15.2)

(iv) Finally multiply by the three-day weather forecasts (15.3).

15.3 The GAM model

This second approach uses the SPlus gam (generalised additive model) function to establish a suitable model of overnight facility use in the Tongariro Northern Circuit based on the 2000/1 summer seasons use and the NIWA dataset for the same period.

An introduction to the mathematical theory behind GAM modelling is presented first, with the description of why this method is considered appropriate for modelling the overnight use on the Tongariro Northern Circuit. Then the final GAM model is presented before discussing the significance of the terms, the graphical output and other investigations.

The gam function comes within the SPlus *Modern Regression Module* as the methods are computer intensive and have only been feasible with the development of computers and their computational power, hence the term modern.

Background theory for GAM models

The two steps below are used by Venables and Ripley (1996) to describe the formation of the SPlus Modern Regression *generalised additive model* (GAM). The first step is the extension of linear models to accommodate *non-normal responses distributions* and *transformations to linearity*, this is the foundation of generalised linear models (GLMs). The second step extends the GLMs to GAMs. More detailed discussions of these steps for GLMs and GAMs are provided in McCullagh & Nelder (1989) and Chambers & Hastie (1992) respectively.

Step 1: The GLM

GLMs allow a unified treatment of statistical methodology for several important classes of models.

If Y follows a known distribution with mean μ, predictor (observed) variables $X_1,.. X_p$, the linear coefficients β_j, then we assume that:

$\ell(\mu) = \alpha + \sum_{j=1}^{p} \beta_j X_j$ where ℓ is the link function.

For a given distribution in the exponential family, the variance of Y will be a known function of μ (to within a scale parameter) and the parameters β can be estimated using iteratively re-weighted least squares (see McCullagh & Nelder, 1989).

Step 2: The GAM

The generalised additive model (GAM) extends the GLM to include nonlinear functions (Hastie & Tibshirani, 1990). Some or all of the linear terms $\beta_j X_j$ can be replaced by smooth nonlinear functions f_j. The GLM general form becomes the GAM:

$$\ell(\mu) = \alpha + \sum_{j=1}^{p} f_j(X_j)$$

How this relates to the overnight use of facilities on the Tongariro Northern Circuit.

The GAM seems an appropriate model due to:

- Use is Y in the model, and this is count data which suggests a Poisson distribution is appropriate.
- The Use dataset is believed to be determined by a number of effects, which include time of year (the base model, see below), holidays–such as Easter, the day of the week, and the weather conditions.
- The base model or underlying annual pattern appears well modelled as a non-linear smooth function of time (variable DayNum). This is non-linear, hence GAM not GLM.

The effects appear to be multiplicative, such as the Easter effect being approximately three times the ordinary use, which suggests the log link function (and this is the default canonical link for Poisson).

The base model and the choice of lowess span length

The base model is similar to that used in the earlier piecewise model, but the base model is now estimated simultaneously with the other effects in the GAM model.

The lowess smoothing option has been used because it required no prior assumptions of the underlying data, and it is robust, yet allows the easy alteration of the degree of smoothing. The degree of smoothing is altered by changing the span length.

The span length is the proportion of all data observations taken into account for estimating the smoothed (predicted or expected) value. The points used are those in the vicinity of the point being estimated, with nearby points given the most weight and a robust weighted regression is used in the prediction (Venables and Ripley, 1996). A span length of 0.2

represents 20% of the data being used in the estimate, thus with 212 observations in the data set 42 observations are used.

An appropriate span length is determined graphically in Figure 15-5. The span of 0.2 is used in the lowess smoothing as it provides responsiveness to conditions that are not observed with a span of 0.3, and is not overly responsive to weather conditions as observed with a span of 0.1. One of the key areas for the determination of span length was the drop in use between around the Christmas–New Year period, this is visible after day 50 in Figure 15-5. Part of this decline was related to the Christmas Day/Holiday and part due particularly bad weather that followed. The span length of 0.1 was too responsive, following the observation too closely to allow the more accurate determination of holiday and weather effects. The span length of 0.3 lacked any visible response during the week of particularly low use, indicating that it might not be a particularly good estimate of the trend. The choice of the span length of 0.2 was a compromise, showing some responsive to the long low use yet not too much. This also was close to what I have become accustomed to with longer-term moving average time-series models, so though subjective the smooth line looked representative.

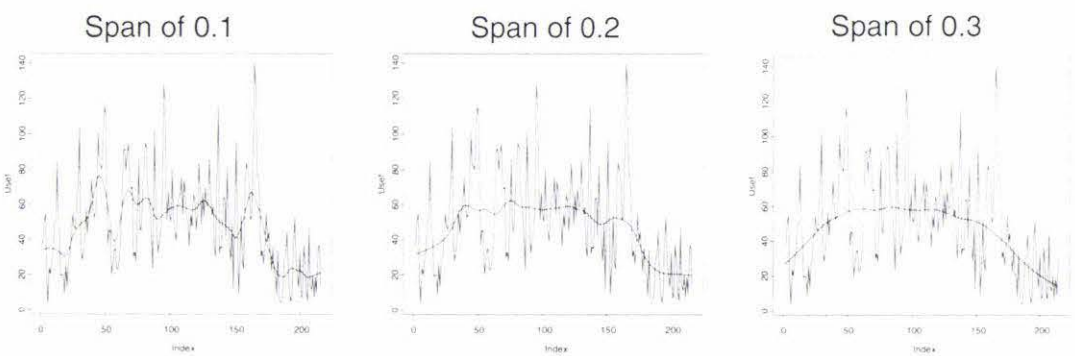


Figure 15-5: *2000/1 Use series plotted with different lowess (smoothing) span lengths*

The application of GAM

In SPlus the GAM model was defined as:

gam(Use ~ lo(Daynum, span = 0.2) + Easter + Xmas + DoW + nrain + nmntemp + Radn + wind9am + nsnow + Windgust, family = poisson)

The model used the 2000/1 summer season Use dataset containing the number of overnight facility users each that night (Use), the day-number (Daynum), the Easter effect (Easter), the Christmas effect (Xmas) and the corresponding NIWA dataset which included the

precipitation, minimum temperature, solar radiation, wind speed at 9 AM, possibility of snow, and maximum daily wind gust.

The coefficients are obtained from the SPlus output (Appendix Y) for use in the model and these are substituted into the model for predicting (mean) Use:

Use = exp(intercept + lowess effect + Easter effect + Xmas effect + DoW effect + nrain effect + nmntemp effect + Radn effect + wind9am effect + nsnow effect + Windgust effect)

Applying these, the GAM model of overnight use is:

Use = exp(4.389 – 2.411×lowess_value + 1.321×Easter_value – 0.739×Xmas_value + DoW_value – 0.0035×nrain_value – 0.022×nmntemp_value + 0.0077×Radn_value – 0.017×wind9am_value + 0.399×nsnow_value – 0.017×Windgust_value)

where the values of the six NIWA variables come from the NIWA dataset and the Easter and Xmas values from the Use dataset. The DoW value is given with the other SPlus coefficients and summarised in the Table 15-5, but the lowess_value needs to be estimated from the graphical output (first graph in Appendix T) or printed out and read directly from the SPlus output.

Table 15-5: *Day of week multipliers (DoW_value) for use in the GAM model*

Day of Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Multiplier	0	0.007	0.020	-0.012	-0.014	0.039	-0.005

To apply this model for predicting the next season's use (assuming no general increase in use) the predetermined values could be grouped into a *base-model*. This would simplify the formula by grouping the first five terms (intercept, lowess effect, Easter effect, Xmas effect and DoW effect) into a single term, and then this leaves the estimation of the six NIWA variables before application. Two of these are usually determined in the morning (nmntemp and wind9am), two are often zero or readily predictable (nsnow and nrain), leaving Radn and Windgust to estimate. This then appears manageable but with the degree of computation required it would be more usable if a pre-programmed function was set up on a calculator or spreadsheet template. The need for the exponential function would likely hinder park managements ready interpretation of the formula, however if pre-programmed they would not need to have a working knowledge of how it the model works.

Simplified GAM model:

Use = exp(base_model_value – 0.0035×nrain_value – 0.022×nmntemp_value + 0.0077×Radn_value – 0.017×wind9am_value + 0.399×nsnow_value – 0.017×Windgust_value)

The significance of the terms in the model

By removing terms individually from the final model it is possible to assess the significance of the individual terms in the model. The output shows the degrees of freedom and the reduction of sum of squares and this is summarised in Table 15-6. The level of significance (p-value) is also provided in the table indicating that all terms used are highly significant.

Table 15-6: *The significance of individual terms in the GAM model*

Term	Degrees of freedom	Reduction in sums of squared deviance	p-value
lo(Daynum,span=0.2)	9	589.2	0.000
Easter	1	193.3	0.000
DoW	6	93.8	0.000
Xmas	1	42	0.000
wind9am	1	56.5	0.000
nmntemp	1	42.1	0.000
Windgust	1	23.1	0.000
nrain	1	21.8	0.000
nsnow	1	19	0.000
Radn	1	12.5	0.000
The later inclusion of derived variables gave the following successive improvements			
WxCat	4	83.2.	0.000
Forecast3	6	120.2	0.000

There may also be significant interactions between these variables but these would introduce an even greater level of complexity and have not been investigated here.

Graphs

Plotting the resulting GAM model with the standard error option (se=T) allows for the visual comparison of categories within terms in the model and their significance, as well as an indication of the significance of non-categorical terms. The full set of graphs is provided in Appendix T, however the main graphs of interest are provided in Figure 15-6.

The width of each category is representative of the relative number of observations in it. Note in Figure 15-6 that usually the categories with the greatest number of observations have the smallest interval representing a greater level of certainty in the estimate. The significance of the individual category can be assessed by checking whether the interval includes zero on the vertical scale. If it does not include zero then it provides a significant influence. The relative difference between categories can be judged informally by checking whether the category intervals overlap. If they don't overlap then they are significantly

different from one another. If they do overlap they may still be significantly different. The GAM deviance analysis described earlier gives a formal test of overall significance.

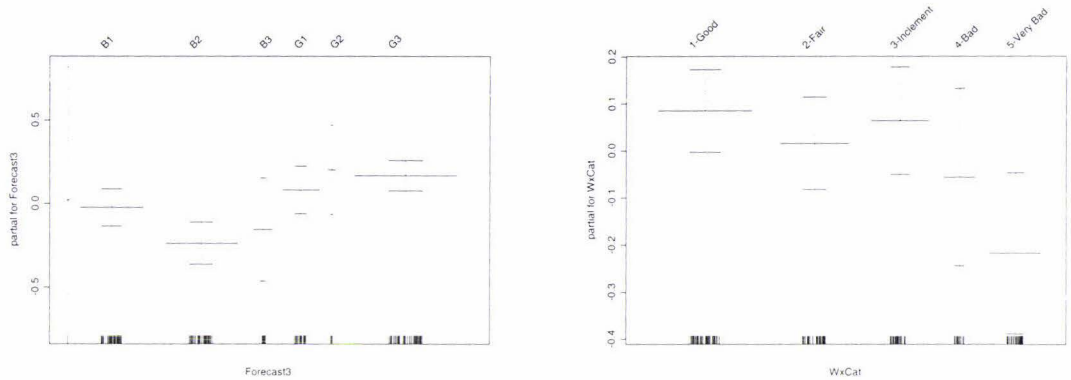


Figure 15-6: *Categorical variables added to the GAM model*

With reference to Figure 15-6 the three-day advanced forecast *(Forecast3)* categories have two significant categories: B2 and G3, and they are significantly different from each other. The only significant category in the *WxCat* (observed morning weather) is *Very-bad* weather leading to a reduction in Use.

Similarly in Figure 15-7 the only day with a significant increase in Use in this model is Saturday, but the Saturday use may not be significantly different from Wednesday (due to the overlapping confidence intervals).

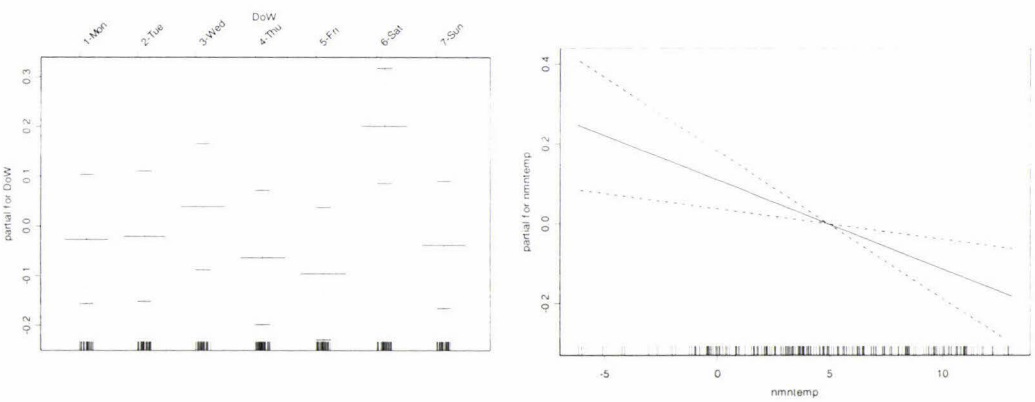


Figure 15-7: *The significance of other GAM terms*

The minimum temperature term *(nmntemp)* is significant, as zero is not included everywhere throughout the entire temperature range. What is interesting is that the graph indicates that as the minimum temperature increases, use decreases. This phenomenon can be explained by the usual drop in overnight temperatures on cloudless nights. On nights when it is cloudy or even raining it is usually warmer than on cloudless nights.

The possibility of snow (*nsnow)* had only six positive observations, included zero in the confidence interval, and showed an increase with the potential of snow. This seemed natural as snow would be preferable to rain. All other terms behaved as expected (see Appendix T for the graphs). The graphs for *nrain*, *Radn*, *nsnow* and *Windgust* all marginally included zero in their confidence interval plots, however I took the model alterations and results in Table 15-5 as the most accurate determination of significance.

Other investigations: individual year and DoW effects, then the DoW interactions with year

Ideally, improvements for the 2000/1 summer GAM model could have been made by obtaining a better estimate of the day-of-week effects based on the past five years of data. If these could be fixed in the current model with the better estimate, the results should be more appropriate. Two models were set up from using the last five seasons of data:

oneseq6.gam<-gam(Use6~lo(daynum1,span=0.2)+DoW6+Year6+Xmas6+Easter6,poisson)

and

oneseq6int.gam<-gam(Use6~lo(daynum1,span=0.2)+DoW6*Year6+Xmas6+Easter6,poisson)

There were no visible differences between the year (Year6) and day of week (DoW6) categories plotted in Figure 15-8.

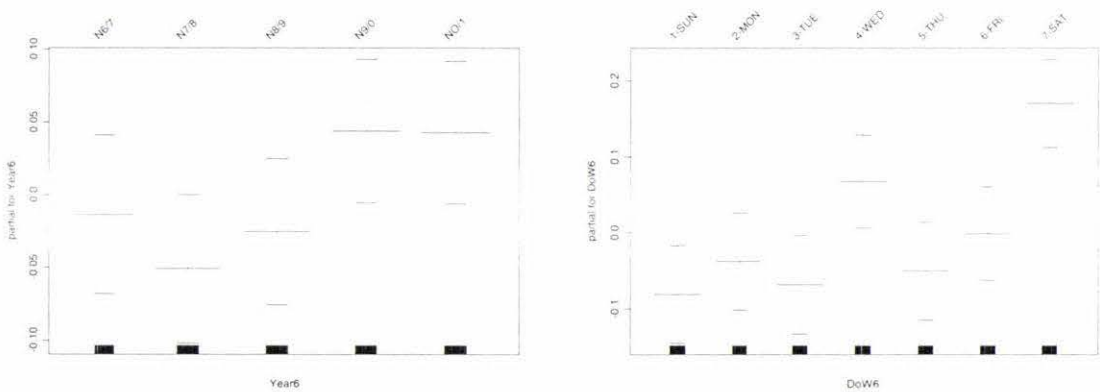


Figure 15-8: *Individual year effects and longer term day-of-week results*

When considering the differences between the two models the model containing the year by day-of-week interaction (oneseq6int.gam) indicated a significant improvement. However, further investigations into the fluctuations that caused the significance identified numerous differences between years, making them hard to characterise. This suggests that there is little to be gained by using data from past years.

The results of the analysis are in Appendix V. My concerns were that the GAM modelling was finding the best fit for the data provided, including fluctuations in weather (not accounted for in the model used) and anomalies (such as unexpected freedom-camping high school use during extreme weather) that were not investigated and removed from the data. When comparing these imperfect models, significance could be related to the poor quality of the initial models, the data, or correlation between the data variables used. This being the case, no advantage was likely to be gained from pursuing model improvements in this way.

Residual analysis (see Section 15.4) shows unexplained correlation which may account for the high significance of many terms in the GAM model.

15.4 Model comparisons

The two models are plotted with the observed use in Figure 15-9. There is little apparent difference between the two models. A plot of the residuals (Figure 15-10) confirms this.

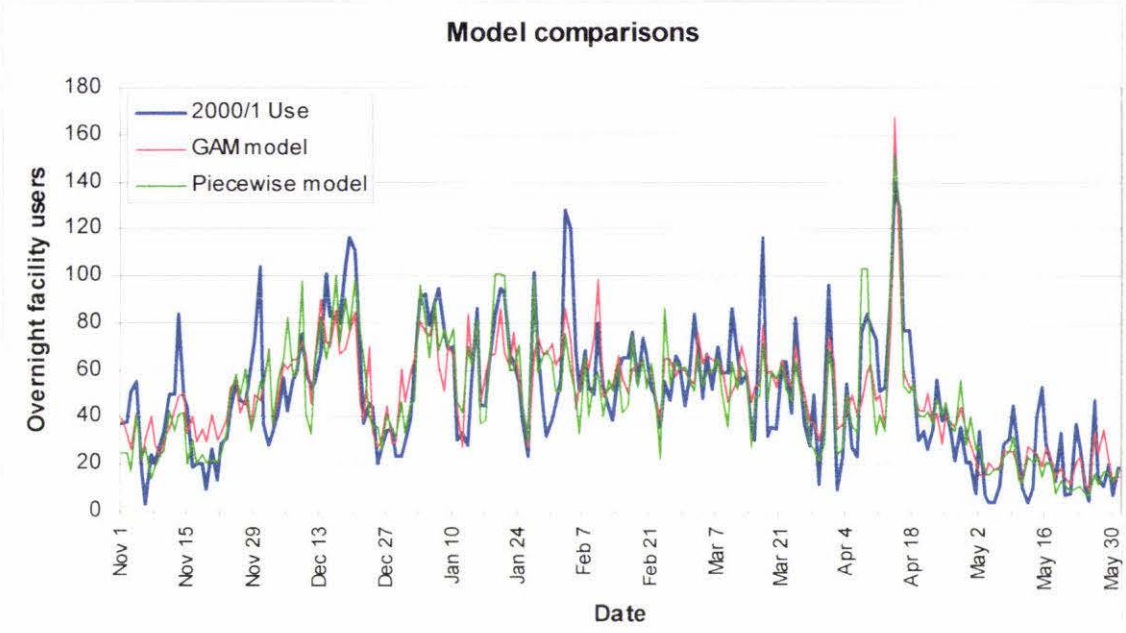


Figure 15-9: *Plots of the two models with the observed use*

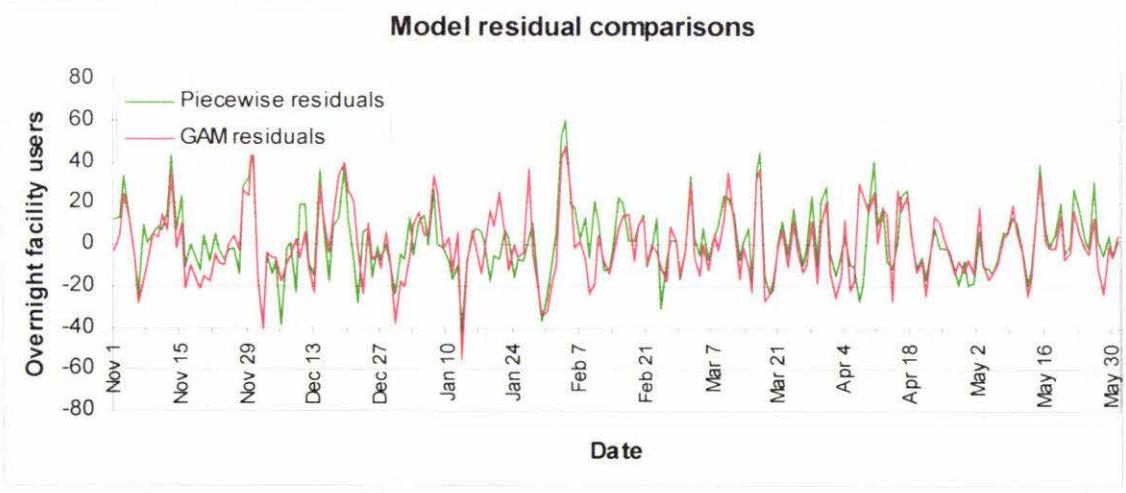


Figure 15-10: *Plot of the residuals for the two models*

The residual tests (output in Appendix X) are almost identical for both sets of residuals indicating non-constant variance, non-independence, too little fluctuations and non Gaussian distribution. This is not surprising considering the nature of the original data.

Table 15-7: The advantages and disadvantages of the two models

Advantages and disadvantages of the two models	
The advantages of using the gam function within SPlus are:	**The disadvantages of using the gam function within SPlus are:**
• It automatically takes into account the count data when specifying it is a Poisson model	• The model is fitted for, and incorporates all unusual or extreme observations that are not explicitly specified
• It automatically selects a multiplicative model which is most appropriate for the conditions	• There is a loss of control due to the iteration process
• It performs many iterations finding the best model for the parameters specified	• Some output is difficult to account for, such as year by day of week interaction
• It automatically determines the trend for the smoothing factor that is specified with the lowess span length	• There are some spurious interactions that appear to be significant
• It allows for interactions between terms if specified in the model	• It is harder to interpret the coefficients and apply the model
• It can readily examine the significance of terms in the model and gain estimates of some effects	• It is not as easy to understand due to variable transformations and the resulting scale
• It provides a mechanism for testing the significance of the inclusion of different terms into a model	
Advantages of the Piecewise model are:	**Disadvantages of the Piecewise model are:**
• It is simple to apply	• It requires a setting up stage for the base-model, with the inclusion of the annual and moving holidays
• It is understandable, justifiable and all methods make sense	• It is not statistically robust. It is developed based on intuition and logical/rational choices for use of median over mean for model multipliers. Choices are justifiable but are more subject to criticism than using existing models with automated settings.
• It is a very good fit considering the simplicity of the model.	

Main similarities between the models

Both models:

- fit the data very well, explaining approximately 80% of the variation in the original use dataset.
- can be seen as having a base model which can also incorporate the holiday and day of week variations throughout the summer season.
- are multiplicative with the effects of holidays and weather
- have used only the 2000/1 season's weather data to determine the weather effect in the model. This was unfortunate, but necessary as the earlier NIWA datasets were incomplete. The hut warden observations and mountain weather forecasts were only collected for the 2000/1 summer season.

Main differences

The **base model** in the piecewise model was developed from the previous six years of observed use, then simplified into linear sections. In the GAM the use of all six years would have necessitated the inclusion of interaction terms for the effects which were not stable over the six years, resulting in a very complex model. Therefore in the GAM the base model was estimated from only one year.

The **weather datasets** differed substantially between the two models. The piecewise model used two categorical variables, one determined from the three-day advanced weather forecasts and the other from the hut warden morning weather observations. The GAM used only the NIWA dataset with recording captured electronically.

Summary

There is little difference between the two models with regards to their closeness of fit with the existing data, however there is greater statistical validity for the GAM model due to the theoretical foundation. The simplicity of the piecewise model would make it preferable for use in the field, and for general understanding of the effects of daily weather and weather forecasts. If the yearly base models were set up in a spreadsheet template requiring only the estimates to be entered, they are expected to provide equivalent results.

The inclusion of the daily categorical weather observation and three-day weather forecast into the GAM indicated both were significant, however time did not allow further investigation.

15.5 Multiple regression model and time series analysis

Neither of these showed particularly promising results.

In time series analysis the standard procedure is to transform the data first to form a Gaussian series. With the Use series differencing improves the shape of the distribution by removing the trend; this also removes the annual *base-model* (as depicted in Figure 15-1).

Other problems encountered with the time series data included:

- Difficulties providing a suitable link between the seasons. Linking the seasons with many zeros for the months between summer seasons, or even shortening this period does not seem to aid the modelling analysis.

- The historical weather data from NIWA lacked critical field information that has been shown to be significant.

Work on regression models stopped with the development of the more promising models described previously. The best model obtained (prior to the availability of the weather forecast data) was

$$Use = -16.2 + 0.453 \times Use(t-1) - 0.161 \times Use(t-2) + 0.6131 \times mdldow + 0.6138 \times Wxgdns$$

The series used in the model include the lags of the Use series, *Use(t-1)* and *Use(t-2)*, a base-model series with the day of week variations incorporated *(mdldow)*, and a series indicating how good the weather was *(Wxgdn)* calculated from the original *State of the weather* introduced in Section 14.5 *(Wxgdn = 42- State of the weather).*

This explained less than two thirds of the variation (taken from the R^2 value). The appropriate output and analysis of the residual is in Appendix U.

Part VI

Summary, Conclusions and Recommendations

Chapter 16

Summary, Conclusions and Recommendations

16.1 Summary

Three main sources of data collected during the 2000/1 summer season have been used to put together this snapshot of overnight facility use. They include a summer survey (n = 1,090) conducted for this research, along with the Great Walks pass butts and hut warden observations of site use.

The overnight facility use on the Tongariro Northern Circuit is characterised by both high fluctuations and the diversity of trips undertaken by overnight facility users.

Despite the highly fluctuating nature of facility use, an underlying seasonal trend exists. The trend shows annual effects of holidays, such as Easter, Christmas and anniversary weekends. Some of the fluctuations around the trend can be seen as weekly cycles regularly peaking on weekends, and larger deviations from the 'expected trend' caused by prolonged extreme or inclement weather. Initially there appears to be the basis for model development based on time of year (proximity to holidays), day of week and weather conditions.

Over 100 different trips—noting differences in direction of travel, length of trip and hut combinations used—were recorded in the 1,090 surveys collected midsummer 2000/1, with the two most popular trips accounting for about 10% of the total use each. The two most common routes for overnight facility users are the *Circuit* (53%) and the *Crossing* (25%), and these predominantly followed the clockwise and northerly directions respectively.

Other key observations from the surveys are as follows:

- International users completing the *Circuit* make up 41% of all overnight facility users.
- International users tend to tramp either singly or in pairs and they tend to stay slightly longer than New Zealanders.
- New Zealanders tend to be in larger party sizes than their international counterparts and they show a greater diversity of trip patterns.

- The proportion of New Zealand users differs significantly from international users in the following areas (with respective proportions in brackets): previous visits to the park (29%, 5%); aged 40 years or over (29%, 13%); those who experienced extreme crowding (17%, 7%); those who indicated that their trip was worse than expected (17%, 9%).

When considering the movement within the park:

- The track section of highest use by overnight facility users lies between the Tama Lakes and Ketetahi Hut. This higher use is primarily due to the *Circuit* users who spend a night at the Ketetahi facilities and have to double back over this section of track. This group represents approximately 28% of all overnight facility users and 54% of *Circuit* users.

- The *Ditch* is used by approximately 45% of all overnight facility users, with the majority staying a night at Mangatepopo.

- The majority of the overnight facility users heading up the Mangatepopo Valley, who are spending another night in the park, stay at Ketetahi.

- Most (87%) of those completing the *Circuit* spend a night at Waihohonu, which is experiencing both the highest consistent use, and the highest overall use during the summer season.

When comparing the 1993/4 survey results with those of 2000/1:

- The proportion of New Zealand users has not changed.

- Significant changes have occurred in the use patterns with (i) a change from the *Crossing* to the *Circuit* as the most preferred route, (ii) the reduced usage of the once most-popular Ketetahi overnight facilities and (iii) an increased proportion moving in the main direction of travel. With these changes, the use of facilities on the Eastern and Southern sides of Ngauruhoe has increased 40–70% when compared with seven years ago.

- The following proportional changes are also significantly different between surveys: the gender balance is evening out with the drop in the proportion of males (65% to 54%), the increase in those aged 40 years and over (14% to 18%), the increased proportion of

those experiencing extreme crowding (5% to 10%), and the increase of first-time international users (92% to 95%).

The analysis of the Great Walk pass butts reveals that:

- New Zealanders account for 30%–40% of the annual overnight facility use and are typically the cause of the higher weekend and holiday use.

- Youth users make up 7% of the annual users, they are predominantly New Zealanders and their use of the overnight facilities is concentrated at three main times in the year—pre-Christmas, around Easter, and near the end of the season—with low use during the summer school holidays.

All facility sites show large irregular within-week fluctuations in use. During the central season (1 December–30 April) each facility typically experiences a weekly low of around four users and a high in the mid-to-high twenties. The weekly maximum site use frequently exceeds the number of beds in the hut. Even though the huts have bunks for 24–26 people, crowding—congestion and cramped conditions—occurs well before the bunks in the huts are full. The indication is that congestion may start when the huts are only half full. This problem is due to the initial design of the huts, which were built 30 years ago when the user group and use characteristics of today could not have been imagined.

16.2 Conclusions

As has been shown, the trip patterns in the Tongariro Northern Circuit have changed significantly.

Use follows a predictable pattern seasonally showing the influences of public holidays and day of week. The use deviates from these pre-determined influences during times of bad weather and bad weather forecasts. A simple model has been developed that explains over 80% of the variation. This includes the extreme deviations dropping the modelled use by 56% (*very bad* weather with bad weather forecasted to two more days) to an increased use of 52% (*good* weather with the weather deteriorating three days hence). These extreme alterations in use seem quite reasonable, particularly with an increased understanding of use patterns. The worst-case scenario (56% drop) is caused by users delaying their entry so that they are likely to experience good weather towards the end of their trip. The increased use

(52%) can be seen as those flocking into the Circuit to complete their trip while the weather is good.

Overall use has increased but there have been no corresponding developments taking place to address the space and general congestion issues within the TNC huts. These issues were noted seven years ago in the Great Walks report.

16.3 Recommendations

There are a number of recommendations that have been made throughout this thesis, however it is appropriate to refer to them here and elaborate further in some areas. Though this research and thesis focus on the Tongariro Northern Circuit, these initial recommendations are more general and relate to DoC as a national body.

Procedures need to be established within DoC to ensure that useful information flows from the recreational areas, through local management, conservancies, and where appropriate to Head Office. As well as this more information needs to be made available for the public to allow them to make more informed choices of where and when to visit.

In many places there is a shortage of information being collected, and in some cases this is through a lack of planning and forethought as to how information can be collected with minimal effort. The three main sources of information used in this research can attest to this. The hut warden observations and almost all of the Great Walks pass butt information are entered onto the computer as part of routine management. With minor changes the accuracy of the information can be improved for statistical accuracy and completeness (refer to section 13.3 page 100 and 13.4 page 101). The surveying itself was carried out by DoC summer staff (the hut wardens) as part of their existing evening duties so that it increased their workload only minimally. The recommendation for DoC is to set up these situations nationwide where useful information can be gathered for both management and public information, thus allowing for more informed management decisions and greater public awareness relating to the recreational experiences available.

In some cases the information is being collected already, but few are aware of the full potential contained within the datasets. This is the case with both the hut warden observations and Great Walks pass butts. The research conducted here attests to the additional information that can be obtained, and the potential benefit for management.

If there was to be a greater inflow of information DoC would need to employ additional staff for the analysis and reporting of the incoming data, but the value of the information (as contained in this report) really is priceless. Advantages of scale would mean that similar information gathered in different locations could be processed using the same procedures, and software could be developed (such as macros or templates) to give local management instant information about the data they have collected.

Recommendations specific to Tongariro Northern Circuit Management

The TNC huts cannot comfortably accommodate as many people as there are bunks. There are inadequate cooking facilities, gear storage areas, drying areas, seating and living space within the huts for the number of bunks available. These communal areas are also shared with those camping at each facility. This flaw in the TNC hut design will remain a problem, which will continue to make itself felt in the huts that are not replaced in the short term—two new facilities are currently being planned for building in the next three years (meeting July 2001). However, Management establishing a carrying capacity for the existing huts would mean an acknowledgement on their part of this problem, which could then be monitored and plans made for the future relief of the congestion.

Overnight facility users need to be provided with access to use-trend information; which would help align the Tongariro Northern Circuit recreational facilities with information services, as requested in Hugh Logan's introduction (page 6). This would allow them to avoid known times of crowding and cramped conditions. Both the Internet—the Department of Conservation's website—and information centres could be used to distribute use-trend information.

TNC Management needs to establish methods (or a framework) for monitoring changes in user groups and use patterns. It may be considered worthwhile to complete a similar use analysis, as provided here, every five to seven years, or prior to the development of every business plan so that they can best meet the needs of the users.

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The following documents have been referred to in this thesis, as well as personal communications with Department of Conservation staff and retired staff. These are:

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Personal Communications:

- Jimmy Johnson: Email 10 October 2001, Senior Hut Warden/Hut Warden Co-ordinator, Department of Conservation
- Neil Small: 9 November 2000, Retired Staff, Department of Conservation.

Department of Conservation
Te Papa Atawhai

Visitor Survey [Summer Season 2000/01]

This survey should be completed on your last night on the Tongariro Northern Circuit (TNC). The information gathered this summer is being used in the creation of the next Management Plan later this year. Your participation would be appreciated so that management can plan for the numbers using the overnight facilities and the movement within the park

All Group Members: Please give us a brief description of yourself (*tick box, fill in gap or circle choice*).

- Gender: ☐ Male ☐ Female
- Nationality: _____
- Age (*please circle age group*)

  Under 20 20-29 30-39 40-49 50-59 60 and over
- Have you done this trip before? ☐ Yes ☐ No
- How many overnight trips like this have you done before?

  0 1-5 6-10 11-20 21-50 51-100 100+

Did you feel crowded on this trip? (*Please circle number*)

Not at all crowded		Slightly crowded			Moderately crowded		Extremely crowded	
1	2	3	4	5	6	7	8	9

Overall, I expected there would be (*tick one*) ☐ more people ☐ the same number of people ☐ less people on this trip

---

Was this trip better or worse than you expected it would be?
(*Please circle number*)

1	2	3	4	5
Very much better than I expected	A little better than I expected	It was just like I expected	A little worse than I expected	Very much worse than I expected

Site: _____ Date: __/__/__ Group no.___

Group/Party Leader
This section only needs to be filled out by the party leader (*once for each group*)

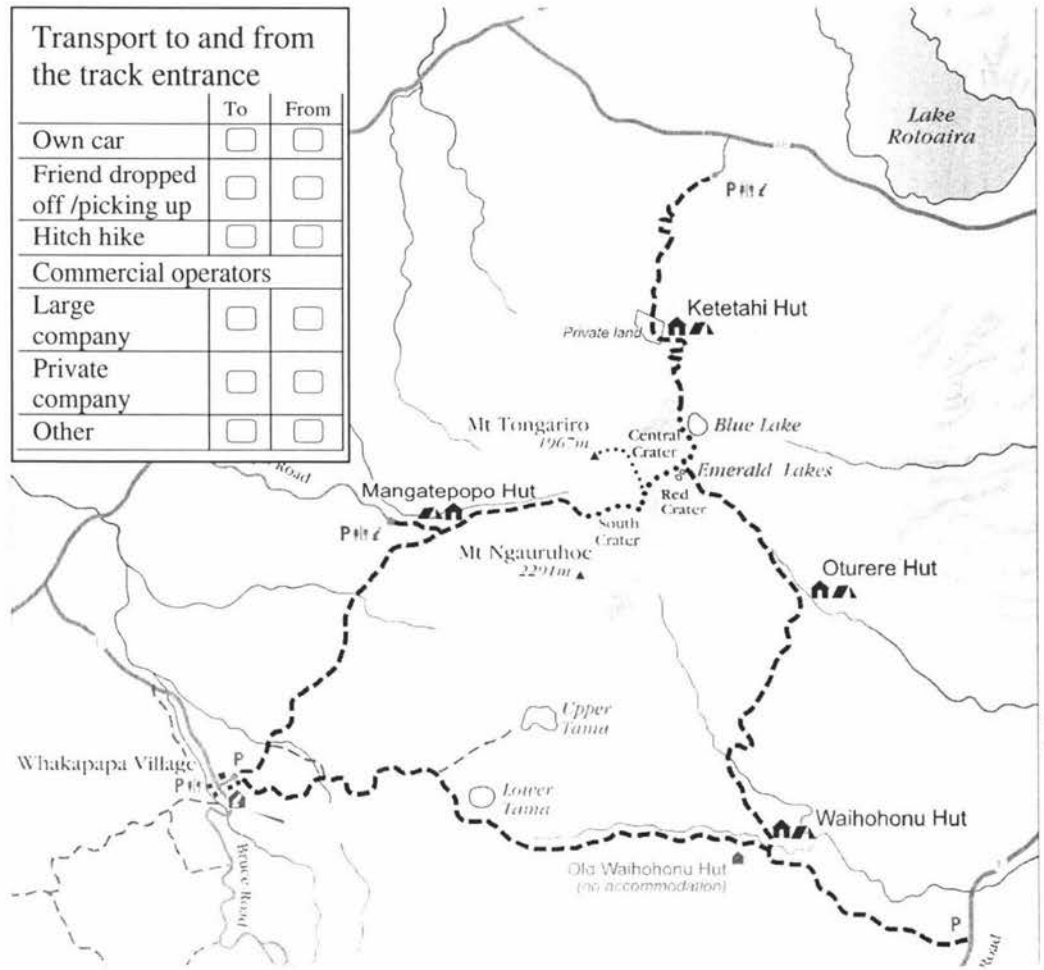
How many in your group: _____ Number of nights on the TNC: _____

On the map please:

- indicate where you have travelled within the park and your direction of travel
- circle the facilities used (hut or campground). If you have stayed more than one night at any location please indicate the number of nights.

If your party has been split between the hut and camping facilities please indicate how the split has occurred

Transport to and from the track entrance	To	From
Own car	☐	☐
Friend dropped off /picking up	☐	☐
Hitch hike	☐	☐
Commercial operators		
Large company	☐	☐
Private company	☐	☐
Other	☐	☐



Appendix A

Appendix B

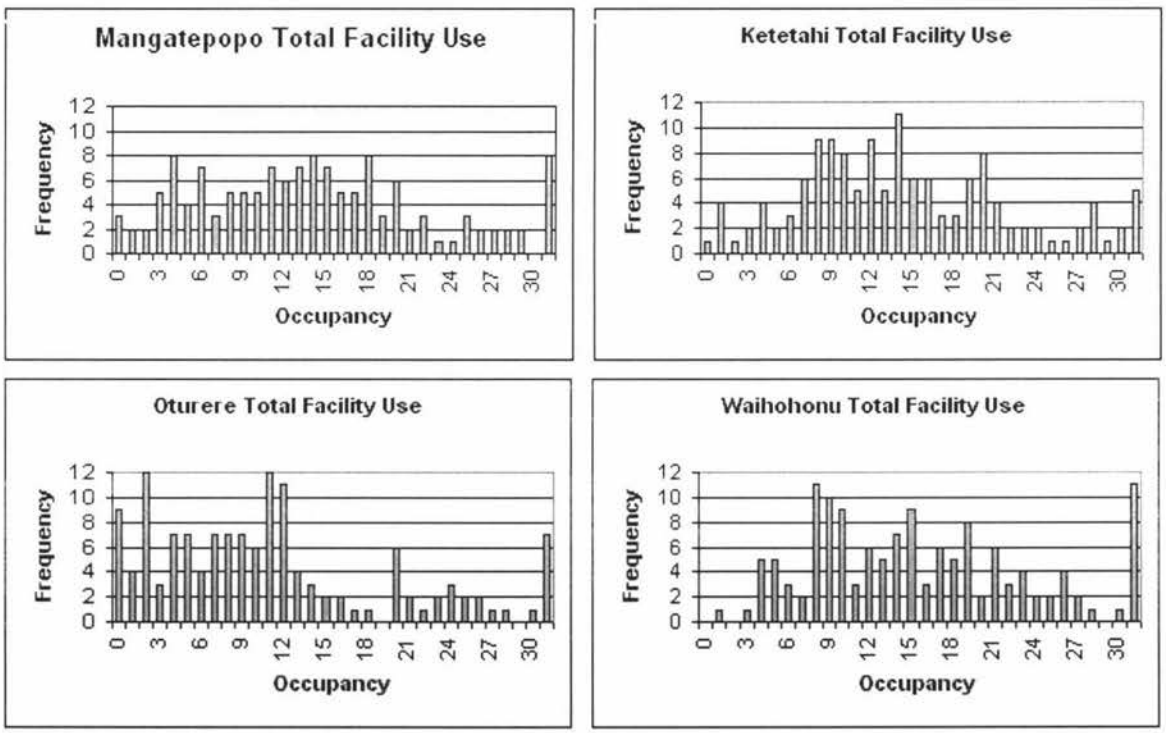
Load Analysis of TNC Facilities during the 1998-99 Summer Season

Unfortunately at the time of writing this report the most recent data available was from the 1998/1999-summer season

The following graphs represent the distribution of nightly facility use for the individual huts on the Tongariro Northern Circuit from 1 December 1998 to 30 April 1999. Total facility use is the total number of hut occupants and campers utilising the hut facilities during the specified period.

The last interval on each graph represents the number of nights the facilities exceeded 30 people. On page 2 of this report there are box and whisker plots which more accurately display the extent of the facility overloading e.g. Mangatepopo's extreme loading was in excess of 80 people (these one-offs are commonly caused at Easter).

I stopped the individual tallies at 30 people per night as (i) beyond this point the distribution thins with many uninteresting zeros (ii) I considered that 30 people using the ablution, cooking and seating facilities was definitely causing some overloading.

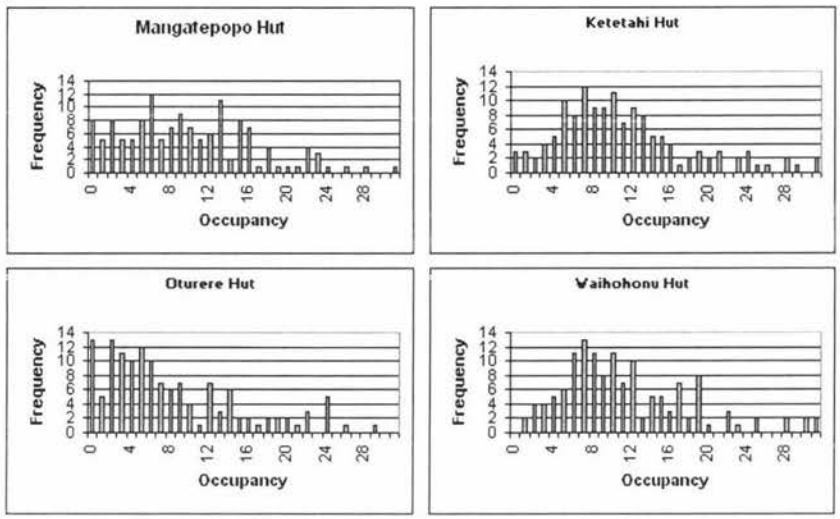


The sites exceeded 26 people the following number of times (Percentage figures represent the percentage of the 137 days between 1 December 1998 and 30 April 1999):

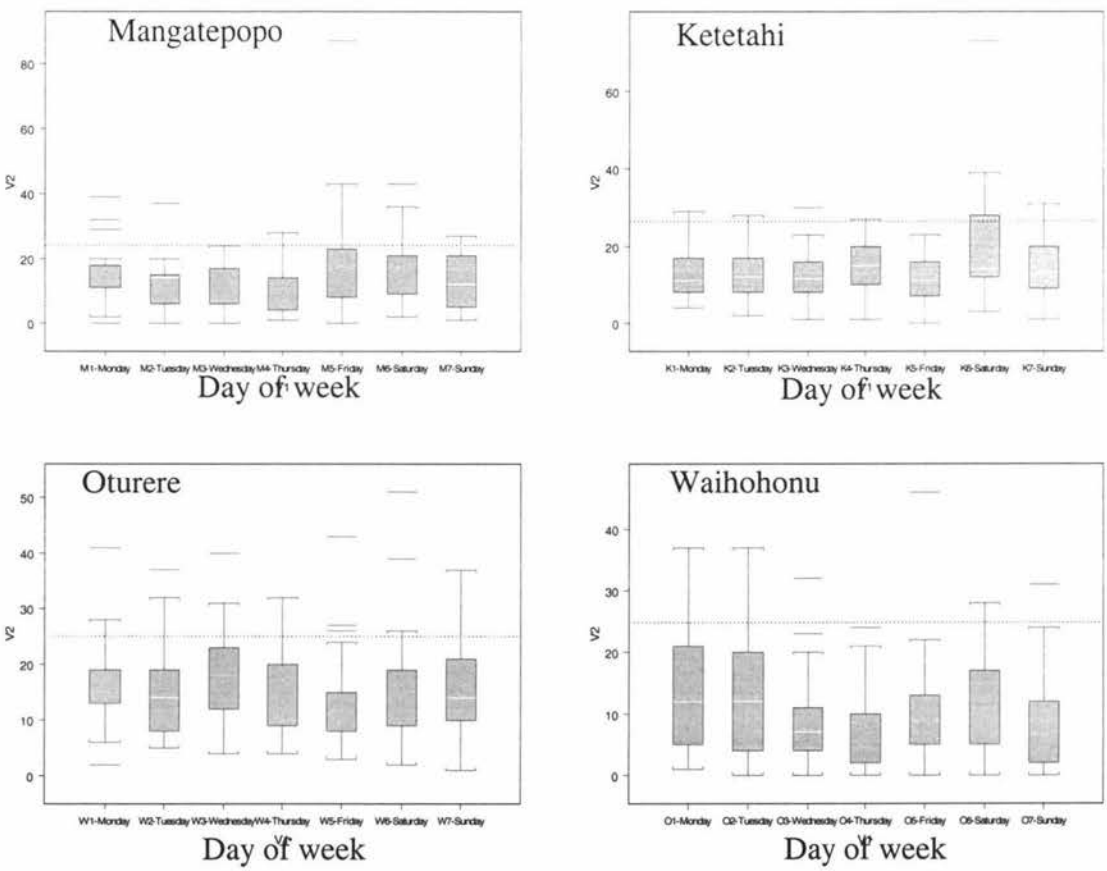
Hut/Site	Total exceeds 26	Hut alone exceeds 26
Mangatepopo	14 nights (10%)	2 nights (1%)
Ketetahi	14 nights (10%)	5 nights (4%)
Oturere	10 nights (7%)	1 night (1%)
Waihohonu	15 nights (11%)	6 nights (4%)

Appendix B

The charts below are those relating solely to hut users. These would indicate that the hut users do to create undue pressure on facilities and cause overloading.



Below are box and whisker plots of the weekday total facility use of the individual huts on the TNC for the period 1 December 1998 to 30 April 1999. On each plot is the approximate location of the 26. The within week cycle was not a high as expected by these plots indicate that (i) Ketetahi exceeded 26 on ¼ of the Saturdays, (ii) Mangatepopo exceeded 26 on ¼ of the Fridays, (iii) the busiest night for Oturere tended to be Wednesday while (ii) Waihohonu tended to be busiest on Monday and Tuesday nights.



Facility Overloading on the Tongariro Northern Circuit

It is important to work towards defining a threshold capacity for the Tongariro Northern Circuit facilities. This brief report is presented as an initial discussion to consider the overuse of the overnight facilities on the Tongariro Northern Circuit.

Background/Introduction

When the Tongariro Northern Circuit (TNC) huts were built in the late 1960s and early 1970s the present-day demands on the overnight facilities could hardly have been predicted. They were simply not designed to withstand the strain of today's needs.

Over the years, with the steady increase in use, peripheral facilities have been upgraded to meet the increased demand. These have included the upgrading of:

- the capacity of the water supplies
- the toilets
- the type of heating and cooking facilities.

Specific areas for camping for about 20 people have also been developed around the huts. These developments have increased the area's ability to accommodate larger numbers of people, but overnight facility use continues to increase, and it is now necessary for Management to assess exactly at what number of people *use becomes overuse*, and *comfortable becomes cramped.* This problem needs to be considered both from a physical perspective and a public relations perspective.

The physical perspective:

Physical space: Most TNC huts have a variety of bunks with a total equivalent of 26 mattresses. Some of the platform bunks can accommodate extra people when required, some huts have spare mattresses under bunks that can be pulled out when the other bunks are full, and most hut wardens' quarters have sleeping mats to provide a few with some padding who would otherwise have to sleep on the floor.

Even though there is sleeping space for 26 or more, the physical space available is not sufficient to comfortably house this number. Hut floor space becomes congested with no storage left for gear, and movement within the hut strictly limited.

Limited cooking facilities: During the summer season each hut has only four gas rings to cater for all of the hut and campground users. As there are frequently more than 30, this is clearly inadequate, with groups having to queue to cook their meals.

Limited bench space, seating, and table space: Most huts have only one table and seating for up to 14 people. More than half the time there are more than 14 occupants, and about 10% of the time there are more than double this number. The table and seating space then, is woefully inadequate.

Factors causing further congestion: *Inclement Weather:* Rain can lead to additional pressure on the hut facilities by bringing campers inside to socialise, as well as those who would have otherwise eaten and socialised outside, thus increasing hut congestion.

Extreme Weather: Most of the campsites around the huts are exposed to high winds, and it is not uncommon for campers to be driven to sleep inside under severe conditions. This can lead to excessively cramped huts with little room to move.

On occasions, freedom-camping school parties have been forced to take shelter in the huts as well, making conditions unpleasant.

The public relations perspective:

This looks beyond the physical discomfort of crowded conditions to the potential for public relations damage.

Management should be concerned about the possibility of tourists being left with unfavourable impressions of facilities and having disappointing experiences. The focus should be to provide such amenities that the wonderful outdoor experience of the Park is not in any way detracted from, for any visitor.

In the report *Visitor satisfactions, impact perceptions and attitudes towards management options on the Tongariro Circuit Track* (by Gordon Cessford Nov 1999, based on data obtained during the 93-4 and 94-5 summer seasons) the nine highest areas of dissatisfaction were as follows:

- Hut lighting (22%)
- Hut cooking and facilities (19%) **
- Hut relaxation space (18%) **
- Drying facilities (14%) **
- Hut washing facilities (14%)
- Hut bunk numbers (14%) **
- Campsite toilets (13%)
- Campsite rain shelters (12%) **
- Hut toilets (12%)

Since this survey was gathered, most TNC hut sites have had toilet and washing facilities improved. However, the cramped physical conditions ** continue to be a major issue and no improvements have been made in this area at all. Yet hut usage continues to increase....

Crowding levels and booking systems:

Related to the issue of facility overuse in Tongariro Northern Circuit is the question of using a booking system. It is of interest to note that the Tongariro Northern Circuit was ranked third highest on the crowding levels of the 11 Great Walks surveyed in the 1993/94 summer season. The two with higher perceptions of crowding (Routeburn and Able Tasman) have since developed and implemented hut booking systems. It is perhaps time that Management began to consider this option for Tongariro Northern Circuit.

By determining a threshold capacity Management would be able to predict, plan and prepare for a change in the style of facility management.

Summary:

With hardened campsites and huts with 26 bunks, an imbalance has been created. It is physically possible to sleep about 46 people but there is insufficient living space for this number. Hut congestion increases discomfort levels and visitor dissatisfaction. Management needs to address this.

Building larger, sheltered areas for visitors to sit, eat and socialise, would alleviate the immediate problem, however management will still need to identify a threshold level of use for the facilities.

Comfort level is now paramount in determining a satisfactory level of use. Beyond this, use becomes overuse and comfortable becomes cramped.

What is this current threshold or maximum acceptable level of use?

Department of Conservation
Te Papa Atawhai

Tongariro Northern Circuit Summer Visitor Survey

A survey of all overnight facility users is underway this summer. The aim is to get a detailed picture of the users of the overnight facilities to monitor the changing nature of both the user groups and trip patterns within the park.

This survey is an important part of a bigger study looking at the increasing overnight facility use trends within the Tongariro Northern Circuit. The information gathered this summer is being used in the creation of the next Management Plan later this year.

Your participation in this survey ***on your last night*** *on the Tongariro Northern Circuit would be appreciated.*

Appendix D

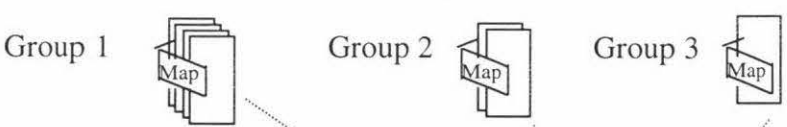
Appendix E

TNC Summer Survey Summary and Helpful Hints

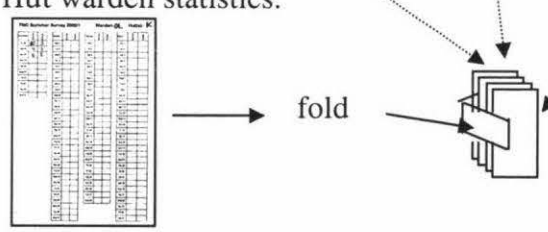
They following points should act as a guide, use your judgement to change the method so it will work efficiently for you

- The survey should only be given to those on their last night on the Tongariro Northern Circuit. The others will have an opportunity on their last night.
- Be positive in presenting the survey. They are doing us a service by filling in the form. It will help with the management of the park as DoC will have a comprehensive picture of who is using the overnight facilities and the relative popularity of the different trip/route options. This survey is important in itself, but it is also part of a bigger study looking at the increasing overnight facility use on the TNC
- If the survey is included with your checking of hut tickets it should take minimal extra time. Most of the surveys (and pens) should be returned to you as you progress around the hut/camp site.
- The party leader may be willing to coordinate getting all of their party's surveys completed.
- If one person is uncooperative, that it fine – thank them anyway, be polite and positive and move on. *It may be possible to get their age group and nationality details from another group member.*
- The top box ***Group no***. should be filled out when the survey is handed out. If the first group has 4 people and the group leader is happy to coordinate their group's surveys, hand the leader 4 surveys with the Group number 1. If not busy you may be able to complete the site letter (eg W for Waihohonu) and date as you go.

- It would be helpful for data entry and processing if the surveys came back ordered in their groups. Please fold the group leaders in half, map forward and the other group members inside. Please also scan the map to see that it makes sense.



- Fill in your trip/day count sheet, and fold with all the surveys collected inside it. Bring this and all the completed surveys out with you and give them to Jimmy with your other Hut warden statistics.



This should be the most complete set of tramper (overnight facility user) data ever collected. It should produce a comprehensive picture of the trampers, group/party composition, and trip patterns on the TNC.

Thanks, your contribution is appreciated.

Tongariro Northern Circuit Summer Visitor Survey

Additional Reading

- Survey justification and background
- Previous Great Walks' survey briefing notes
- Examples of completed maps

Tongariro Northern Circuit Summer Survey

The importance of this survey

This survey is an integral part of a bigger detailed study looking at the changing nature of the user groups and the change in use patterns within the Tongariro Northern Circuit (TNC). It is important for management to have a picture of the increasing and changing use within the TNC in order to effectively cater for those using the overnight facilities and to protect both the environment and the user's experience when using the overnight facilities.

This survey provides an opportunity to effectively gather accurate and comprehensive information on:

1. the current user group. Specifically it will identify who the users are, the party/group composition, and the level of experience of users

2. trip patterns. The results will quantify the most popular trips and facility use combinations, as well indicating how these combine to form the current pressure on overnight facilities.

3. changing use. The same information was collected 7 years ago, so it will be possible to identify, quantify and document major changes in the users of the overnight facilities and their trip patterns

The survey will also create another set of data from which further changes can be monitored in the future.

Background: previous survey.

The original TNC Great Walks Survey form was substantially longer, consisting of four A4 sides packed about 90 questions and an attached map. The objectives of the original GW Survey were different but as this summer survey repeats a few of the questions a direct comparison can be made. This summer survey is substantially shorter (only 8 questions) and should only take a few minutes for participants to complete.

Most of the following survey briefing notes have been taken from the 1993 in the Great Walks Survey training notes given to the task force green (TFG) surveyors. Nationally, most of the TFG surveyors had little prior association with DOC so much of what follows will already be understood and part of standard public relations procedures.

Back in the 1993/94-summer season there was one TFG surveyor on the TNC but hut wardens at other huts collected the majority of the surveys. Jimmy, then a volunteer, helped collect surveys over the Christmas-New Year period at Ketetahi.

The content and style of the questionnaire is designed to minimise the number of open-ended questions, and to be as short, simple and brief as possible.

Your role in the study

Your role in this study is to hand out the questionnaires and collect them off people when they are finished. This sounds simple, but this role is vital to the study. You are the people who will be meeting the public, and who will be representing the Department in this study. It is very important that you establish a good atmosphere when you are dealing with the public. If they see you in a positive way, they will be more likely to do the questionnaire. You will enjoy it more as well.

In all your dealings with the public, there needs to be a friendly, helpful and generally positive 'attitude'. There are a few key points:

- **be friendly, helpful and positive.**
- they are doing us a favour, make them feel good about it.
- explain what the study is for if they ask about it, and be positive.
- try to encourage anyone who is not keen by emphasising how helpful their responses would be, and how the study is important. If they have a particular problem with it, see if you can sort it out.
- don't worry if you can't answer all their questions, nobody knows it all. Anything major can be referred back to your managers.
- if you strike a negative person, who will not agree to do the questionnaire, take the attitude that 'the customer is always right'. Just thank them anyway and leave them feeling good.
- help anyone who is having trouble understanding questions by explaining how they work and what they mean (watch out you don't accidentally tell them which answer to make).
- don't let them do a single questionnaire for the whole group they are with, we want individual responses (that goes for couples as well).

Overall, people are happy to do these sorts of questionnaires if they think it would help, and they don't feel their own use will be affected. From this you can see that your role is vital. So, how do you go about doing the actual survey work?

Applying and collecting the questionnaire

There are three stages to this:

a) the approach and introduction;

b) discussion of the study and questions about the questionnaire; and

c) collecting the questionnaires back.

The following general points can be made:

a) Approach and introduction

This is probably the **most important** thing you will be doing. It will set the tone of the interaction, and may make the difference between getting the questionnaire done or not. Take note of the entire 'attitude' suggestions made previously, and try to make them feel good about doing it.

Make sure you approach them in a situation where they have time and conditions to complete the questionnaire. Early evening in huts for example, where they are relaxing, preparing dinner, and while there is still sufficient light (make sure you have plenty of spare pens!). In this situation you can then approach each individual (or group if they are together), and introduce yourself.

Once you have introduced yourself as a Department research assistant, and have told them about the survey and what it is about (briefly), ask them about their trip. You will have to fill in the information at the top of the questionnaire (see page 4). In some cases they will not be eligible for the survey (eg they have just started the trip, they are day visitors etc).

If they are not eligible, tell them why, thank them and move on. If they are, and they are happy to do it, leave them to it. If they are a little reluctant, encourage them as described earlier. We want to get a representative sample at the finish, so we want everybody selected to do it.

b) Answering questions

Some people will ask you questions about the reasons for the study, what some of the questions mean, and sometimes about things totally un-related to the survey. These notes will have provided you with some material to help you with such enquiries, and we are happy to answer any questions you may have which could help you with this. Please feel free to contact us about anything we can help you with.

One thing, which may be a problem where there are many overseas people, is language. Most visitors will have enough English to get by. If language is a problem, see if there is anyone else who can help the person's understanding of the questions. If you have time, try and work through it with them. We want to get everybody selected to fill a questionnaire.

After a little time in the field, you will start to 'get a feel' for this, and you find you have more answers. But if you don't know, just tell them so and refer them to Department staff if it will help. Whatever you do here, stay positive about your role, and about the study. The main aim here is to get them to complete the questionnaire. So if someone has a problem, just do whatever you can to get them through it.

c) Collecting the questionnaire

This should be easy, as people will simply hand them back to you in most cases. You may be able to check their responses, to see if there are any problems with how they have marked the questionnaires (eg circled two numbers instead of one etc). If you can get back to them and fix these, the data-entry people will have a much more simple job.

Some may ask if they can take the questionnaires with them, to be finished and returned later (drop-off or postal). Avoid this. Their intentions may be good, but it raises a high risk of non-returns. You should be staying around the site while they are filling the questionnaires out anyway, to answer questions and collect returns. You will find chatting to people while you wait is a good social and learning experience.

At the end of each of your survey sessions, collect all the questionnaires you have got done, and bring them out to your manager. Then, we take over again. THANKS!!!

Survey Brief:

Approaching people

There are a number of questions you must be thinking about when you approach someone about doing this survey:

1. Are they eligible?

They must be on an overnight trip, and in most cases on their last night on the TNC. Exceptions to this are those heading to a hut that you know will not be staffed the following night.. For your part of the survey, the following conditions apply:

2. What do I fill in at the top?

The information required at the top right of the questionnaire is the:

- **Site:** Where you are doing the survey, the first letter is sufficient; **K**etetahi, **M**angatepopo, **O**turere or **W**aihohonu
- **Date** (easy!).
- **Group no.** To keep track of the number of groups filling in the survey each night. This number is important so we can gather information about the composition of the groups

3. What is this study for, what is it to me, why should they help us with it?

A good positive attitude and a friendly and relaxed style will be the easiest to do, and be the most effective. You also need to have a clear idea of the purpose of the study. Check the objectives of this study as shown below:

- get a descriptive profile of visitors to the 'Great Walks' (who they are)
- identify where they have gone on their trip and which facilities they have used
- identify and quantify the change in use patterns and user groups

When you have a good understanding of what the study is for, you will be able to use this knowledge to help curious people, or convince others who are suspicious of DOC's motives in doing the work. Most people will be happy to help anyway, but telling them this will help IF they are unsure. But don't spend too much time telling them these if they are happy to do a survey.

4. Will they understand how the questionnaire works?

It is very useful for you to be **familiar with the questionnaire.** It can make things very easy if you know clearly how each question works, and can easily explain it to others. A quick description of the questionnaire and it's questions will help, especially if you quickly show them through it (don't spend too long on it though). Be prepared to explain some questions more IF asked. Remember to be careful you don't tell them what they should be putting for their response though!

Left Hand Side: simple, describe themselves, circle a number for how crowded they felt on the trip overall, and whether the trip was better or worse than expected

Right Hand Side: only needs to be completed once for each group. This is relatively self-explanatory but some may want help or you to confirm that they have filled it in correctly.

How can I do all this and not put them off?

Just remember to be yourself, and be natural. Along with that, remember that your **role** is vital, and that the public will expect you to be professional. It won't take much practice to make it quite normal. Take your time early on, and remember all the hints. These are summarised on the next page.

Key Points To Remember

Attitude: be friendly, helpful, natural, relaxed, and enjoy yourself (a good sense of humour is very helpful).

Knowledge: remember what the survey is for, how their response will help, and how their help matters.

Questionnaire: remember what topics are in it, how to fill it out, what the questions mean.

Eligible: check for who should do it, who should not, why? why one cannot be done for their whole group?

Questions: answer if you can, refer to your immediate manager if you cannot, show them you are prepared to take some action (note their concern, and pass it on)

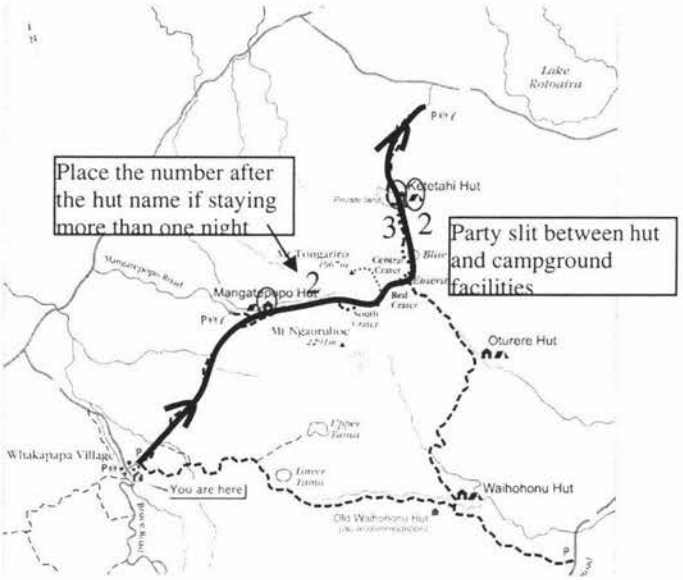
Complaints: if they are annoyed by something, try and relate to their problem - but don't let them argue with you, show them how the survey is a chance to have their say, indicate that there is space on the back, give them more paper if they feel it strongly, show them their opinion counts, remember that you are only the DOC representative, not making it's policy!

Negative people: rare, but if all your attempts fail, thank them anyway and move on, it's their problem, be nice anyway.

Top line: remember to fill the details of SITE, DATE and GROUP NO. for each person (at the top right of the questionnaire).

Map Notes.

Most groups travel plans will be straightforward and can be checked with a quick glance. The following two cases demonstrate the trickier situations where the party has split:

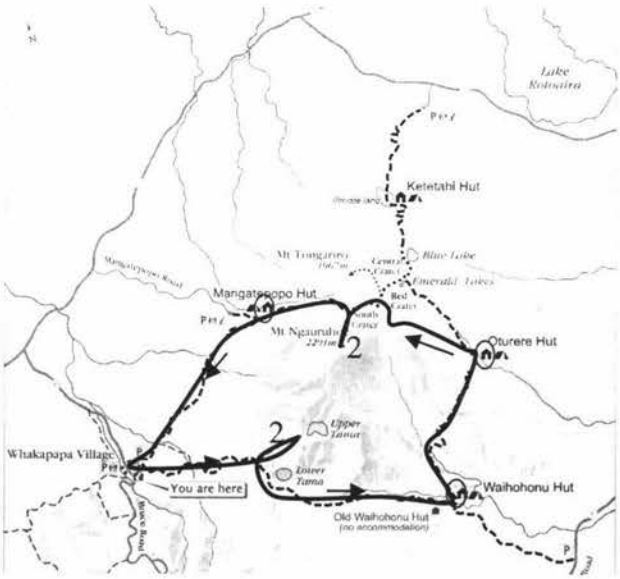


Please check that they have:

- indicated **where** and their **direction** of travel
- **circled the facilities** used (hut or campground), and **indicated the number of nights if stayed more than one night.**

If the party has been split between the hut and camping facilities please check they have indicated how the split has occurred

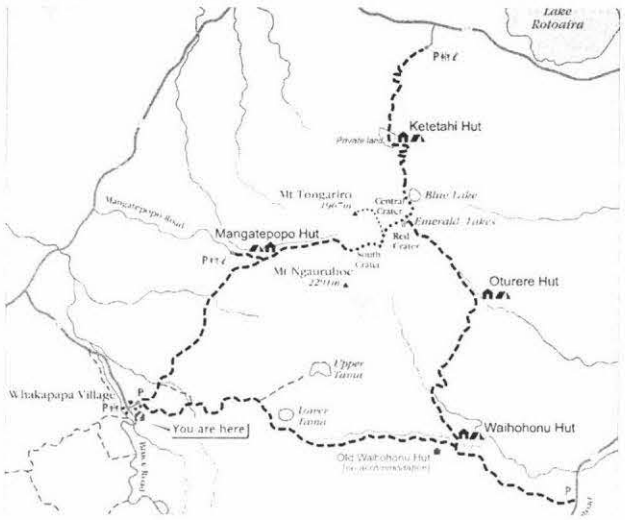
Case 1 above is a party of 5 that spent 2 nights in Mangatepopo Hut and one night using the Ketetahi facilities, where two tented and 3 stayed in the hut



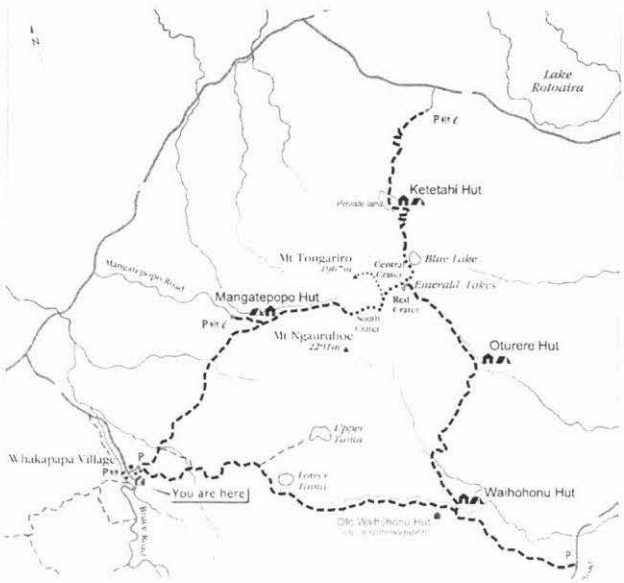
Case 2 is a party of 4 spending 3 nights on the TNC with the party splitting on two occasions with two walking to Upper Tama, and two climbing Ngauruhoe. They also travelled off trail heading up the Oturere Valley.

Appendix F

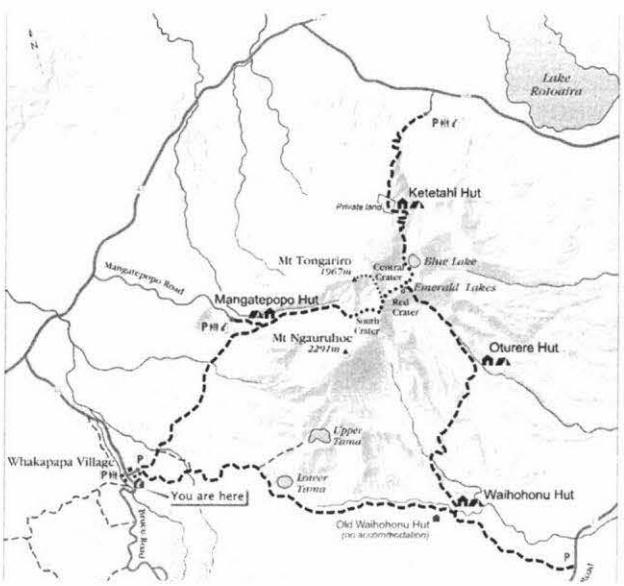
Straight forward trips following the tracks and with the whole party using the same overnight facility.



Two nights using huts (K and W) heading from Whakapapa to Ketetahi car park



Three nights using huts (M, K and W) completing a clockwise circuit from Whakapapa to Whakapapa



Two nights using the camp grounds at W then K heading from Whakapapa to the Mangatepopo car park

Appendix G

TNC Summer Survey 2000/1 Warden: Hut(s):

December	Surveys	Groups
Fri 22		
Sat 23		
Sun 24		
Mon 25		
Tue 26		
Wed 27		
Thu 28		
Fri 29		
Sat 30		
Sun 31		

January	Surveys	Groups
Mon 1		
Tue 2		
Wed 3		
Thu 4		
Fri 5		
Sat 6		
Sun 7		
Mon 8		
Tue 9		
Wed 10		
Thu 11		
Fri 12		
Sat 13		
Sun 14		
Mon 15		
Tue 16		
Wed 17		
Thu 18		
Fri 19		
Sat 20		
Sun 21		
Mon 22		
Tue 23		
Wed 24		
Thu 25		
Fri 26		
Sat 27		
Sun 28		
Mon 29		
Tue 30		
Wed 31		

February	Surveys	Groups
Thu 1		
Fri 2		
Sat 3		
Sun 4		
Mon 5		
Tue 6		
Wed 7		
Thu 8		
Fri 9		
Sat 10		
Sun 11		
Mon 12		
Tue 13		
Wed 14		
Thu 15		
Fri 16		
Sat 17		
Sun 18		
Mon 19		
Tue 20		
Wed 21		
Thu 22		
Fri 23		
Sat 24		
Sun 25		
Mon 26		
Tue 27		
Wed 28		

March	Surveys	Groups
Thu 1		
Fri 2		
Sat 3		
Sun 4		
Mon 5		
Tue 6		
Wed 7		
Thu 8		
Fri 9		
Sat 10		
Sun 11		
Mon 12		
Tue 13		
Wed 14		
Thu 15		
Fri 16		
Sat 17		
Sun 18		
Mon 19		
Tue 20		
Wed 21		
Thu 22		
Fri 23		
Sat 24		
Sun 25		
Mon 26		
Tue 27		
Wed 28		
Thu 29		
Fri 30		
Sat 31		

Appendix H

(Revised 16 February 2000)

PN/ALB Protocol

MASSEY UNIVERSITY HUMAN ETHICS COMMITTEE

To: Ethics Secretary
Human Ethics Committee
Room 2.02, Main Building
Turitea, Palmerston North

OR

Committee Secretary
Human Ethics Committee
Principal's Office
Albany

Please send/deliver this original application plus 12 copies (PN) OR plus 8 copies (Albany)

APPLICATION FOR APPROVAL OF PROPOSED TEACHING/RESEARCH PROCEDURES INVOLVING HUMAN SUBJECTS

APPLICANT(S):

Name: David Olsen

Department: Institute of Information Sciences and Technology

Contact Email/Number: [redacted]

Status: masterate student

Name of Employer: N/A

PROJECT:

Title: Tongariro Northern Circuit trip patterns and impressions of overnight users

Status: masterate

Funding Source: Personal/surveying assistance provided by Department of Conservation

Clinical Trial Status: yes ☐ no ☑

ATTACHMENTS: Information poster, questionnaire, surveyor training documentation and guidelines

SUPERVISOR(S):

Name: Dr Geoff Jones

Department: Institute of Information Sciences and Technology

SIGNATURE(S):

Applicant(s):

Supervisor(s):
(required for all projects involving student research, implies satisfaction with application)

DATE: 12/2/2001

OFFICE USE ONLY

Received:

Decision:

Application Content

1. DESCRIPTION

The Tongariro Northern Circuit visitor survey is a one-page questionnaire designed to gather information about the overnight users. The form gathers basic demographic information, previous tramping experience and their impressions of their trip. Group characteristics, trip/route details and their mode of transport are also gathered.

1.1. Justification

It is important for park management to understand the changes in use patterns within the park. This survey has two main functions, namely the provision of information to DOC management so they may plan for future use and the opportunity for me to study an area of personal interest that partially fulfills the requirements of my masterate.

1.2. Objectives

Obtain an appropriate number of surveys to establish the current use patterns and user impressions within the park. It will be possible to compare the information gathered with that obtained approximately 7 years ago.

1.3. Procedures for Recruiting Participants and Obtaining Informed Consent

Overnight users are invited to complete the questionnaire on their last night on the TNC. All overnight users on the TNC are invited to participate during the survey period.

1.4. Procedures in which Research Participants will be involved

The survey participants complete part or all of a one-page questionnaire.

1.5. Procedures for handling information and material produced in the course of the research including raw data and final research report(s)

Every five to ten days the hut wardens bring the completed questionnaires out of the park. They are collected by the senior hut warden and sent to a DOC representative at Head Office Wellington via the secure overnight bag every 3 to 4 weeks. I collect the completed surveys, code and enter the information onto my own computer. Progress reports are regularly produced and distributed to DOC staff and to my supervisor for comment. DOC management (Turangi) has requested to view my analysis and any recommendations prior to publication.

1.6. Procedures for sharing information with Research Participants

This is not directly applicable. The participants are invited to complete the questionnaire so that the park management can plan for the numbers using the overnight facilities and their movement within the park. No personal details are being gathered to allow the direct reporting back to participants, nor was this ever considered appropriate to do so.

1.7. Arrangements for storage and security, return, disposal or destruction of data

This is not an issue as there is no potentially sensitive information being collected. The procedure for completed surveys coming to me is secure. At this stage it is considered that the data may be held for many years to allow for future comparisons. The original survey forms may also be stored in case they need to be referred back to at a later date.

3. ETHICAL CONCERNS

2.1. Access to Participants

The Department of Conservation has given full approval for the conduct of the survey within the Tongariro Northern Circuit. This is demonstrated by their willingness to utilize their staff (Hut Wardens) as surveyors in the course of their daily duties.

2.2. Informed Consent

The participants are aware that park management will use the information for planning purposes. They are not aware of my involvement as a Massey student. Though early drafts of the survey included my involvement as a Massey student, the need to save space and keep things as simple as possible resulted in my involvement being taken off of the questionnaire.

2.3. Anonymity and Confidentiality

No personal information is being recorded that could link a completed questionnaire to any person. Administrative coding is often completed to allow the surveyor to keep track of the number of groups and the number of people within those groups surveyed on the night. Anonymity and confidentiality of the participants is ensured as the information gathered is grouped in such a way that no individual could be identified.

2.4. Potential Harm to Participants

Not applicable. Participants are invited to complete a written questionnaire.

2.5. Potential Harm to Researcher(s)

Not applicable. Surveys are requested to invite overnight users to complete the survey. If they turn down the invitation the surveyor accepts this and goes on with their evening duties.

2.6. Potential Harm to the University

Not applicable. Due to the nature of the survey, the staff involved in data collection and the location of surveys, it seemed appropriate that only the DOC logo be placed on the survey forms. DOC management and the surveyors know who created the survey, and that I am completing the subsequent data analysis, reports and recommendations as a Massey student. The participants will not be aware of any relationship with Massey University unless they request the information specifically.

2.7. Participant's Right to Decline to Take Part

All participants have the right to refuse the invitation to complete the survey and they are not pursued if they decline.

2.8. Uses of the Information

There are two immediate functions of the data (i) the supply of information to DOC management for use in the business plan and (ii) in the process of providing this information, the analysis will aid in the completion of my masterate thesis. It is likely that the information will be stored for comparative purposes and monitor changes in use.

2.9. Conflict of Interest/Conflict of Roles

No conflicts are foreseen.

2.10. Other Ethical Concerns

This survey raises no ethical concerns.

3. LEGAL CONCERNS

3.1. Legislation

3.1.1. Intellectual Property legislation

Approval has been obtained to use the DOC logo and map on the survey form. Various questions are being used from a larger survey completed seven years ago and approval has also been obtained for this. The design and layout of the questionnaire is my own.

3.1.2. Human Rights Act 1993

No known breaches: People are invited to participate.

3.1.3. Privacy Act 1993

No known breaches: no sensitive information is collected, and no information is collected that could identify any individual participating

3.1.4. Health and Safety in Employment Act 1992

No known concerns

3.1.5. Accident Insurance Act 1998

No known concerns

3.1.6. Employment Contracts Act 1991

No known concerns

3.2. Other Legal Issues

No other known issues

4. CULTURAL CONCERNS

No known issues

5. OTHER ETHICAL BODIES RELEVANT TO THIS RESEARCH

5.1. Ethics Committees

This application is not being referred to any other ethics committees. The survey has been accepted by the DOC scientist and management in Turangi, various other DOC staff and my masterate supervisor and no ethical issues have arisen.

5.2. Professional Codes

Approval has been obtained for the questionnaire to be completed on the DOC estate, and to utilize DOC staff located there.

6. OTHER RELEVANT ISSUES

I have no issues that I would like to discuss with the MUHEC.

Map: Route/Facility Coding Sheet for the Tongariro Northern Circuit

Route	Direction	Option	Code	Hut/Facility Options							
			Tens	Units (and thousands)							
Crossing											
	North	from VC	1	**M**	**K**	**MK**	**MOK**	**O**	**OK**	**MO**	
		from Mcp	2	1	2	3	4	5	6	7	
	South	to VC	3								
		to Mcp	4								
Circuit				**O**	**K**	**MK**	**MO**	**MW**	**MKW**	**KO**	**KW**
	Clockwise	from VC	5	1	2	3	4	5	6	7	8
		from Mcp	6								
	Anticlockwise	to VC	7	**KOW**	**MKOW**	**MKO**	**MOW**	**W**	**OW**		
		to Mcp	8	9	1000	2000	3000	4000	5000		
Back Crossing											
	North		9	**O**	**K**	**W**	**KO**	**KW/WK**	**OW**	**KOW**	
	South		10	1	2	3	4	5	6	7	
One-Hut Return			11	**M/Mcp**	**M/Vc**	**K/Kcp**	**K/Mcp**	**W/Vc**	**W/D Rd**	**O/D Rd**	**O/Mcp**
				1	9	2	6	3	4	5	7
Round The Mountain			12	**W**	**W**	**MKW**	**KW**	**MW**	**O**	**O**	**MO**
				1	2	3	4	5	6	7	8
				MW	**K**	**MOW**					
				9	1000	2000					
Desert Road											
	D Rd entry	to VC direct	13	**O**	**K**	**W**	**WO**	**WK**	**WM**	**OK**	**OM**
		to VC via Red Crater	14	1	2	3	4	5	6	7	8
		to Mcp	15								
		to Kcp	16	**WKM**	**WOKM**	**OKM**	**KM**	**WOK**	**WOM**		
	D Rd exit	from VC direct	17	9	1000	2000	3000	4000	5000		
		from VC via Red Crater	18								
		from Mcp	19								
		from Kcp	20								
Other			21								
Desert Rd Entry and Exit			22								

```
*decode routine
*This routine converts the trip (code) into trips and hut combinations.
*It assigns the entry and exit points for subsequent analysis
*
*This file should be read in conjuction with the
* Tonagariro Northern Circuit Map:Route/Facility Coding sheet
*as the sheet contains the codes which are being decoded
*in this program
*
*The file NWB6 (or similar needs to be active, having all the appropriate
* fields empty)

survey_no = 0
scan
 hut_code = 0
 trip_code = 0
 replace survey_no with survey_no + 1
 survey_no = survey_no + 1
 replace trip with mapcode
*Extract numeric trip code and hut use combination
* trip_code is the route followed
* hut_code is the hut combination which is determined by the
* trip pattern
*
 replace num_part with int(trip)
 num_prt = num_part
 exceeded = .F.
 if num_part > 999
   replace Hut_code with int(num_part/1000)
   num_prt = num_part - hut_code * 1000
   exceeded = .T.
 endif

 replace trip_code with int(num_prt/10)
 if .not. exceeded
   replace hut_code with int(num_part - trip_code*10)
 endif

*Assign the entry and exit point (depending on trip_code)
*The call the routine which decodes the appropriate hut combinations
*
 do case
   case trip_code = 1
        replace X with 1
        replace WVCi with 1
        replace KCPo with 1
        do Xhuts
   case trip_code = 2
        replace X with 1
        replace MCPi with 1
        replace KCPo with 1
        do Xhuts
   case trip_code = 3
        replace X with 1
        replace WVCo with 1
        replace KCPi with 1
        do Xhuts
   case trip_code = 4
        replace X with 1
        replace MCPo with 1
        replace KCPi with 1
```

```
      do Xhuts
case trip_code = 5
      replace C with 1
      replace WVCi with 1
      replace WVCo with 1
      do Chuts
case trip_code = 6
      replace C with 1
      replace MCPi with 1
      replace WVCo with 1
      do Chuts
case trip_code = 7
      replace C with 1
      replace WVCi with 1
      replace WVCo with 1
      do Chuts
case trip_code = 8
      replace C with 1
      replace MCPo with 1
      replace WVCi with 1
      do Chuts
case trip_code = 9
      replace Y with 1
      replace WVCi with 1
      replace KCPo with 1
      do Yhuts
case trip_code = 10
      replace Y with 1
      replace WVCo with 1
      replace KCPi with 1
      do Yhuts
case trip_code = 11
      replace ONE_HUT with 1
      do Ohuts
case trip_code = 12
      replace RTM with 1
      do Rhuts
case trip_code = 13
      replace DRDi with 1
      replace WVCo with 1
      do Dhuts
case trip_code = 14
      replace DRDi with 1
      replace WVCo with 1
      do Dhuts
case trip_code = 15
      replace DRDi with 1
      replace MCPo with 1
      do Dhuts
case trip_code = 16
      replace DRDi with 1
      replace KCPo with 1
      do Dhuts
case trip_code = 17
      replace DRDo with 1
      replace WVCi with 1
      do Dhuts
case trip_code = 18
      replace DRDo with 1
      replace WVCi with 1
      do Dhuts
case trip_code = 19
      replace DRDo with 1
      replace KCPi with 1
      do Dhuts

case trip_code = 20
      replace DRDo with 1
      replace MCPi with 1
      do Dhuts
   case trip_code = 21
      replace OTHER with 1
      do Dhuts
   case trip_code = 22
      replace DRDo with 1
      replace DRDi with 1
      do Dhuts
   case trip_code = 23
      replace MCPo with 1
      replace MCPi with 1
      do Dhuts
   case trip_code = 24
      replace WVCo with 1
      replace WVCi with 1
      do Dhuts

 endcase
endscan

*Tongariro Crossing hut combinations
*
procedure xhuts
do case
   case hut_code = 1
      replace M with 1
   case hut_code = 2
      replace K with 1
   case hut_code = 3
      replace MK with 1
   case hut_code = 4
      replace MKO with 1
   case hut_code = 5
      replace O with 1
   case hut_code = 6
      replace KO with 1
   case hut_code = 7
      replace MO with 1
endcase
return

*Ngauruhoe Circuit hut combinations
*
procedure chuts
if .NOT. exceeded
do case
   case hut_code = 1
      replace O with 1
   case hut_code = 2
      replace K with 1
   case hut_code = 3
      replace MK with 1
   case hut_code = 4
      replace MO with 1
   case hut_code = 5
      replace MW with 1
   case hut_code = 6
      replace MKW with 1
   case hut_code = 7
      replace KO with 1
   case hut_code = 8
      replace KW with 1
   case hut_code = 9
      replace KOW with 1
endcase
else
do case
```

```
   case hut_code = 1
        replace MKOW with 1
   case hut_code = 2
        replace MKO with 1
   case hut_code = 3
        replace MOW with 1
   case hut_code = 4
        replace W with 1
    case hut_code = 5
        replace OW with 1
endcase
endif
return

*Back Crossing hut combinations
*
procedure yhuts
do case
   case hut_code = 1
        replace O with 1
   case hut_code = 2
        replace K with 1
   case hut_code = 3
        replace W with 1
   case hut_code = 4
        replace KO with 1
   case hut_code = 5
        replace KW with 1
   case hut_code = 6
        replace OW with 1
   case hut_code = 7
        replace KOW with 1
 endcase
return

*"Other" hut combinations
*
procedure ohuts
do case
   case hut_code = 1
        replace M with 1
        replace MCPi with 1
        replace MCPo with 1
   case hut_code = 2
        replace K with 1
        replace KCPi with 1
        replace KCPo with 1
   case hut_code = 3
        replace W with 1
        replace WVCi with 1
        replace WVCo with 1
   case hut_code = 4
        replace W with 1
        replace DRDi with 1
        replace DRDo with 1
   case hut_code = 5
        replace O with 1
        replace DRDi with 1
        replace DRDo with 1
   case hut_code = 6
        replace K with 1
        replace MCPi with 1
        replace MCPo with 1
   case hut_code = 7
        replace O with 1
        replace MCPi with 1
        replace MCPo with 1
   case hut_code = 8
        replace W with 1
        replace WVCi with 1
        replace WVCo with 1
   case hut_code = 9
        replace M with 1
        replace WVCi with 1
        replace WVCo with 1
 endcase
return

*Round Ruapehu hut combinations
*
procedure Rhuts
replace WVCI with 1
if .NOT. exceeded
do case
   case hut_code = 1
        replace WVCi with 1
        replace W with 1
        replace RTMo with 1
   case hut_code = 2
        replace W with 1
        replace RTMi with 1
        replace WVCo with 1
   case hut_code = 3
        replace MKW with 1
        replace RTMo with 1
        replace WVCi with 1
   case hut_code = 4
        replace KW with 1
        replace RTMi with 1
        replace WVCo with 1
   case hut_code = 5
        replace MW with 1
        replace RTMo with 1
        replace WVCi with 1
   case hut_code = 6
        replace O with 1
        replace RTMo with 1
        replace WVCi with 1
   case hut_code = 7
        replace O with 1
        replace RTMi with 1
        replace WVCo with 1
   case hut_code = 8
        replace MO with 1
        replace RTMo with 1
        replace WVCi with 1
   case hut_code = 9
        replace MW with 1
        replace RTMi with 1
        replace WVCo with 1
 endcase
 else
 do case
   case hut_code = 1
        replace K with 1
        replace RTMi with 1
        replace WVCo with 1
   case hut_code = 2
        replace MOW with 1
        replace RTMo with 1
        replace WVCi with 1
 endcase
endif
return

*Desert Road hut combinations
```

```
*
procedure dhuts
if .NOT. exceeded
do case
   case hut_code = 1
        replace O with 1
   case hut_code = 2
        replace K with 1
   case hut_code = 3
        replace W with 1
   case hut_code = 4
        replace OW with 1
   case hut_code = 5
        replace KW with 1
   case hut_code = 6
        replace MW with 1
   case hut_code = 7
        replace KO with 1
   case hut_code = 8
        replace MO with 1
   case hut_code = 9
        replace MKW with 1
endcase
else
do case
   case hut_code = 1
        replace MKOW with 1
   case hut_code = 2
        replace MKO with 1
   case hut_code = 3
        replace MK with 1
   case hut_code = 4
        replace KOW with 1
   case hut_code = 5
        replace MOW with 1
endcase
endif
return

.
```

Appendix K

Tongariro Northern Circuit Overnight Visitor Survey - Opening Analysis

The following analysis is from the first 238 surveys returned to Turangi by 17 January 2001. There is an initial bias due to four more days of survey returns from Waihohonu (at 26 days) over the other sites, but this will come right with time.

Survey returns

The survey rate is lower than my initial estimate of 8 per night per site during the busy period. This should not affect the results at all as the final analysis will look at the relationship of weather with use. The weather may already have a bearing on the results. Jimmy commented that use was down by about 800 bed-nights on last season.

So far the highest number of survey returns on a given night from any site has corresponded with large groups. Waihohonu's highest number of surveys collected on one night was 16, which included a group of 9, and the 13 at Oturere included a group of 10. The maximum number of groups completing surveys at a site on a given night so far has been 6 resulting in 10 surveys. Waihohonu is currently averaging about 5 surveys per night.

Surveys per night	K	M	O	W
max	10	7	13	16
median	2	1	0	4
min	0	0	0	0
average	2.8	1.9	1.4	4.8

Site returns and site use

Almost half of the surveys returned to date have come from Waihohonu. This proportion may drop with time but it is likely to remain higher than the other huts due to its location being:

(i) the last hut on the clockwise circuit of Ngauruhoe (one of the most popular trips) combined with it being a relatively long way from the Whakapapa Visitor Centre (this distance being a good day's walk for most groups)

(ii) on the Ruapehu circuit

Despite the high number of surveys collected from Waihohonu, the overnight use given in the maps (or trip patterns) indicates that Waihohonu's use is about the same as Ketetahi and Mangatepopo. Oturere's surveyed use is currently about half that of the other three huts.

Survey site	Number collected	Percentage of those collected	Site overnight use	Percentage use
K	56	24%	111	26%
M	34	14%	118	28%
O	32	13%	69	16%
W	116	49%	125	30%
Total	238		423	

Route/trip patterns

The surveys so far indicate that the most popular overnight trip on the TNC is the Ngauruhoe circuit. Travelling in a clockwise direction is preferred (94%) following the traditional direction for the start of the Tongariro Crossing. Many unsolicited comments have indicated the tracks of the Tongariro Crossing have been crowded but not crowded on the rest of their journey. Those completing the circuit account for more than half of the surveyed overnight facility use to date. This is due to the relatively long trip length with 86% staying more than one night.

Route	Freq.	Freq. percent	Use nights	Use percent
Circuit	104	44%	252	57%
Crossing	50	21%	71	16%
One-hut return	32	13%	45	10%
Other: mainly D.Rd	25	11%	29	7%
Around Ruapehu	20	8%	29	7%
Back Crossing	7	3%	14	3%
Grand Total	238		440	

Thank you for your support to date

Tongariro Northern Circuit Overnight Visitor Survey – Analysis update – 2

The following analysis is from the first 462 surveys. Two additional bundles of surveys had arrived in Wellington by 16 February 2001. (Thanks Jimmy!)

The users of the TNC overnight facilities:

Gender and age breakdown

The surveys indicate a higher proportion of males (54%) to females (45%) use the overnight facilities on the TNC. This gender imbalance is caused by slightly higher numbers of males in all age groups 30 years and above. The two youngest age groups, Under-20 and 20-29, are evenly split gender wise and these groups make up 61% of the overnight users.

Age\Gender	Male	Female	Total	Age percent
Under 20	24	23	47	10%
20-29	118	117	236	51%
30-39	55	38	93	20%
40-49	28	16	44	10%
50-59	17	10	27	6%
60+	9	4	13	3%
Total	251	208	462	
Gender percent	54%	45%		

Comparison/further research: A gender by age group breakdown was not produced in the Great Walks Survey (GWS), though I hope to access this data in the near future for a direct comparison. The GWS reported a 61% male to 39% female split. This would indicate that the gender imbalance is now lessening.

Nationality b/down by gender

The nationality breakdown by gender presented here includes the GWS figures for comparison. The two biggest changes are the decrease in the proportion of Germans and the increase in users from "Other European" countries. Jimmy's annual reports give a more detailed picture of the changing composition of the overnight facility users with regards to nationality.

Approximately half of the gender imbalance is caused by NZ users with the next greatest gender imbalance coming from Other Europe and Great Britain.

Nationality	M	F	blank	Total	T%	GWS
New Zealand	94	74		168	36%	(40%)
Germany	31	34		65	14%	(21%)
Other Europe	29	15		54	12%	(3%)
Great Britain	30	22		52	11%	(10%)
Israel	12	12		24	5%	(1%)
Australia	14	9		23	5%	(5%)
Netherlands	10	12		22	5%	(3%)
United States	13	7	1	21	5%	(7%)
Switzerland	8	6		14	3%	(4%)
Canada	6	5		11	2%	(2%)
Japan	1			1	0%	(1%)
blank/other	3	2	2	7	2%	(0%)
Grand Total	251	208	3	462		

Experience b/down by gender

Half of those surveyed indicated having little (1 to 5) or no previous experience of similar overnight trips. This is comparable to the 52% in the GWS. A few overseas visitors qualified their response of little experience by writing "in New Zealand" alongside, leaving the question of their overseas experience. As many countries do not have, or offer, access to huts in their back country, the question may not be getting the intended information.

The less experienced users have a fairly even gender split, however those surveyed reporting a high to very high level of experience tended to be male.

Number of previous trips	Male	Female	Total	
0	28	31	59	13%
1-5	80	89	169	37%
6-10	30	26	57	12%
11-20	38	28	66	14%
21-50	38	19	57	12%
50-100	16	8	24	5%
100+	17	5	22	5%
Blank	4	2	8	2%
Total	251	208	459	

Feedback, general comments or requests for specific analysis are welcome. Send to Olsend@xtra.co.nz

My next update should include an analysis of the surveyed transportation (eg 45% arrive and/or leave by their own transport) and a breakdown of the relative use of entry and exit points on the TNC.

Tongariro Northern Circuit Overnight Visitor Survey – Analysis update – 3

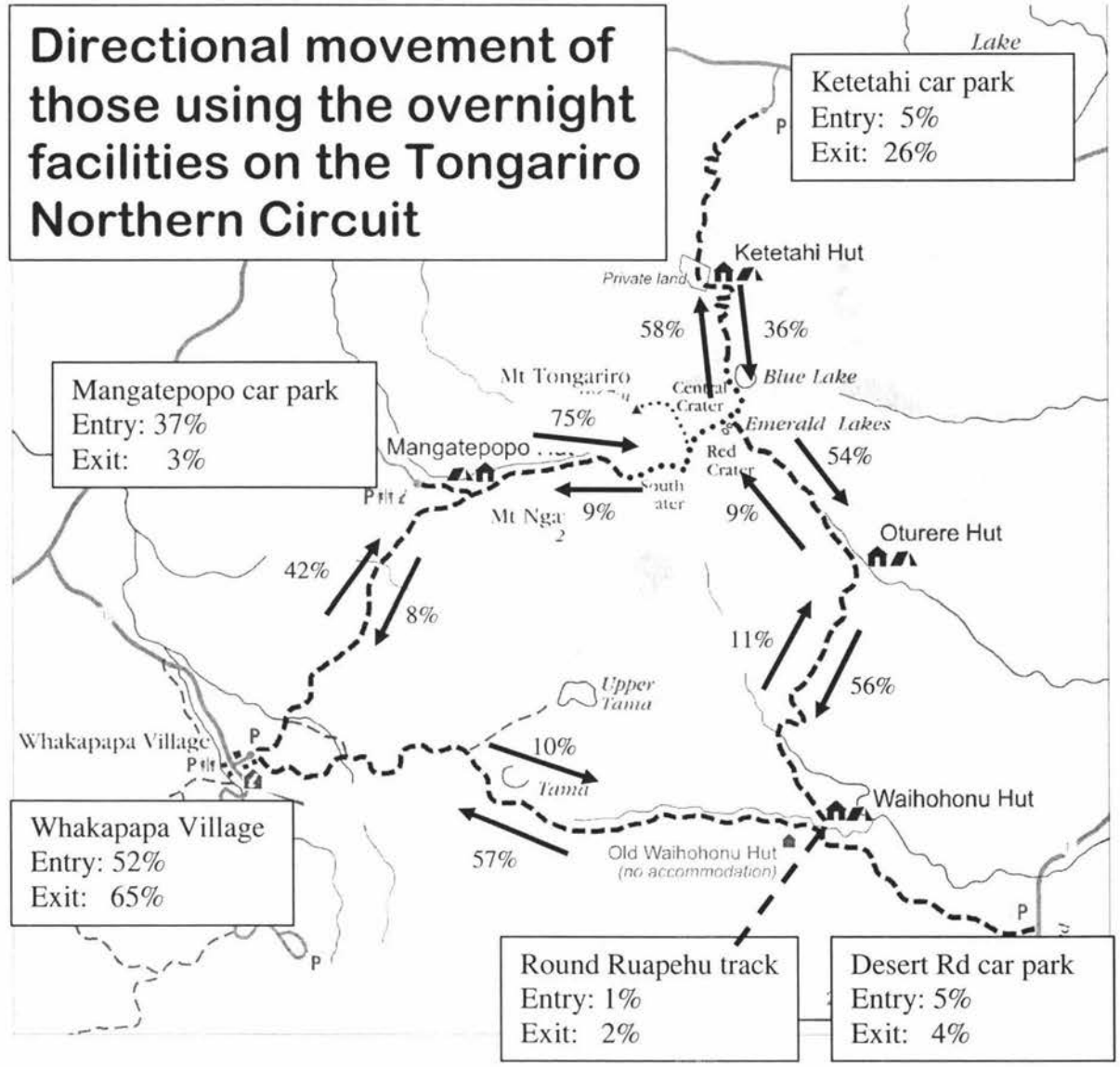
The following analysis is from the first 739 surveys. Only 5 surveys have come in with incomplete maps: these 5 were ignored in the generation of the figures opposite.

The survey returns indicate that 60% of all overnight visitors stayed a night at the Mangatepopo. Similarly 59% stayed at Ketetahi and 60% stayed at Waihohonu. Only 30% stayed at Oturere.

The directional movement map indicates that the track most walked by overnight facility users is the section between Emerald Lakes and Ketetahi. This is due to the 32% of overnight users that including Ketetahi in their circuit (thus having to backtrack and being counted for both directions). The 32% of overnight users (equating to 57% of those completing the circuit) surprised me as I expected less due to the Ketetahi Springs being out of bounds. *It will be interesting to compare these results with the surveys from 7 years ago.*

Transportation data for surveyed visitors indicates that:

- 48% used commercial operators (33% for both directions)
- 44% used their own car (34% for both directions)
- 9% hitchhiked (3% both directions)
- 8% where dropped off or collected by friends (4% both directions)
- 4% selected other (2% both directions)
- 8% included at least one non-response (2% both directions)



If I find time and space in my next analysis I will include a breakdown by road-end.

Feedback, general comments or requests for specific analysis are welcome. Send to Olsend@xtra.co.nz

Appendix M

Summary TNC Results [Summer Survey 2000/01]

These results are from 1090 surveys completed by overnight facility users on their last night on the Tongariro Northern Circuit (TNC) between 22/12/00 and 16/04/01. A more detailed breakdown of the interrelationships between their survey responses will follow...

- **Gender:** Male 55% Female 45%
- **Nationality:**

New Zealand	Germany	UK/Ireland	Other European	Australia	Netherlands	USA	Canada	Israel	Switzerland	Sweden	Japan	Other
33%	14%	13%	7%	6%	6%	5%	4%	4%	4%	2%	<1%	1%

- **Age group**

Age	< 20	20-29	30-39	40-49	50-59	60 +
Percent	9%	48%	24%	10%	6%	2%

- **Have you done this trip before?** Yes 13% No 87%
- **How many overnight trips like this have you done before?**

Experience	0	1-5	6-10	11-20	21-50	51-100	100+
Percent	13%	37%	14%	14%	13%	4%	4%

Did you feel crowded on this trip?

Not at all crowded		Slightly crowded			Moderately crowded		Extremely crowded		**Multiple entry**
1	2	3	4	5	6	7	8	9	*
17%	13%	16%	9%	7%	8%	11%	4%	5%	10%

Overall, I expected that there would be: more people 27%
the same number of people 41% less people on this trip 32%

Was this trip better or worse than you expected it would be?

25%	34%	30%	10%	2%
Very much better than I expected	A little better than I expected	It was just like I expected	A little worse than I expected	Very much worse than I expected

Group/Party Details **Analysis update - 4**

How many in your group:

Group size	1	2	3	4	5	6	7	8	9	10+
Percent	15%	43%	12%	11%	4%	5%	2%	1%	3%	4%

Number of nights on the TNC:

Night(s)	1	2	3	4
Percent	33%	42%	23%	2%

Transport to and from the track entrance

	To	From
Own car	45%	42%
Friend dropped off /picking up	6%	5%
Hitch hike	4%	7%
Commercial operators	43%	42%
Other	2%	4%

Entry and exit points

	In	Out
Whakapapa	52%	61%
Mangatepopo	36%	7%
Ketetahi	6%	28%
Desert Road	5%	3%
Round Ruapehu	1%	2%

Trip pattern/route taken:

Route	Percent
Circuit	53%
Crossing	25%
One-hut return	10%
D-Rd entry/exit	5%
Back crossing	3%
Around Ruapehu entry/exit	3%
Other	1%

Comments/feedback or special requests for analysis are most welcome. Please send to Olsend@xtra.co.nz

Appendix N

Tongariro Northern Circuit Overnight Visitor Surveys – Comparison 1994 and 2001

This map shows the proportion of overnight facility users using the individual track sections and entry and exit points for the Tongariro Northern Circuit. The 1993/4 figures are also given for comparison. Three main changes are notable:

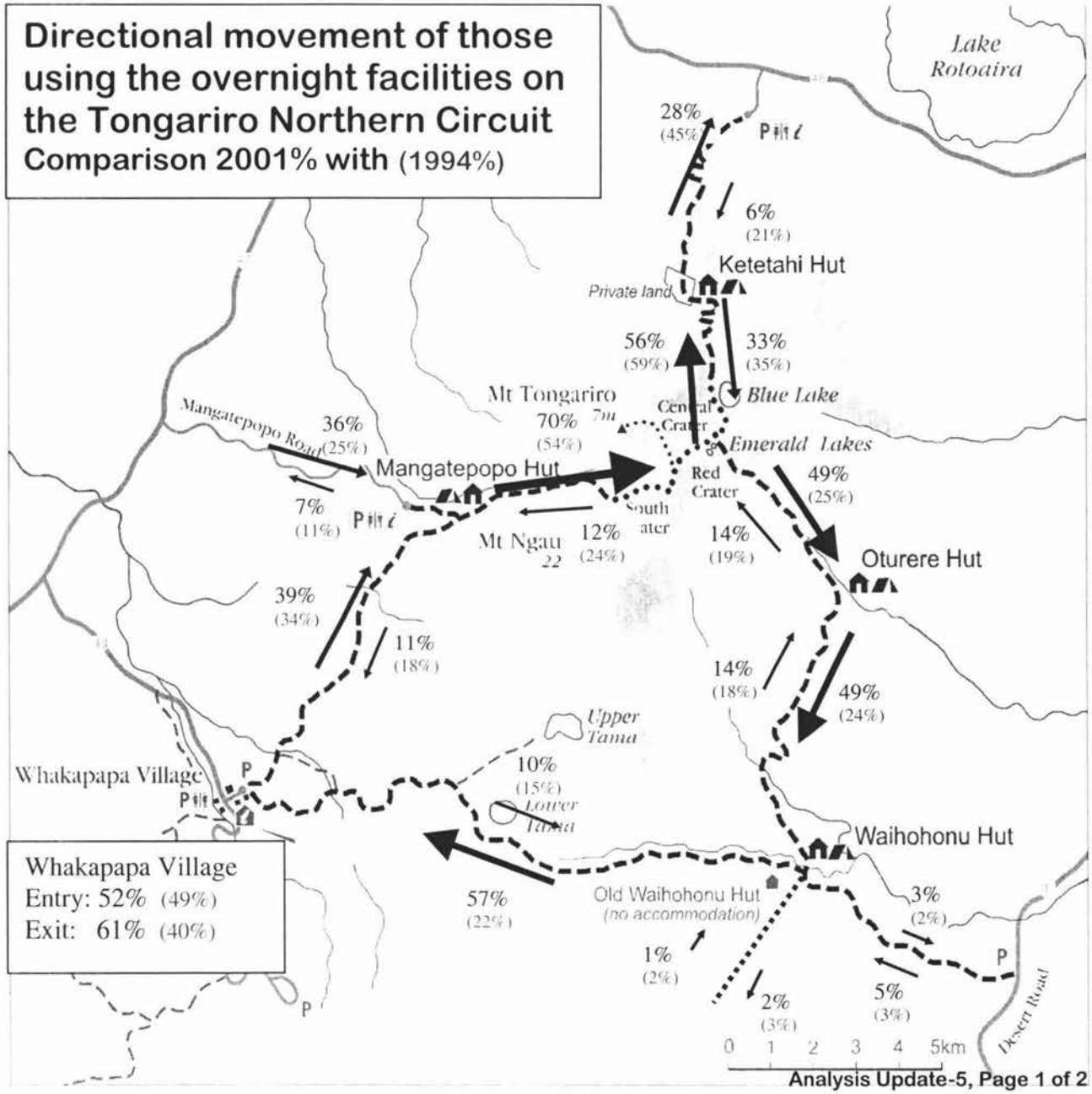
i) a two fold increase in those moving in a clockwise direction from Emerald Lakes back to Whakapapa Village

ii) the number of overnight facility users entering from Ketetahi carpark is less than a third of the previous survey along with a 40% decrease in the proportion exiting that way

iii)a drop in those completing the circuit moving in an anticlockwise direction.

There has been a shift in where the majority of overnight facility users spend their final night on the Tongariro Northern Circuit. This shift is reflected in Table 1 below, which shows that almost half of the overnight facility users are now spending their last night at Waihohonu whereas seven years ago it the majority left from Ketetahi.

Table 1: The proportion of surveys collected from each site		
Site	**2001**	**1994**
Mangatepopo	15%	19%
Ketetahi	26%	57%
Oturere	10%	6%
Waihohonu	49%	18%



Appendix O

Tongariro Northern Circuit Overnight Visitor Surveys – Comparison 1994 and 2001

The proportion of overnight facility users staying at each site is given in table 2 below. Ketetahi shows the greatest decrease in use. This decrease is probably due to the two factors:

i) Ketetahi springs being out of bounds

ii) the users impression that the Ketetahi site is overcrowded. (ref. Jimmy's email 11 May)

Table 2: The proportion of overnight facility users staying at each site

Site	2001	1994
Mangatepopo	47%	47%
Ketetahi	56%	73%
Oturere	31%	18%
Waihohonu	55%	35%

Statistically, there are two major changes in overnight use patterns on the TNC that have contributed to the decreased proportional use of Ketetahi. Firstly the reduced frequency of Ketetahi's use as a "One-hut return" route, and secondly the most popular route for overnight facility users has changed from the Crossing to the Circuit. These are outlined in more detail below.

The 1994 surveys indicated nine percent of overnight facility users were categorised as "Ketetahi One-hut return"; entering and exiting via the Ketetahi car park and staying only at the Ketetahi facilities. In the recent survey this group only represented only three percent of those surveyed.

The change in the most popular overnight route (table 3) has indirectly reduced the proportion of those staying at Ketetahi. Over 80% of those completing the Crossing continue to stay at Ketetahi, whereas the proportion of those completing the Circuit staying at Ketetahi has dropped from 68% in 1994 to 54% in the recent survey.

Table 3: Trip patters/route taken by overnight facility users

Route	2001	1994
Circuit	53%	28%
Crossing	25%	40%
One-hut return	10%	13%
Desert Road entry/exit	5%	4%
Back Crossing	3%	5%
Around Ruapehu entry/exit	3%	5%
Other: Non Standard	1%	4%

Table 4 shows the change in the composition of those staying overnight at Ketetahi. In 1994 the largest overnight user group of the Ketetahi facilities were those completing the crossing and they made up 47% of the total Ketetahi use. The Circuit users only made up 26% of the Ketetahi users. The recent survey results show the primary user group are those completing the Circuit with 51% of total Ketetahi use, and Crossing users only account for 37% of Ketetahi's overnight use.

Table 4: User group composition for those staying overnight at Ketetahi

Route	2001	1994
Circuit	51%	26%
Crossing	37%	47%
One-hut return	5%	12%
Desert Road entry/exit	2%	4%
Back Crossing	4%	5%
Around Ruapehu entry/exit	1%	2%
Other: Non Standard	1%	3%

The change in the most popular route has brought about a natural increase in the number of bed-nights, as those completing the circuit tend to require, on average, a greater number of nights. So the increase in TNC bed-nights for the season may not be entirely represent an increase in number of different people using the overnight facilities.

The surveys indicate that overnight facility users are currently staying longer and using 8% more facilities than 7 years ago, representing an increase in bed-nights of approximately 1% per year.

Feedback, general comments or requests for specific analysis are welcome. Send to Olsend@xtra.co.nz

Tongariro Northern Circuit Overnight Visitor Survey 2001:

Analysis update 6: Crowding and trip expectations

Three questions in the survey contained a subjective component. All three of these questions are directly comparable with those from the GW survey.

The first two of these questions ideally need to be cross-referenced with the numbers on the circuit tracks at that time. However, even without this they: (i) give a general indication of what the overnight facility users are experiencing and (ii) give an indication of the satisfaction level relating to the numbers of people on the circuit.

The third question is very general but gives and indication of how enjoyable they found their experience. This is where the analysis begins.

Responses to all 3 questions showed no significant difference between the genders but all showed highly significant differences in route/trip pattern.

Was the trip better or worse than expected?

The vast majority (89%) of the surveyed overnight facility users reported that their visit was at least as good as expected, and the majority (59%) found their visit was better than expected. These results are the same as those obtained in the Great Walks (GW) survey.

	Question Response					
Route Taken	1	2	3	4	5	Total
Circuit	136	231	159	34	1	561
Crossing	77	76	74	29	9	265
One-hut return	23	20	33	23	10	109
Other: mainly D-Rd	11	18	21	6		56
Back crossing	6	12	9	7		34
Around Ruapehu	5	6	15	5		31
Other: NS	5	1	4			10
Total	263	364	315	104	20	1066
Percent	25%	34%	30%	10%	2%	

Of the 12% registering their visit was worse than expected at least one third qualified their response by stating that it was due to the weather.

The route ***One-hut return*** had the highest level of dissatisfaction with 30% indicating that their visit was worst than expected. All 10 in this category responding *very much worse than expected* stayed only at Mangatepopo. However this was misleading as (i) many had attempted to get over Red Crater to the another hut but had to retreat due to extreme weather conditions (i.e. ***one hut return*** was not their intention) and (ii) all 10 of these survey forms clarified that their response was due to poor weather conditions.

Crowding responses

As discussed in an earlier update, 10% of those surveyed gave a multiple response, where each clearly distinguished between track sections on the Tongariro Crossing versus *the rest*. Ideally it would be desirable to quantify the impacts of the relatively large numbers of day users on the overnight users experience.

Excluding the multiple responses 18% of those completing the crossing experienced extreme crowding (8 and 9) compared with only 7% on the Circuit. Again time of season and weather conditions may also play a part in this, and cross-references with hut occupancy rates may be beneficial.

	Crowding response										
Route	1	2	3	4	5	6	7	8	9	M	Total
Circuit	62	65	93	62	45	63	50	21	11	87	559
Crossing	49	31	39	17	20	13	42	17	30	9	267
One-hut return	40	16	15	5	4	3	12	3	9	1	108
Other: mainly D-Rd	8	14	11	1	3	5	8	4	1	2	57
Back crossing	6	5	2	5	2	3	7	1	1	2	34
Around Ruapehu	12	6	8	2	1	2	1		1		33
Other: NS	2	1	3	1	1	1				1	10
Total	179	138	171	93	76	90	120	46	53	102	1068
Percent	17%	13%	16%	9%	7%	8%	11%	4%	5%	10%	
1993/4 GW cmp	*15%*	*16%*	*21%*	*11%*	*10%*	*12%*	*9%*	*3%*	*2%*		

Comparisons with figures presented in the GW survey report show a slight increase in overall percentage crowding (up 2% to 70%). This result still falls in the ***more than capacity*** judgement by Shelby et al. and I have repeated the comments below.

> *"Studies and management are necessary to preserve recreation experiences, especially if low visitor impacts (social/physical) are important components. Immediate management to control use-levels at around 65% level of crowding conditions may be considered as an option. Research may be needed to establish more long-term solutions"*
>
> From Gordon Cessford's GW report *Visitor satisfactions, impact perceptions and attitudes toward management options on the Tongariro Circuit Track*, page 54.

It is interesting to note that the two other Great Walks that were also classified in this category in the GW survey have since introduced booking systems. However a booking system on the TNC may help to minimise hut congestion but it will not address the impacts of day use numbers on the Crossing.

Appendix Q

Tongariro Northern Circuit Overnight Visitor Survey

Analysis update 7a. Walks by day: where from, where to, and what they were up to

This update looks at the movement of overnight facility users within the TNC between facilities. Each hut site/facility has percentage breakdowns of where they came from that day, where they went the next day, and the route or trip pattern they followed.

Each day's trip has been shortened to the first letter of each site facility, with road-end facilities ending with Cp for Car park, or Vc for the Visitor Centre at Whakapapa. Each movement is directional as M-K represents the day's movement from Mangatepopo to Ketetahi, whereas K-M is the movement from Ketetahi to Mangatepopo.

Mangatepopo overnight users

502 (47%) of the 1079 completed surveys containing trip patterns stayed overnight at this facility. The following tables indicate that two thirds of those staying at Mangatepopo arrived via *the ditch* (the track between Whakapapa and Mangatepopo). Sixty five percent of those who stayed at Mangatepopo spent the next night at another facility in the TNC, and on departure, the most popular destination was Ketetahi.

Arrived from	% of those using this facility
WVc-M	68%
MCp-M	15%
O-M	7%
K-M	6%
W-M	3%
KCp-M	1%

Went to	% of those using this facility
M-K	42%
M-WVc	19%
M-O	18%
M-MCp	9%
M-KCp	7%
M-W	5%

Route	% of those using this facility
Circuit	58%
Crossing	25%
One-hut return	11%
All others	6%

Over half (58%) of the Mangatepopo overnight facility users were completing the Circuit.

Ketetahi overnight users (602 surveys, 56%)

Approximately 80% of those staying at Ketetahi arrive via the Mangatepopo Valley. Just over 50% of Ketetahi's overnight users are spending the next night at another facility within the TNC.

Arrived from	% of those using this facility
MCp-K	37%
M-K	35%
WVc-K	8%
KCp-K	8%
W-K	8%
Other	4%

Went to	% of those using this facility
K-KCp	42%
K-W	39%
K-O	7%
K-M	5%
K-WVc	4%
K-MCp	2%

Route	% of those using this facility
Circuit	51%
Crossing	37%
One-hut return	5%
Back xing	4%
All others	4%

Oturere overnight users (334 surveys, 31%)

With just under one third of all overnight facility users staying the night at Oturere, this is the least popular overnight destination on the TNC. Over half of those staying here overnight came up the Mangatepopo Valley that day, with approximately equal numbers (a quarter of the total use each) coming directly from Mangatepopo and from the Mangatepopo Car Park. Over half who stay overnight have a short trip to Waihohonu the next day. Almost three quarters of those staying overnight are completing the circuit.

Arrived from	% of those using this facility
M-O	28%
MCp-O	24%
WVc-O	16%
K-O	14%
DRd-O	11%
W-O	7%
All others	3%

Went to	% of those using this facility
O-W	53%
O-WVc	16%
O-M	10%
O-K	6%
O-KCp	5%
O-Drd	5%
O-MCp	4%

Route	% of those using this facility
Circuit	72%
D.Rd entry and/or exit	12%
Back xing	7%
Crossing	4%
All others	4%

Waihohonu overnight users (596 surveys, 55%)

For overnight facility users completing the circuit 87% spend a night a Waihohonu, and they make up 83% of this facility's total use. Approximately three quarters of those staying here have spent at least one night on the TNC already and for 86% of those staying here, it is their final night on the TNC.

Arrived from	% of those using this facility
K-W	39%
O-W	30%
WVc-W	19%
M-W	4%
DRd-W	3%
All others	5%

Went to	% of those using this facility
W-WVc	81%
W-K	8%
W-O	4%
W-RTM	3%
W-M	3%
W-Drd	2%

Route	% of those using this facility
Circuit	83%
Around Ruapehu	5%
Back xing	5%
All others	8%

*Next weekend I will endeavour to complete **Part b** of this update, which should contain the entry/exit point information similar to that provided here.*

Feedback, general comments or requests for specific analysis are welcome. Send to Olsend@xtra.co.nz

Tongariro Northern Circuit Overnight Visitor Survey

Analysis update 7b. Walks by day: where from, where to, and what they were up to

TNC access points: where overnight facility users enter and exit

Unlike the facilities within the TNC, the access points/road ends have differing numbers of overnight facility users going into the TNC compared to those departing via that point. The crosstab below of entry versus exit point shows that only 43% of overnight facility users enter and exit via the same point.

		Exit point					
		WVc	KCp	MCp	DRd	RTM	
Entry point	WVc	35%	13%	0%	1%	2%	52%
	MCp	21%	12%	3%			36%
	KCp	2%	3%	1%			6%
	DRd	1%		2%	2%		5%
	RTM	1%					1%
		61%	28%	7%	3%	2%	100%

The two most popular trip patterns, *the circuit* and *the crossing*, contribute to the differing use of entry and exit points on the TNC. For the largest overnight user group, those completing *the circuit*, 60% enter at Whakapapa Village and 40% enter at the Mangatepopo car park. 99% of those completing *the circuit* exit at Whakapapa. Overnight facility users completing *the crossing* also boost the numbers entering at Mangatepopo car park and leaving at Ketetahi car park.

		Access/Entry Points					
		WVc	MCp	KCp	DRd	RTM	
Route	Circuit	31%	21%	0%			53%
	Crossing	11%	12%	2%			25%
	One-hut return	4%	3%	3%			10%
	D-Rd users	1%		0%	4%		5%
	All Others	4%		1%		1%	7%
		52%	36%	6%	5%	1%	100%

		Exit Points					
		WVc	KCp	MCp	DRd	RTM	
Route	Circuit	52%	0%	0%			53%
	Crossing	1%	23%	1%			25%
	One-hut return	4%	3%	3%			10%
	D-Rd users	1%		2%	2%		5%
	All others	2%	2%			2%	7%
		61%	28%	7%	3%	2%	100%

Whakapapa Village/Visitor Centre (in 52%, out 61%)

Whakapapa is the single most popular access and exit point for the TNC overnight facility users. This access point contributes over half (52%) of those entering the TNC and over three fifths (61%) of those departing. The dominant direction into and out of the TNC at Whakapapa follows the clockwise movement around the circuit.

Entering TNC: where to	% of those entering using this point
WVc-M	61%
WVc-W	20%
WVc-O	9%
WVc-K	9%

Leaving TNC: where from	% of those leaving using this point
W-WVc	74%
M-WVc	14%
O-WVc	8%
K-WVc	4%

For those entering from Whakapapa 79% walk *the ditch*, and almost 80% of these stay their first night at Mangatepopo. For the 21% entering via the Tama Saddle 95% spend their first night at Waihohonu.
For those leaving the TNC through Whakapapa 82% came out via the Tama Saddle, and 74% have come directly from a night at Waihohonu.

Mangatepopo car park (in 36%, out 7%)

Over 80% of the overnight facility users entering from the Mangatepopo car park head over Red Crater to another facility that day. The majority of these are heading to Ketetahi for their first night.

Entering TNC: where to	% of those entering using this point
MCp-K	56%
MCp-O	20%
MCp-M	19%
MCp-W	4%

Leaving TNC: where from	% of those leaving using this point
M-MCp	62%
O-MCp	20%
K-MCp	18%

Ketetahi car park (in 6%, out 28%)

The majority (83%) of the overnight facility users exiting via the Ketetahi car park spent their final night at Ketetahi. The numbers entering from the Ketetahi car park are small relative to the previous two entrances, however 78% spend the night at Ketetahi and most of these exit the same way the next day.

Entering TNC: where to	% of those entering using this point
KCp-K	78%
KCp-O	11%
KCp-M	10%
KCp-W	2%

Leaving TNC: where from	% of those leaving using this point
K-KCp	83%
M-KCp	11%
O-KCp	6%

The Desert Road (DRd) and the Round the Mountain Track (RTM) entry/exit points have not been analysed here due to their relatively low use.

Feedback, general comments or requests for specific analysis are welcome. Send to Olsend@xtra.co.nz

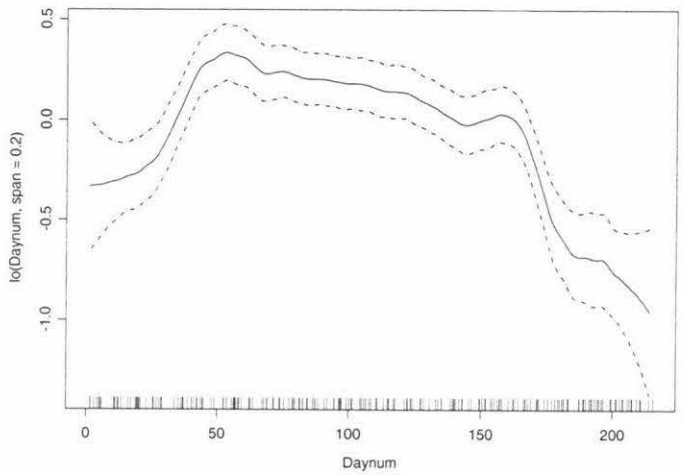
```
* This DBase IV program works out the daily overnight use from
* the database file containing the Great Walks pass butts (pb01).
* The results are stored in the pre-dated use file (pb-guse1).
*
*
* the logic: reads in the number of nights from the pass-butt (a->nights)
*            then locates the pass butt start date in the results file
*            adds one nights use to the appropriate output field the
*            records the total number of people (num_p), number of hut
*            or camping users (num_hut/num_camp) or the number of adult
*            or youth users (num_adults/num_youths) as desired.
*
*            The program adds one to each result field while the pass is
*            still active and counts down the number of nights remaining
*            (rep_it)
*
*            To select only one nationality use the corresponding
*            nationalit (if/endif) lines below (currently set up to
*            select the NZ use if activated).
*****************************************   opens the database files
use
select 2
use
select 1
use pb-guse1 in 2 order date
use pb01
rep_it = 0
*
*************************************  repeat for all pass butts
scan
  ? recno()
* ################## use next line if only want NZ use
*  if nationalit = "N"
    rep_it = a->nights
    select 2
    seek(a->start_dt)
    do while rep_it > 0
      replace num_p with num_p + 1
* ################## use next 5 lines if want hut/camp breakdown
*      if a->type = "H"
*        replace num_hut with num_hut + 1
*      else
*        replace num_camp with num_camp + 1
*      endif
* ################## use next 5 lines for adult/youth breakdown
      if a->Y_A = "a"
        replace num_adults with num_adults + 1
      else
        replace num_youths with num_youths + 1
      endif
      rep_it = rep_it -1
      skip
    enddo
    select 1
*  endif
endscan
•
```

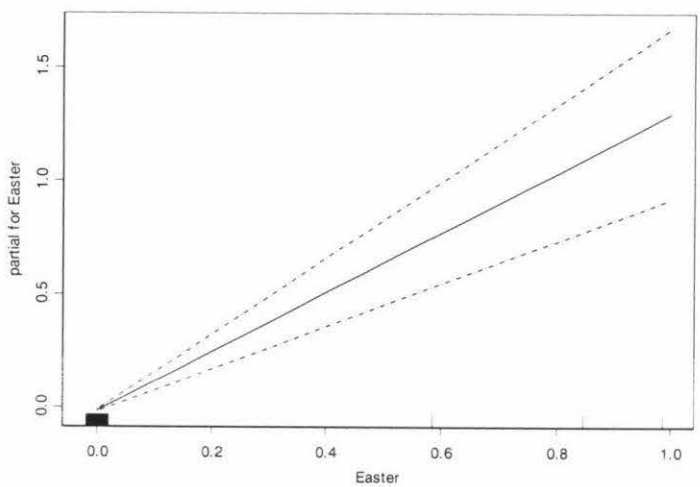
Appendix T

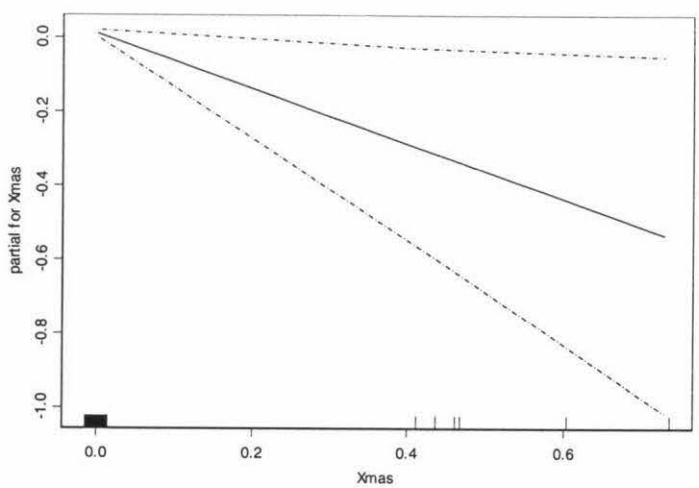
Graphical output of terms used in the gam model showing confidence intervals

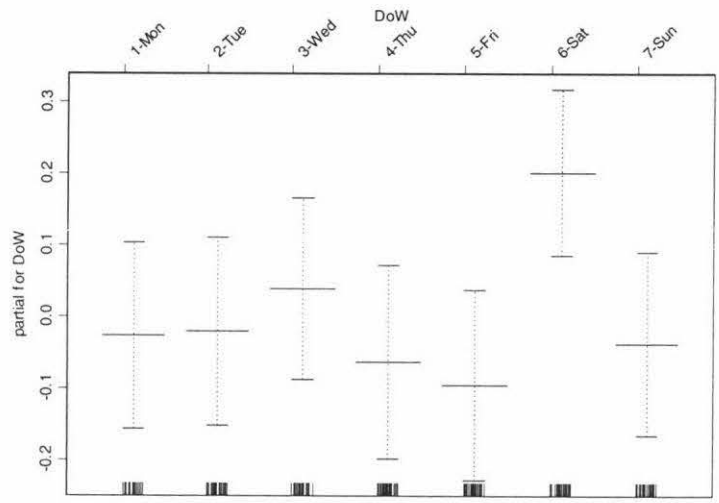
The gam model is

gam(Use ~ lo(Daynum, span = 0.2) + Easter + Xmas + DoW + nrain + nmntemp +
Radn + wind9am + nsnow + Windgust, family = poisson)





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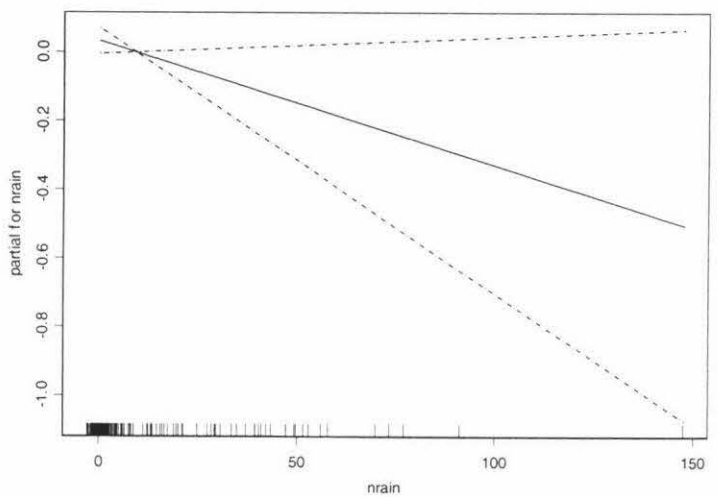
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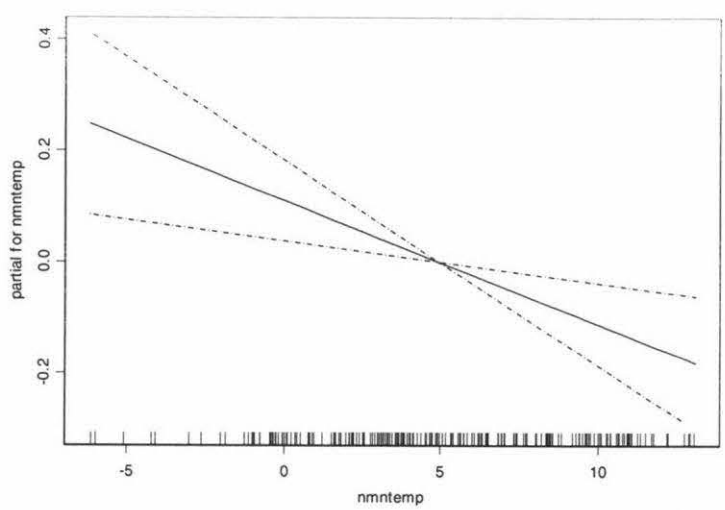
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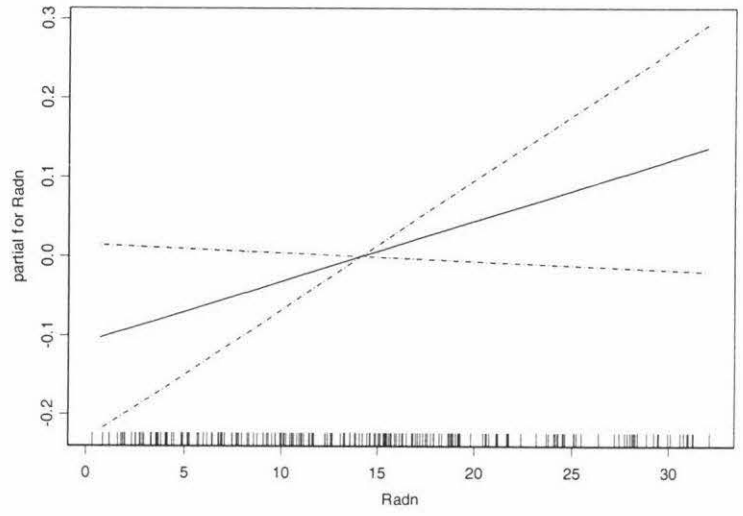
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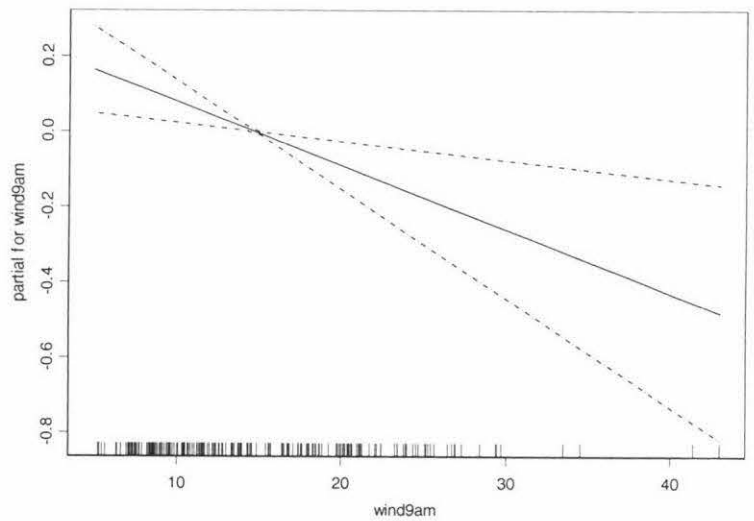
Radn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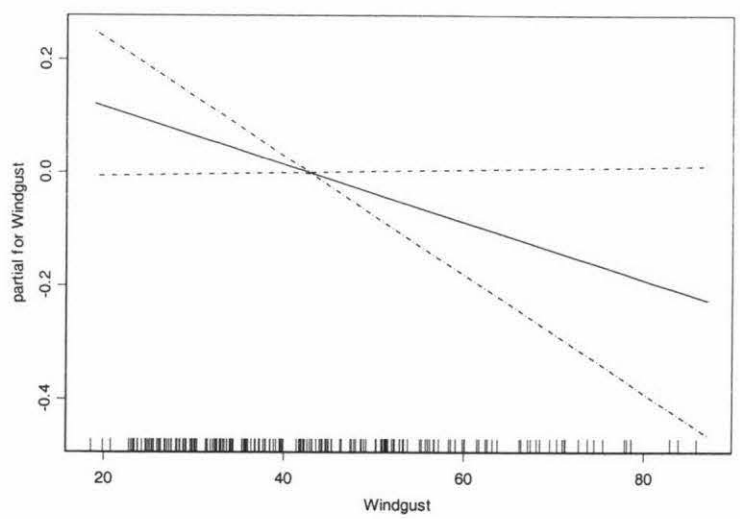
20
30
40
wind9am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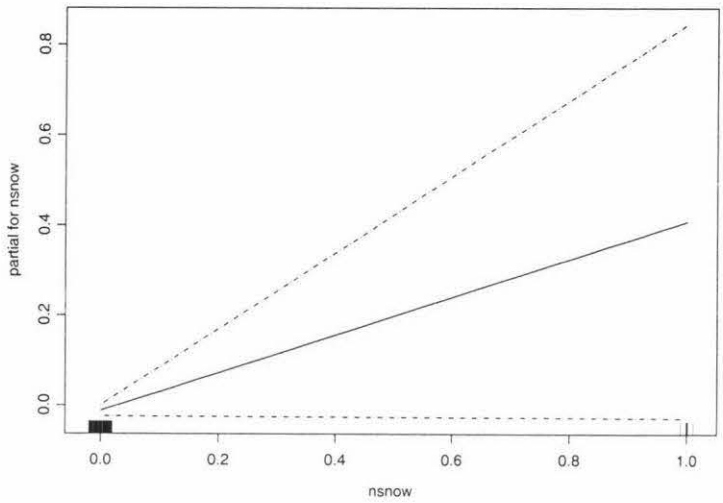
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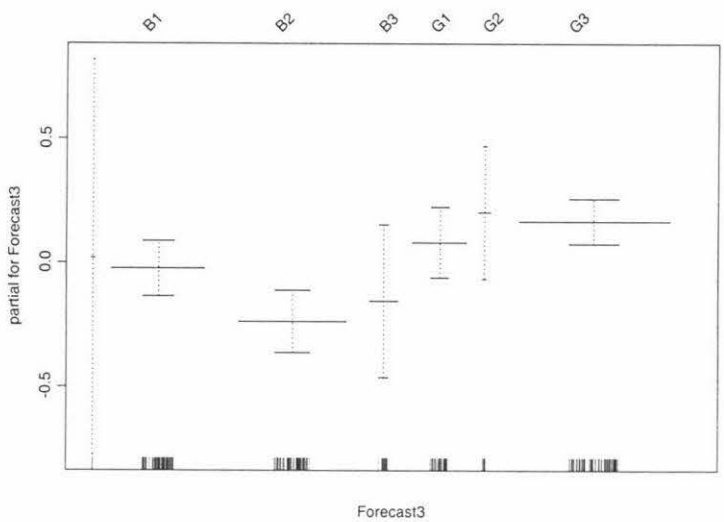
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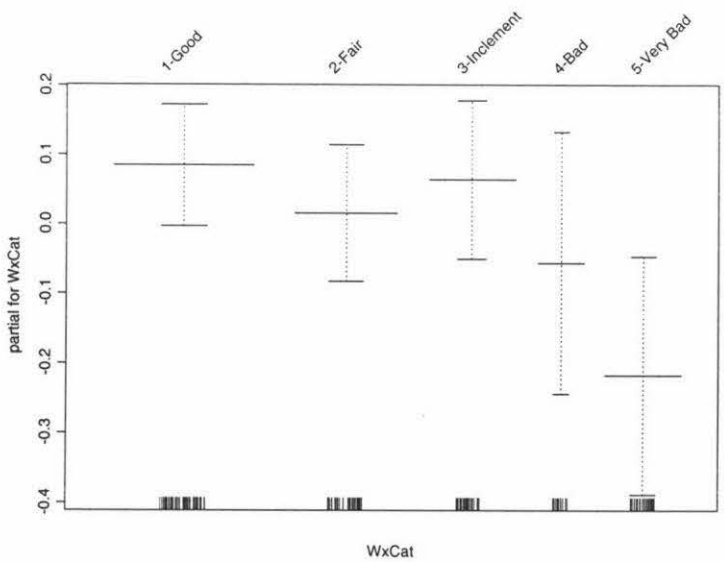
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3-Inclement
4-Bad
5-Very Bad
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WxCat

Multiple Regression Investigations

Use Series

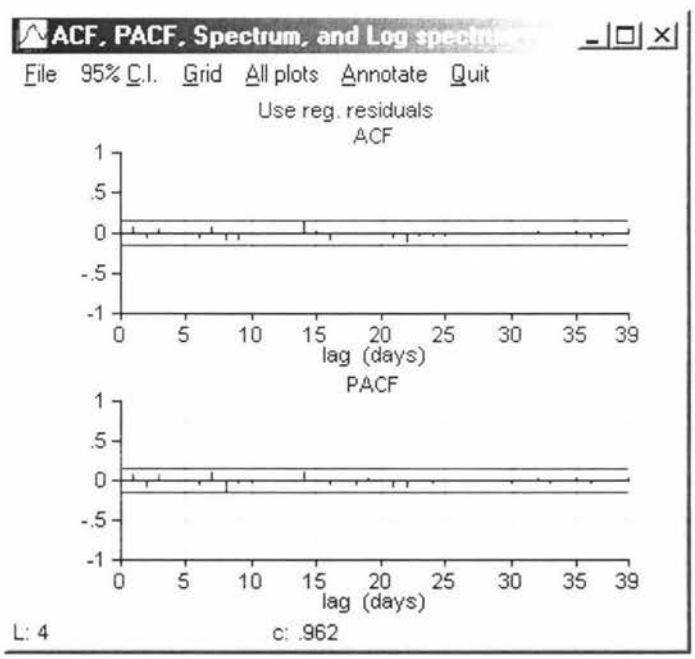
Multiple regression on Use

AICc = 6.65655 Variance = 275.358 df = 187 R2 = 0.6476

predictor	coef	st. error	t-ratio	p-value	series
beta(0)	-16.2393	4.7851	-3.3937	.001	constant
beta(1)	.4533	.0634	7.1563	.000	Use t-1
beta(2)	-.1612	.0583	-2.7662	.006	Use t-2
beta(3)	.6131	.0632	9.7040	.000	mdldow t-0
beta(4)	.6138	.1371	4.4755	.000	WXgdns t-0

mdldow: Model with day of week correction
WXgdns: Weather "goodness"

(residuals saved)



GAM Model: Day of Week by Year Calculations

Below are the primary SPlus commands and output obtaining the *day of week* by *year* interactions.

```
> options(contrasts=c("contr.treatment","contr.poly"))
> oneseq6yp2.gam<-gam(formula = Use6 ~ lo(daynum1, span = 0.2) + DoW6 * Year6
+ Xmas6 + Easter6, family = poisson)
> oneseq6ynp2.gam<-gam(formula = Use6 ~ lo(daynum1, span = 0.2) + DoW6 + Year6
+ Xmas6 + Easter6, family = poisson)
> anova(oneseq6yp2.gam,oneseq6ynp2.gam)
Analysis of Deviance Table

Response: Use6

                                                    Terms Resid. Df Resid. Dev        Test        Df
1 lo(daynum1, span = 0.2) + DoW6 * Year6 + Xmas6 + Easter6   988.126   7485.444
2 lo(daynum1, span = 0.2) + DoW6 + Year6 + Xmas6 + Easter6  1012.126   7670.639 -DoW6:Year6 -23.99981
   Deviance
1
2 -185.1952
> 1-pchisq(185,24)
[1] 0
> oneseq6yp2.gam$coef
 (Intercept) lo(daynum1, span = 0.2)   DoW6MON    DoW6SAT    DoW6SUN   DoW6THU    DoW6TUE     DoW6WED
    3.977038              -6.495828 -0.246268 0.05309333 -0.2483586 -0.143887 -0.1753295 -0.06997808
  Year6N7/8  Year6N8/9   Year6N9/0  Year6NO/1      Xmas6  Easter6
-0.1530312 -0.1537586 -0.01003894 -0.2162524 -0.6922204 1.343652
DoW6MONYear6N7/8 DoW6SATYear6N7/8
       0.1565355        0.1128206
 DoW6SUNYear6N7/8 DoW6THUYear6N7/8 DoW6TUEYear6N7/8 DoW6WEDYear6N7/8 DoW6MONYear6N8/9
       0.2035116        0.07160629       0.06756825        0.1979523        0.3573574
 DoW6SATYear6N8/9 DoW6SUNYear6N8/9 DoW6THUYear6N8/9 DoW6TUEYear6N8/9 DoW6WEDYear6N8/9
       0.1055522          0.18948       0.08455921        0.1915204       0.06537386
 DoW6MONYear6N9/0 DoW6SATYear6N9/0 DoW6SUNYear6N9/0 DoW6THUYear6N9/0 DoW6TUEYear6N9/0
       0.1236317       0.08025715        0.0429824       0.09693061      -0.03815566
 DoW6WEDYear6N9/0 DoW6MONYear6NO/1 DoW6SATYear6NO/1 DoW6SUNYear6NO/1 DoW6THUYear6NO/1
       0.1666914        0.4101666        0.2910958        0.4053307         0.219421
 DoW6TUEYear6NO/1 DoW6WEDYear6NO/1
       0.3190254        0.2628536
```

The SPlus output is copied into Excel for analysis
Raw data

DoW6MONYear6N7/8		MON	TUE	WED	THU	SAT	SUN
		-0.246	-0.175	-0.070	-0.144	0.053	-0.248
Year6N7/8	-0.153	0.157	0.068	0.198	0.072	0.113	0.204
Year6N8/9	-0.154	0.357	0.192	0.065	0.085	0.106	0.189
Year6N9/0	-0.010	0.124	-0.038	0.167	0.097	0.080	0.043
Year6NO/1	-0.216	0.410	0.319	0.263	0.219	0.291	0.405

Transformed data indicating the difference relative to Friday during the 1996/7 summer season

	MON	TUE	WED	THU	FRI	SAT	SUN
1996/7	-0.246	-0.175	-0.070	-0.144	0.000	0.053	-0.248
1997/8	-0.243	-0.261	-0.025	-0.225	-0.153	0.013	-0.198
1998/9	-0.043	-0.138	-0.158	-0.213	-0.154	0.005	-0.213
1999/2000	-0.133	-0.224	0.087	-0.057	-0.010	0.123	-0.215
2000/1	-0.052	-0.073	-0.023	-0.141	-0.216	0.128	-0.059

Appendix W

Coding for forecasted *state of the weather*			
Temperature	**Wind (speed)**	**Cloud Cover**	**Rain/Snow**
0 Freezing level above 2000m	0 calm	0 clear	0 none
2 Freezing level between 1500m and 2000m	2 Light (5-10km)	1 up to 1/4 cloud cover	6 light *intermittent showers*
4 Freezing level of 1500m or below	6 Moderate (15-25km)	1.5 up to 2/4 cloud cover	8 moderate
	10 Strong (30-50km)	2 up to 3/4 cloud cover	10 heavy
	14 Gale (>50km)	4 overcast	8 light *rain/sleet*
			10 moderate
			12 heavy
			6 light *snow*
			8 moderate
			10 heavy

Appendix X

ASTSA Residual analysis for the two models in Chapter 15

Residual tests for gam residuals
T = 212

Cumulative spectrum test
max. diff. p-value
.226 < .01
Non-constant variance.

Box-Pierce test
lag chi sq. p-value
1 22.38 < .01
20 59.57 < .01
Non-independence.

Fluctuation test
z p-value
-1.96 < .01
Too little fluctuation - non-random series.

Outlier detection
max. |z| p-value
3.26 N.S.
No outliers.

Normal test
corr. p-value
.99301 < .05
Non-Gaussian distribution.

Residual tests for Piecewise residuals
T = 212

Cumulative spectrum test
max. diff. p-value
.225 < .01
Non-constant variance.

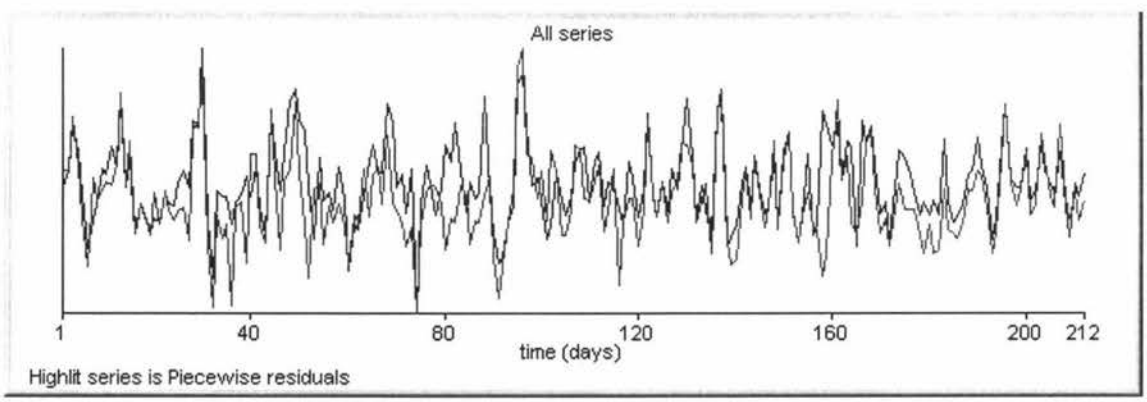
Box-Pierce test
lag chi sq. p-value
1 22.89 < .01
20 39.77 < .01
Non-independence.

Fluctuation test
z p-value
-2.94 < .01
Too little fluctuation - non-random series.

Outlier detection
max. |z| p-value
3.40 N.S.
No outliers.

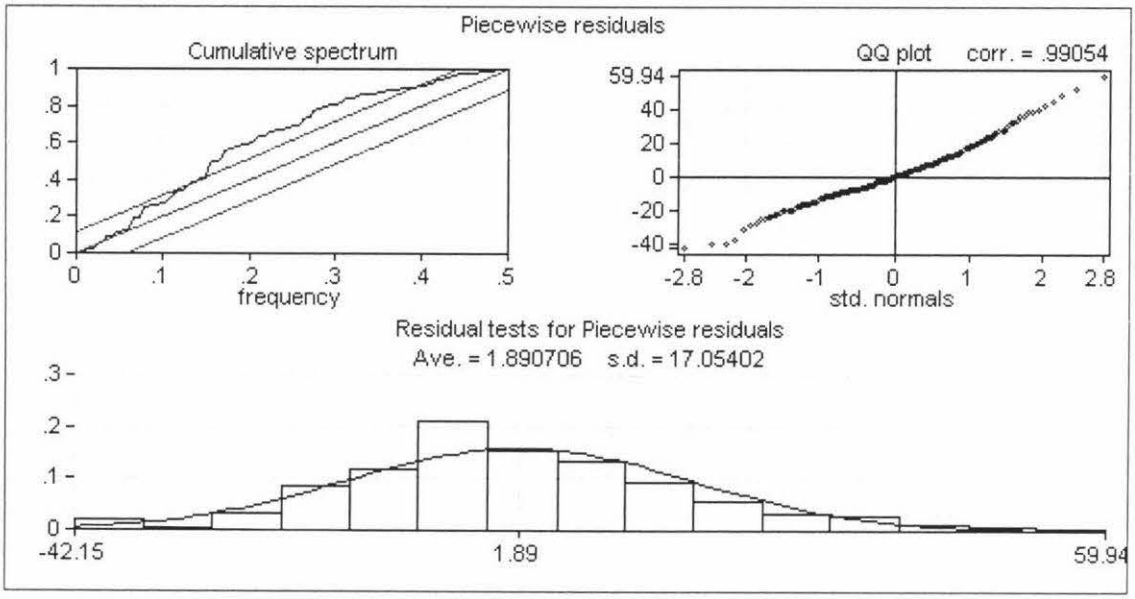
Normal test
corr. p-value
.99054 < .05
Non-Gaussian distribution.

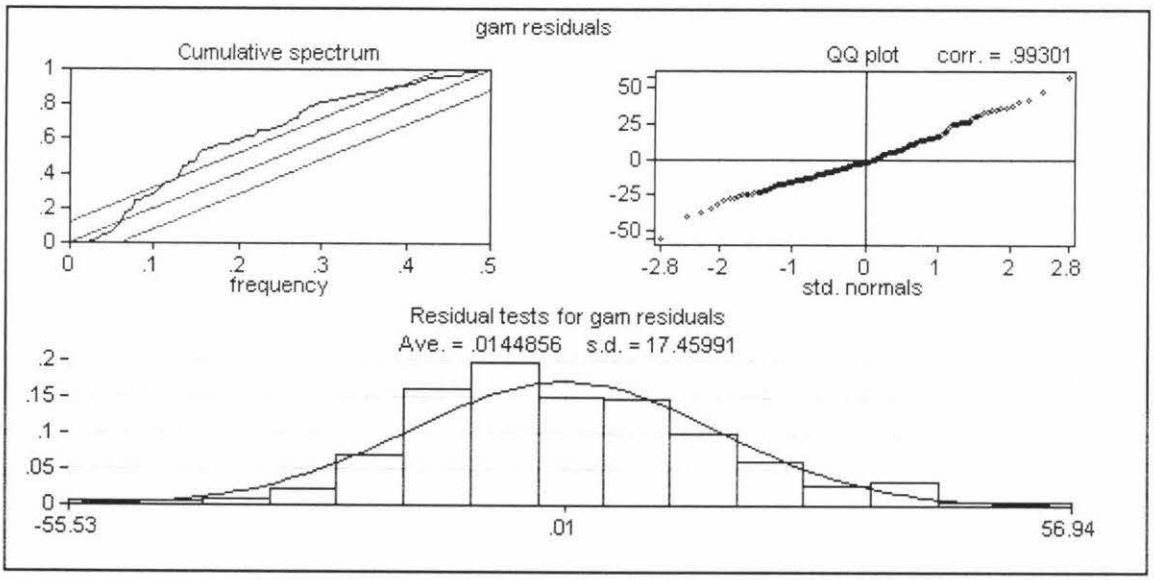
Plots of residuals:



Appendix X

ASTSA plots of residual tests:





Appendix Y

GAM Model Coefficients

SPlus commands and output

> mod6<-gam(Usef~lo(Daynum, span=0.2)+Easter+Xmas+DoW+nrain+nsnow+ nmntemp+Radn+wind9am+Windgust, poisson)

> mod6$coeff

```
 (Intercept) lo(Daynum, span = 0.2)    Easter
    4.388941               -2.411445 1.320568

      Xmas         DoW1        DoW2         DoW3
-0.7394201 0.007499494 0.02024411 -0.01225916

        DoW4        DoW5         DoW6         nrain
 -0.01366274 0.03940573 -0.004996939 -0.003551686

    nsnow     nmntemp         Radn     wind9am
0.3988346 -0.02190627 0.007712847 -0.01731252

     Windgust
 -0.005428976
```