Tourism Recreation Research and Education Centre

Lincoln University

Estimating the Number of Visitors to Kaikoura Over One Year by Developing a Vehicle Observation Method

John R Fairweather
David G Simmons

Kaikoura Case Study

Report No.2 /1998

TOURISM RECREATION RESEARCH AND EDUCATION CENTRE

LINCOLN UNIVERSITY
Te Whare Wānaka O Aoraki

LINCOLN UNIVERSITY, PO BOX 84, CANTERBURY 8150, NEW ZEALAND

Estimating the Number of Visitors to Kaikoura Over One Year by Developing a Vehicle Observation Method

John R Fairweather
Senior Research Officer in the Agribusiness and Economics Research Unit, Lincoln University. Fairweat@lincoln.ac.nz

David G Simmons
Reader in Tourism, Human Sciences Division, Lincoln University. Dsimmons@lincoln.ac.nz

September 1998

ISSN 1174-670X

Tourism Research and Education Centre (TREC)
Report No. 2

Contents

List of Tables

List of Figures

Acknowledgements

During the development of the research reported here a number of people have contributed their expertise. I wish to thank the following people:

Mr Russel McAuliffe and Mr Richard Amor, Commerce Division, for guidance on the intricacies of Excel.

Ms Chrys Horn, Human Sciences Division, and Mrs Robyn Fairweather for providing assistance with recording vehicle observations.

Dr Chris Frampton, Applied Management and Computing Division, for guidance on statistical matters and for critically reviewing an early draft.

Dr David McNeil, Soil, Plant and Ecological Science Division, for analysis of the probabilities of multiple counts of vehicles.

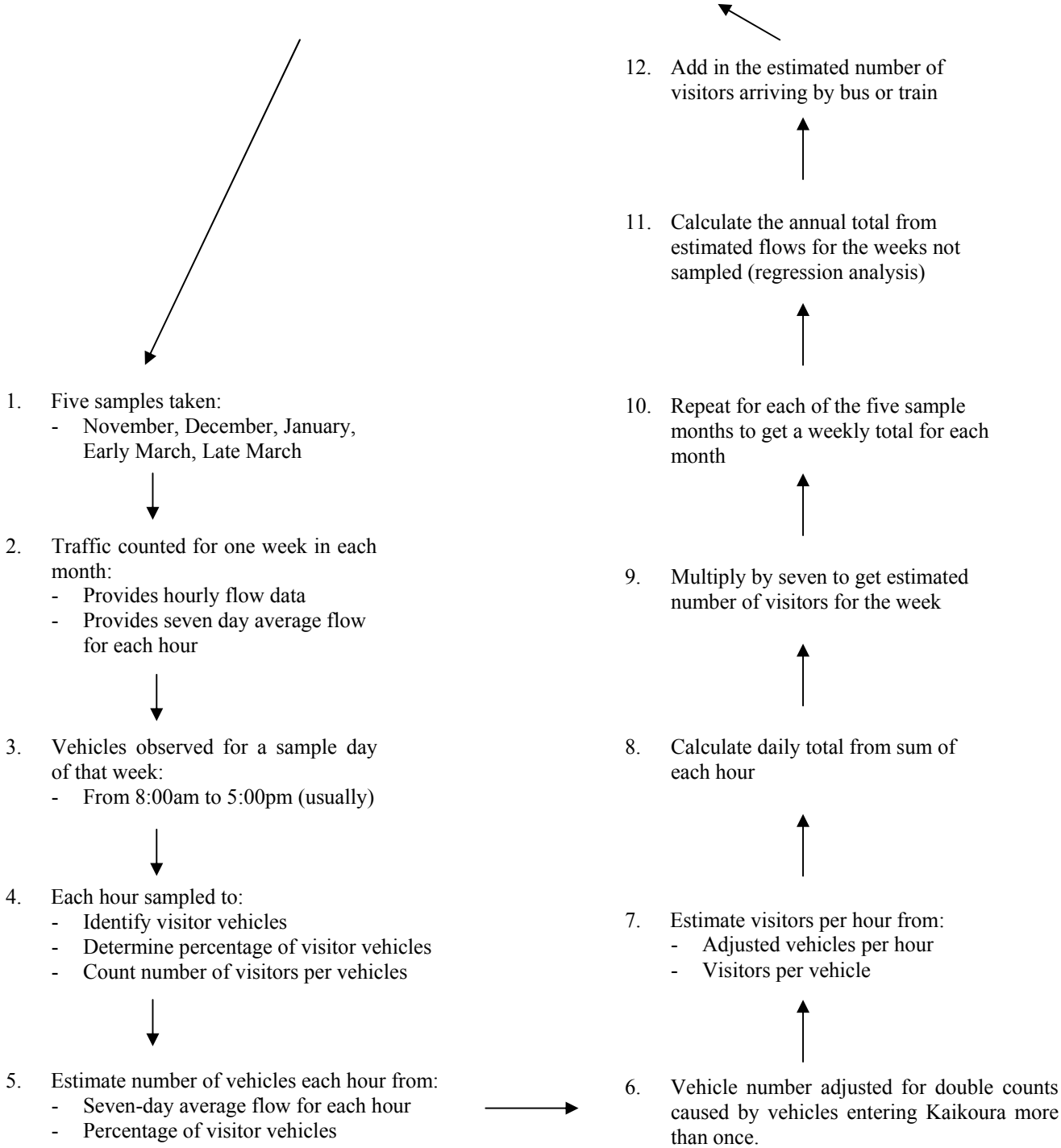
Mr Tony Harcourt, Transit New Zealand, for provision of road traffic data.

Funding for this research was provided by the Foundation for Research, Science and Technology, as a component of programme LIN602, Planning for Tourism Development in New Zealand.

Summary

The annual total of visitors to Kaikoura was estimated at 873,000. This number was derived from a method that involved four key steps: counting all traffic entering Kaikoura, observing a sample of vehicles to record licence plates and the number of people in each vehicle, identifying vehicles from outside of Kaikoura, and then estimating all visitor vehicle numbers and numbers of visitors. The four key steps are illustrated in more detail in the following diagram that shows the steps involved in the estimation of the annual total.

Annual Flow of Visitors into Kaikoura



Chapter 1

Introduction

The research reported here is part of a long-term programme of research on the social, economic and environmental effects of tourism being studied in order to improve planning for tourism development. The first location for this programme was Kaikoura, a relatively small town, which the 1996 census indicates had a usually resident population of 2,208, but which has a significant level of tourism activity. The main objectives of the research programme were to document the social, Maori cultural economic and environmental effects of tourism using a variety of research methods applied within an integrative research framework. The general strategy was to understand the effects of tourism in breadth rather than depth, in order to be able to report generally on the effects of tourism in Kaikoura and focus on important features of its development.

The original design of the research did not include a component that focused on estimating visitor numbers. However, early discussions with the Kaikoura District Council showed that the number of visitors visiting their town were unknown. Data from the Visitor Information Centre were available for the number of visitors to the centre, but these do not accurately measure all visitors to Kaikoura. Knowledge of the numbers was important to the Council because it faced pressures on infrastructure (sewerage, water supply and roading) due, in part to, increases in visitor numbers. Given this local need, we decided to include the additional minor research objective of estimating visitor numbers over one year. (Visitors were defined as any person arriving in Kaikoura from elsewhere in New Zealand or from overseas, and who may be travelling for any purpose.) Knowledge of the number of visitors was also important for the overall programme of research by way of documenting the level of the flow of visitors directly influencing the effects being studied. In addition, the numbers could be used to estimate economic impacts of tourism, since the survey of visitors (from another part of the overall research) would provide an estimate of the average number of dollars spent per visitor.

This report describes in detail the method used to estimate visitor numbers, presents results that show the estimated numbers, and concludes briefly by making an assessment of the method. The focus of the report is primarily on the method and secondarily on the estimated numbers. Hence the report is technical in nature and does not review the literature on relevant tourism research; nor does it refer to the other results from the programme of research.

Chapter 2

Method

2.1 Introduction

The procedure for estimating the number of visitors visiting Kaikoura over one year involved a sequence of four main steps. The first step was to count traffic entering Kaikoura township for one week in each survey month in order to establish a baseline of data for that month. The second step was to observe a sample of the vehicles going over traffic counters during daylight hours in order to record characteristics that would permit identifying the visitor vehicles. The third step was to identify vehicles from outside of Kaikoura. The fourth step was to combine the data and estimate the visitor vehicle numbers and number of visitors. Field research began in November and included each month until March except for February. Two measures occurred in March, one in early March and one in late March. Before providing the details for each of these steps it is necessary to describe the research site. The chapter then gives an overview of the procedure and the final section examines the limitations of the method.

2.2 Details of the Site

Kaikoura lends itself to vehicle observation and analysis of traffic flows because of its physical layout. Kaikoura is a seaside town where most visitors arrive by road and approach from the North or South via State Highway 1 (see Figure 1). The town itself is so laid out that visitor road traffic either passes directly through, stops on Highway 1 somewhere along the northern strip, or enters the main township by turning off Highway 1 at either the northern entrance or the southern entrance. All traffic entering by these two points also leaves by these two points.

The focus of attention was on the traffic entering the township, not on the traffic entering Kaikoura by staying on Highway 1. The latter element typically contains visitors who make a brief stop for refreshment and while they contribute to the effects of tourism on Kaikoura, they are not exceptional nor related to the visitor activities distinctive to Kaikoura, such as dolphin swimming or whale watching. Some visitors stopping on Highway 1 may be visitors who do engage in distinctive visitor activities and stay in accommodation there. However, these visitors are likely to enter the township of Kaikoura at some stage during their visit and would be included in the measurements. Thus the focus on traffic entering the township is warranted in that it captures data related to the main occurrence of visitor activity.

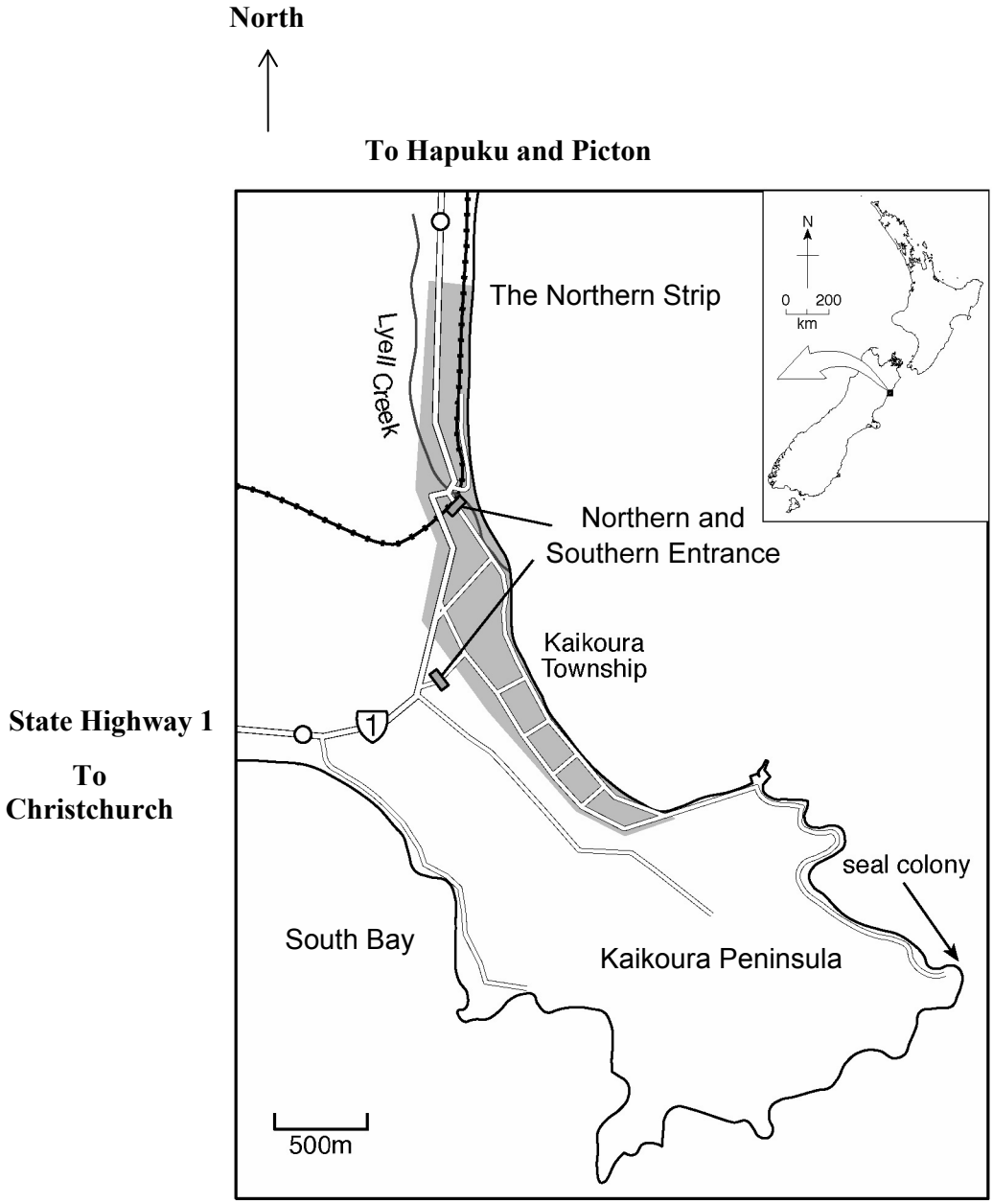


Figure 1
Map of Kaikoura Showing Main Roads and Northern and Southern Entrances to Kaikoura Township

2.3 Counting All Traffic Entering Kaikoura Township

This first main step was an apparently straightforward exercise of setting up road traffic counters at appropriate points on each intersection at the two entrances to Kaikoura township. The two counters were set out for at least one week in each sample month so that data were available for each day of the week and from which seven-day average daily flows could be obtained. Counters provide data for each hour of the day. Some counters also classify by vehicle type and measure direction of travel, while others measure only the flow in both directions. In this research one of each type was used, with the more detailed measurements taken at the northern, and busier, entrance.

Traffic counters are not without their limitations, and experience was needed to operate them effectively. For the five survey months there were two times for which there was a problem with one of the counters usually caused by operator inexperience. In one case no data were recorded, and in the other case, data for only one day were recorded. For these times the missing data were estimated from other data that were as close as possible in time to those missing. Further, one counter was observed to count erroneously the passing vehicles, and a half hour sample of the measurements was taken and compared to the actual number of vehicles passing in order to calculate an adjustment factor.

2.4 Observation of Vehicles Entering Kaikoura

A sample of the traffic flow entering Kaikoura township was taken for a one to three day period in each week that the traffic counters were in place, and observations were made for each hour of the day, typically between 8.00am and 6.00pm. A recording was made of the number of adults, the number of children, the licence plate number and, initially, making an estimate of whether the vehicle was local or a visitor vehicle based on its appearance. Each of these elements of the observation needs to be explained in more detail after commenting on the actual means of recording these data. Initially, we tried a number of recording methods in order to determine the best method. The first attempts involved three people using a handwritten record sheet, a tape recorder and a lap top computer respectively. The first and last technique could not handle the situation when there was a continuous flow of traffic. For these peak flows only the tape recorder was suitable and all later measures were based on tape recordings, later transcribed directly into an Excel spreadsheet.

A number of protocols were developed to ensure accurate records. First, each transcribed spreadsheet was checked against the original tape recording. This procedure resulted in a small number of amendments, and there were more amendments when someone other than the person who made the recording did the transcribing. Second, the microphone was held by hand close to the mouth rather than attaching it to clothing, in order to record clearly when turning to read a licence plate number. Third, the letters on the license plate were recorded using words to distinguish between similar sounding letters of the alphabet, such as ‘M’ and ‘N’.

The sample was taken for either six minutes or twelve minutes and Table 1 reports the actual measurement times at the northern entrance. For November, December and January a six-minute sample was used. This ten per cent sample was thought to be adequate but analysis of the data raised the possibility that the sampling error was high and for the two sampling periods in March a 12-minute sample was used. Each six minute sample began at approximately the beginning of the hour at the northern entrance, followed by a sample at the southern entrance starting about five to seven minutes later. Each 12-minute sample began approximately at the half-hour, and some of the southern entrance measurement times were actually recorded near to the beginning of the hour. The table also shows that the survey for each month extended from one to three days. For November the observations covered three days, for January and March 12-13 two days, and for December and March 30, one day.

Table 1
Actual Measurement Times, Northern Entrance[1]

Month	**November[2]**			**December[2]**	**January[2]**		**March[3]**		**March[3]**
Date	**27**	**28**	**29**	**18**	**28**	**29**	**12**	**13**	**30**
Day	**Thursday**	**Friday**	**Saturday**	**Thursday**	**Wednesday**	**Thursday**	**Thursday**	**Friday**	**Monday**
Hour									
700						707		742	
800		815	810		815			831	824
900		917	902		908			922	923
1000		1028	1015		1013			1032	1044
1100	1107-1119		1113	1100	1105		1129		1130
1200	1218		1215	1158			1233		1229
1300	1325		1312	1256	1331		1333		1320
1400	1400[4]		1410		1353		1440		1441
1500			1515	1500	1500		1531		1528
1600	1615		1620	1552	1557		1633		1630
1700	1718		1702[4]			1718	1726		1735
1800						1801		1828	1830
1900					1904				
2000									

Notes: 1. All times are at the northern entrance, and the count at the southern entrance starts about five to seven minutes later.

2. November, December and January samples were for six minutes and at the half-hour.

3. The two March samples were for 12 minutes and at the half-hour.

4. For the 27/11 at 1400 hours and 29/11 at 1700 hours the sample was for the northern entrance only.

The number of people in the vehicles was recorded without difficulty. Most of the vehicles had only adults in them. It is possible that the number of children recorded may be slightly underestimated because there may have been young children who were sitting very low in their seats and who were not visible to the researchers on the roadside. The number of passengers in buses was estimated when the bus was over half full and these numbers may not have been precise. However, the bus data were not used in the later analysis because they tended to distort results, and because more precise alternative measures were used. The numbers of people in the vehicles were recorded in order to derive an estimate of the average number of persons per vehicle. Casual observation suggested that this figure would be higher for visitor vehicles than for local vehicles.

The licence plate number was recorded in order to determine whether the vehicle was a visitor vehicle of a local vehicle. The Motor Vehicle Registration Centre at Palmerston North provides ownership data pertaining to a given licence plate number, including the address of the owner. Each recorded licence plate number was sent to the Motor Vehicle Registration Centre and the owner's address was used to assess if the vehicle was local or visitor. All Kaikoura district vehicles were labelled as 'Kaikoura'. This method worked well, although there may be a few cases where a vehicle was registered outside of Kaikoura but was used regularly within Kaikoura for typically business purposes.

For the first three month's of observation the location status of each sampled vehicle was assessed using a variety of decision criteria. The intention was to assess the accuracy of this assessment by comparing actual status with estimated status, and if the assessment was reasonable just use that method in future rather than using licence plate data. Results showed that visual assessments of location status were not accurate, and all licence plate numbers recorded were sent to the Motor Vehicle Registration Centre.

2.5 Estimating Visitor Numbers

The traffic count data and vehicle observation data were combined to estimate visitor numbers. The following procedure was used.

1. The traffic count data were used to obtain the average number of cars entering Kaikoura township for each hour. The average was taken across seven days of the week and is referred to here as the seven-day average.

2. For each hour that vehicle observations occurred the percentage of visitor vehicles was calculated.

3. For each hour the estimated number of visitor vehicles was calculated.

4. Visitor vehicles may enter Kaikoura more than once thereby inflating the vehicle counts. To correct for this factor the data for each survey period were analysed to identify the visitor vehicles that entered more than once. These vehicles were counted and recorded as the 'doubles percentage'. The estimated number of visitor vehicles was reduced by a correction factor derived from this proportion.

5. Each hour's record of visitors per vehicle was used to estimate the number of visitors.

6. The estimated number of visitors for each hour was summed to give an estimated total of visitors for the day.

7. The daily total was multiplied by seven to calculate the estimated weekly total of visitors.

8. Each of the five estimates, for November, December, January, early March and late March respectively, were used as the basis for a regression of estimated visitor numbers by week of the year. The regression equation, in the form of $y = a + b x + c x^2$, was used to calculate an estimated number of visitors for each week of the year. The weekly totals were summed to give an estimated annual number of visitors visiting Kaikoura.

Finally, the above data were supplemented with data on people who arrived in Kaikoura by bus and train. Each bus company, and Transrail, was asked to provide monthly totals for the last year and these were summed to produce an overall total. Since Kaikoura residents tend to use one particular shuttle bus to visit Christchurch, the data for that company were excluded.

2.6 Limitations to the Design

The design outlined above is based on a number of assumptions. Each is discussed in turn.

First, it is assumed that all visitors arrive by vehicle and this is not strictly correct. There is an airport at Kaikoura and it is possible that some people may arrive by 'plane but this is likely to be a very small number of people. Similarly, some people may arrive by boat but this number is likely to be very small. A small but significant number of visitors arrive by train. This number is estimated from data provided by Transrail and included in the calculations.

Second, it is assumed that the measurement of the number of visitors entering Kaikoura township is an accurate measure of visitor activity. However, it is possible that some visitors, especially domestic visitors, do not enter the township even though they are at Kaikoura. Bach owners at South Bay may stay many weeks at Kaikoura and avoid the township by buying their supplies from businesses located elsewhere. Similarly, some 'short stop' visitors may go only to businesses on Highway 1 in the northern strip of Kaikoura. They have an economic impact and the method used does not measure their presence. This means that the estimate of visitor numbers is conservative. Data on traffic entering and leaving Kaikoura at each end of town were collected in order to measure vehicle numbers stopping in Kaikoura but not entering the township, but these data have not yet been analysed.

Third, the regression-based estimate of annual data is presently based on estimates for five weeks during the peak months. The interpolation for the winter months may be inaccurate. In order to try and improve the winter estimates a number of other data sources extending over the whole year were examined. One useful source was the Transit New Zealand traffic flow data from Hapuku on Highway 1, ten kilometres north of Kaikoura. Transit data were derived from a permanent traffic recorder that provides daily data. An analysis of the regression of the differences in vehicle numbers between Kaikoura township and Hapuku (in order to minimise variance from known sources) provided an insignificant improvement in estimated vehicle numbers in the winter months. Similarly, a regression of daily visitors to the Kaikoura Information Centre suggested that the curve for estimated visitor numbers might be too low in the winter months. However, this suggestion may not be sound since the Information Centre may have relatively more visitors in winter months because it is colder and wetter and people may use the facilities more. The issue of the winter months' data is best resolved by taking measurements in June, July or August and using these to improve the regression.

Fourth, by observing vehicles during daylight hours, typically between 8.00am and 6.00pm, the estimations exclude visitor vehicles entering the township at night. It is quite possible that domestic visitors might arrive at night and go to their own homes or baches, or go to pre-booked accommodation. Again this means that the estimate of visitor numbers is conservative. By way of a pragmatic note, it is very difficult to make observations of vehicles at night. The March 30 observations extended to 6.45pm and with the shorter day length at that time, it was nearly dark and very difficult to read licence plate numbers.

Fifth, some of the monthly samples spanned more than one day and the data for each hour were taken as if they were for one day only. This procedure was necessary given the practical limitation of arriving in Kaikoura from Christchurch by mid to late morning, collecting data for the afternoon and completing the sample in the morning of the next day.

Another limitation stems from the issue of timing. For a number of measurements it is possible to analyse data for more specific periods of time, e.g., weekdays versus week-end days, and in this research many of these more detailed assessments have not been pursued. There remains scope for assessing variation in visitor vehicles or numbers for separate days of the week, or months of the year and further refining the estimates provided in this report.

Chapter 3

Results

3.1 Introduction

The presentation of results begins with an examination of traffic flows. The data for November are used to illustrate some general patterns and then some comparisons are made across months. The chapter goes on to give an account of each step used to estimate the number of visitors, including: observing vehicles, the percentage of local vehicles, correcting for vehicles that crossed the counters more than once and the number of visitors per vehicle.

3.2 Traffic Flows

The traffic flow data as recorded by the traffic counters provided flow data for each hour. The northern counter measured the flow in each direction, while the southern counter measured the total number of vehicles in both directions. In the latter case the number of vehicles entering is estimated by dividing the total in two, which may not be accurate if there is more traffic flowing in one way compared to the other. Data from the northern counter show that the numbers entering and leaving, for each hour and for each day, were similar. Figure 2 shows seven-day average hourly flows of vehicles entering and leaving the northern entrance and while there are some differences, the hourly levels are quite similar. (The chart also shows that the number of vehicles entering at 8.00am and 9.00am slightly exceeds the number leaving and this pattern is reversed from 4:00pm-7:00pm). The numbers of vehicles entering and leaving the southern entrance must also be nearly equal.

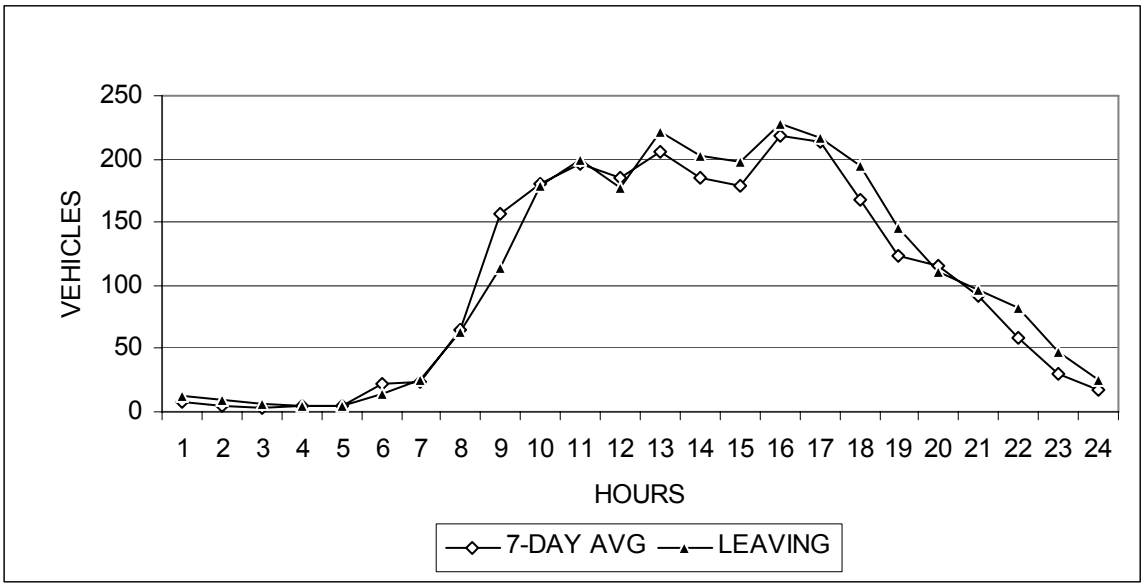


Figure 2
7-Day Average Hourly Flows for Vehicles Entering and Leaving at the Northern Entrance, November 1997

The November data can be used to illustrate some of the general characteristics of the traffic flows, and it is likely that these patterns occur in other months. Comparing all available months on every characteristic is not appropriate here nor is it directly germane to the research objective. First, the seven day average hourly flows (both ways) have a similar pattern for the northern and southern entrances, even though the levels for the northern entrance are nearly two times as high (Figure 3). Flows increase between 8.00am and 11.00am, are high until 5.00pm, then decrease between 5.00pm and 8.00pm. Second, the hourly flows for each day of the week follow the general pattern seen in Figure 3. Figures 4 and 5 show the hourly flows (both ways) for each day for the northern and southern entrances respectively. The figures show some data points at zero because the traffic counters were set out on Thursday and collected on Wednesday. For the northern entrance, Friday has high peaks after 12 noon and after 3.00pm, presumably because people use Friday afternoon to complete their weekly business in the township. Sunday has the lowest flows for many hours. Friday and Saturday have highest flows for the final three hours of the day, while Saturday and Sunday have the highest flows for the first three hours of the day. The southern entrance does not have the Friday peaks or the Sunday lows to the same levels but these patterns are observable to a lesser degree, and overall there are similarities in the patterns.

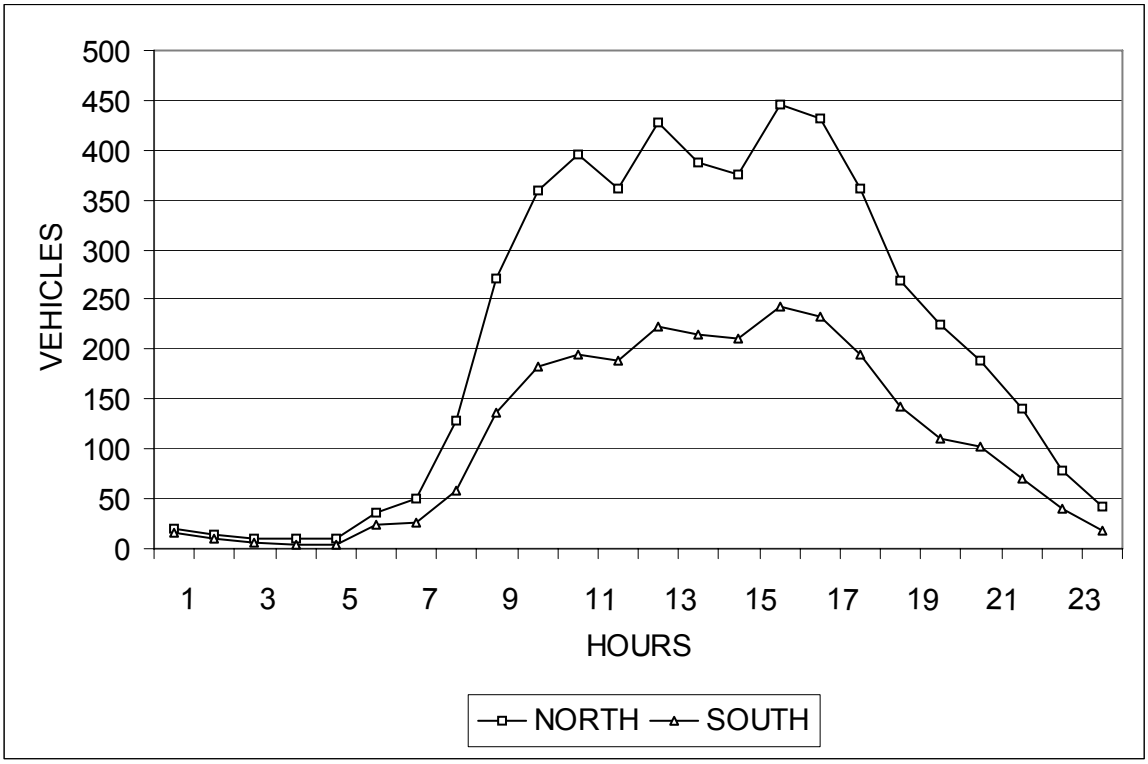


Figure 3
7-Day Average Hourly Flows (Both Ways) Northern and Southern Entrances Compared, November 1997

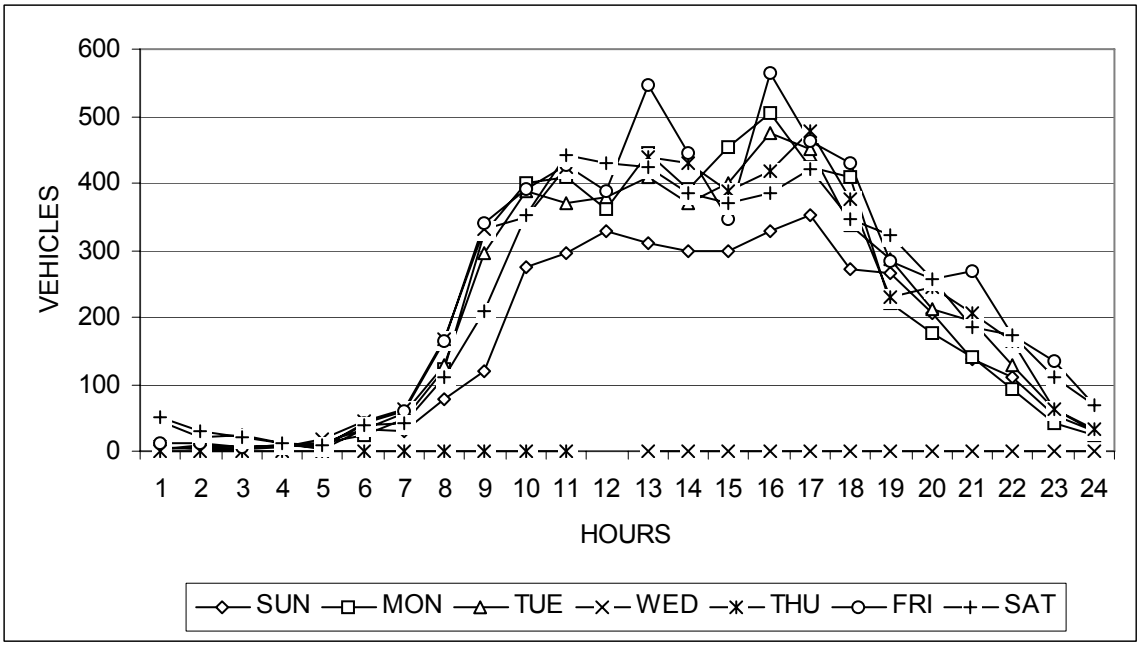


Figure 4
Hourly Flows (Both Ways) for Each Day, Northern Entrance, November 1997

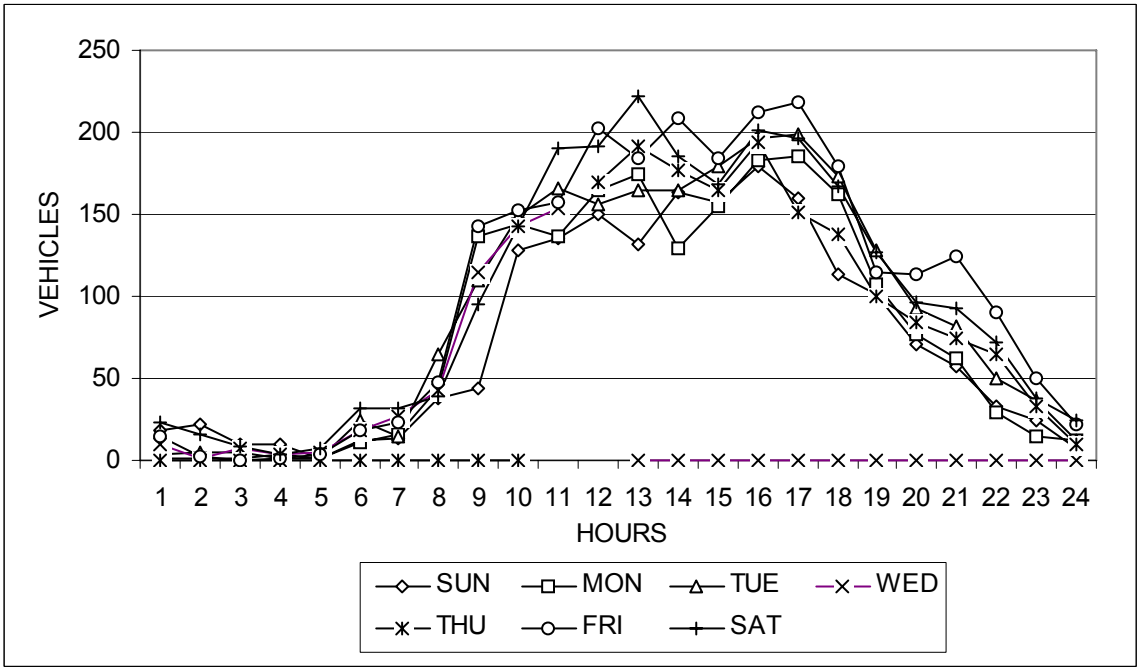


Figure 5
Hourly Flows (Both Ways) for Each Day, Southern Entrance, November 1997

Data over all months can be compared to show changes in patterns over time. Figure 6 shows the seven-day average traffic flow (both ways) for November, December, January, March 12/13 and March 30. November and March 30 have lower flows compared to the other months, and there is an increase in flows from November to a peak in December, then a gradual decline through to March 30.

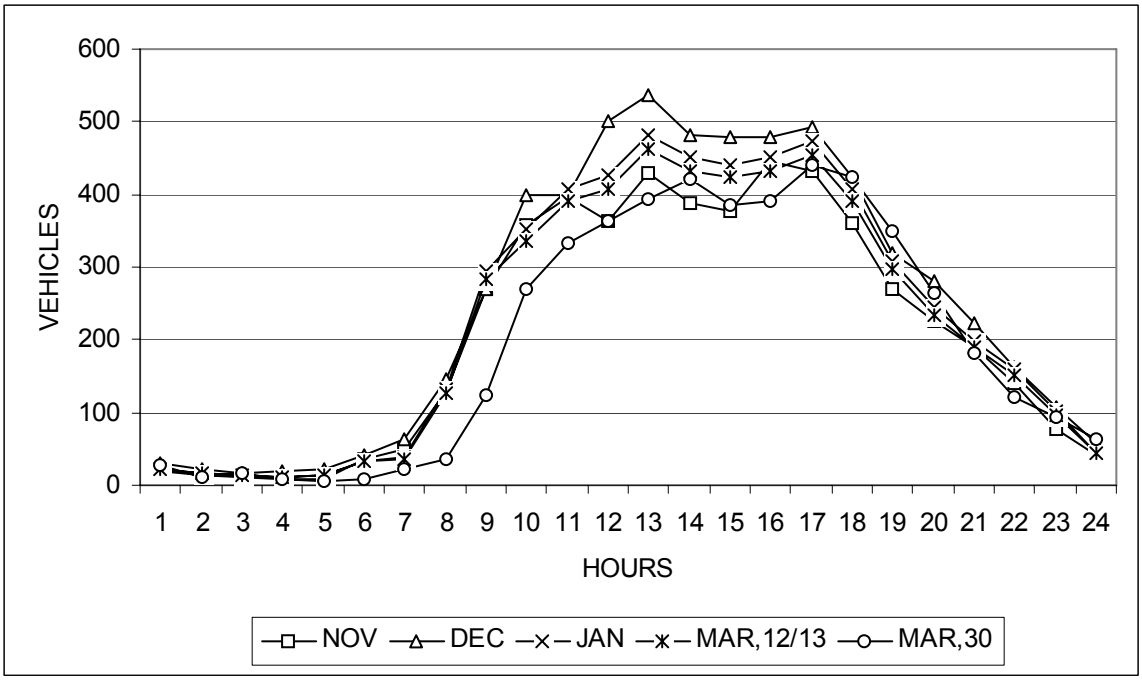


Figure 6
7-Day Average Vehicles Per Hour (Both Ways) at Kaikoura, November to March

Traffic flow data from the permanent recording site at Hapuka just 12 kilometres north of Kaikoura are available from Transit New Zealand to illustrate flows on Highway 1. Figure 7 shows the vehicles per hour (both ways) for each day of the week in January, and Sunday has highest levels in the afternoon. Traffic volumes within Kaikoura are higher because the resident population makes many trips within the town and this ongoing circulation exceeds the bi-directional flows on Highway 1 at Hapuka. Figure 8 shows the average for each week of the year from 1992 to 1997, and there is an approximate curve going from a peak in the summer to a trough in the winter, with exceptions at holiday periods. Generally, traffic flows are increasing each year. Transit New Zealand advise that the heavy-vehicle proportion of the weekly totals is constant throughout the year, an assessment based on relevant data from the Lewis Pass which they consider to be similar to Hapuku.

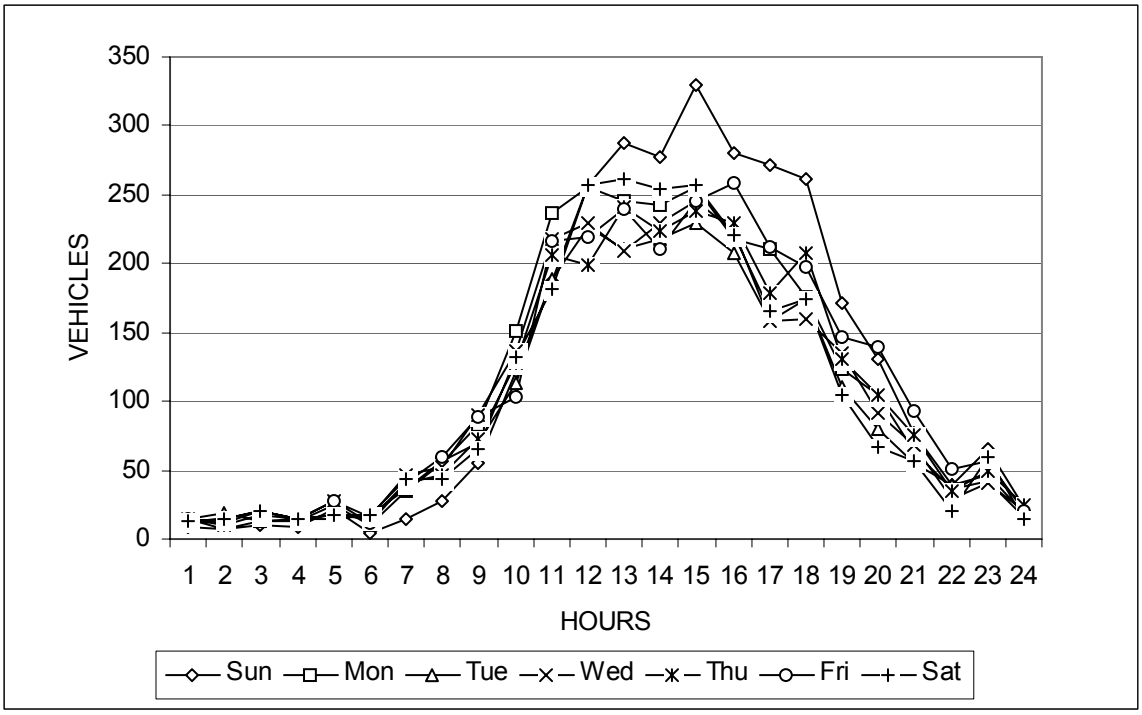


Figure 7
Vehicles Per Hour (Both Ways), Hapuku, January 1996

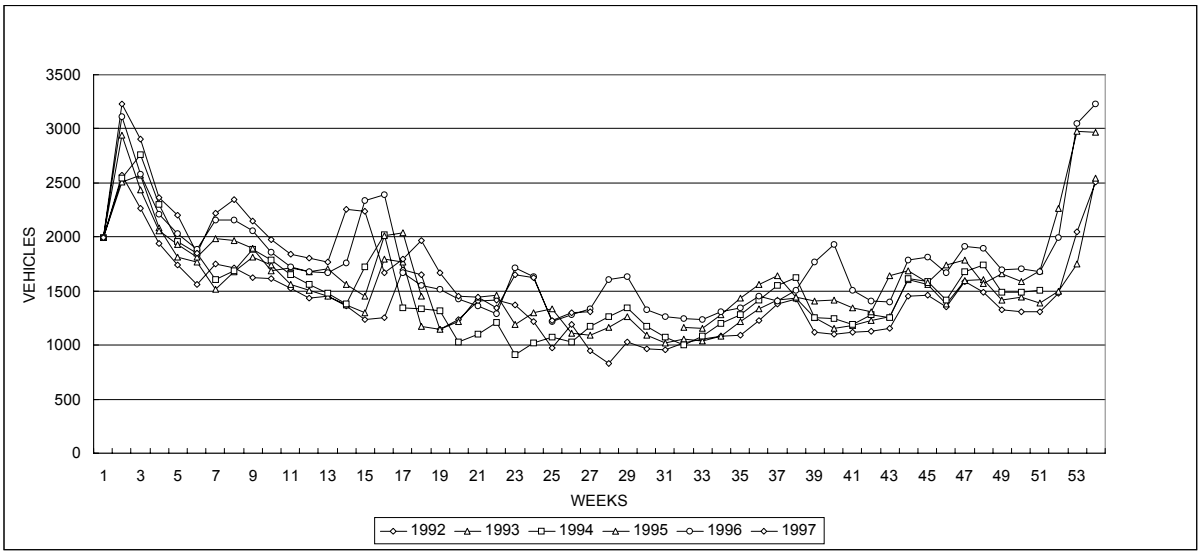


Figure 8
Hapuku Weekly Average (Both Ways), 1992-1997

3.3 Numbers of Vehicles Observed

Table 2 shows the numbers of observed vehicles by day and location for the sample months. Typically, samples were taken from 8.00am to 5.00pm, and for November, December and January, each with a six-minute sample, the total number of vehicles observed was 386, 205 and 330 respectively. For the two March samples, each with a 12-minute sample, the total number of vehicles observed was 703 and 619 respectively. Figure 9 shows for November the observed vehicle number (averaged over the two days) compared with the actual number derived from traffic counters. The observed number has been multiplied by ten in order to rate it up to the hourly level (based on the seven day average). Figure 10 shows the equivalent data for March 30 when a 12-minute sample was used. The November estimates of vehicle numbers tend to underestimate the actual number, a feature possibly caused by the adherence to a regular measuring time (about quarter past the hour). The March 30 estimates of vehicle numbers include overestimates in the morning and underestimates in the afternoon.

Table 2
Numbers of Observed Vehicles by Day and Location for Each Month

Month	**November[1]**						**December[1]**		**January[1]**				**March[2]**				**March[2]**	
Date	**27**		**28**		**29**		**18**		**28**		**29**		**12**		**13**		**30**	
Day	**Thursday**		**Friday**		**Saturday**		**Thursday**		**Wednesday**		**Thursday**		**Thursday**		**Friday**		**Monday**	
Loctn	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**
Hour																		
700											4	1			14	10		
800			9	3	3	5			17	15					50	25	41	20
900			13	2	10	4			16	15					30	8	35	15
1000			22	7	20	6			18	7					55	27	28	12
1100	9	14			28	8	29	12	25	10			51	22			40	25
1200	8	4			13	10	29	8					42	14			51	19
1300	22	4			25	7	31	11	18	10			41	15			44	16
1400	11				13	11			18	7			55	24			43	20
1500					23	11	32	8	29	13			41	24			58	15
1600	13	2			16	10	32	13	21	14			45	13			48	26
1700	4	4			12						15	9	40	10			30	13
1800											20	9			28	19	15	5
1900									13	6								
Sum	67	28	44	12	163	72	153	52	175	97	39	19	315	122	177	89	433	186
Total						386		205				330				703		619
Std Dev						6.9		10.8				6.6				15.32		14.73

Notes: 1. November, December and January samples were for six minutes and at the hour.
2. The two March samples were for 12 minutes and at the half-hour.

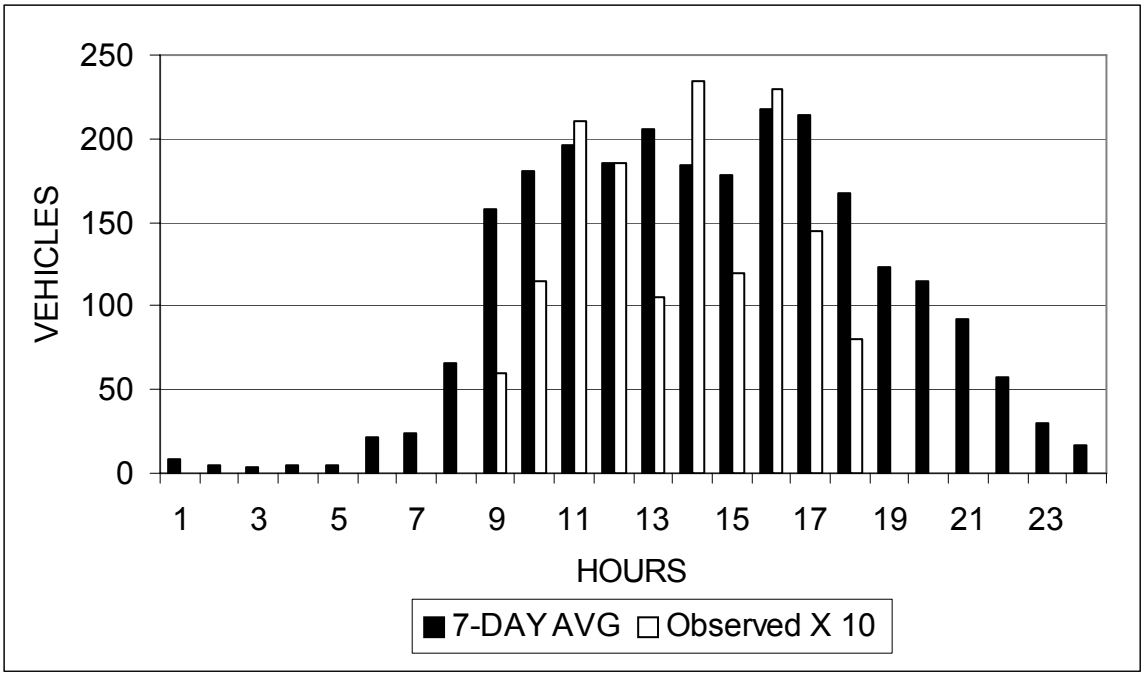


Figure 9
Estimated Numbers of Vehicles Entering Through the Northern Entrance Compared with Actual Numbers, November 1997

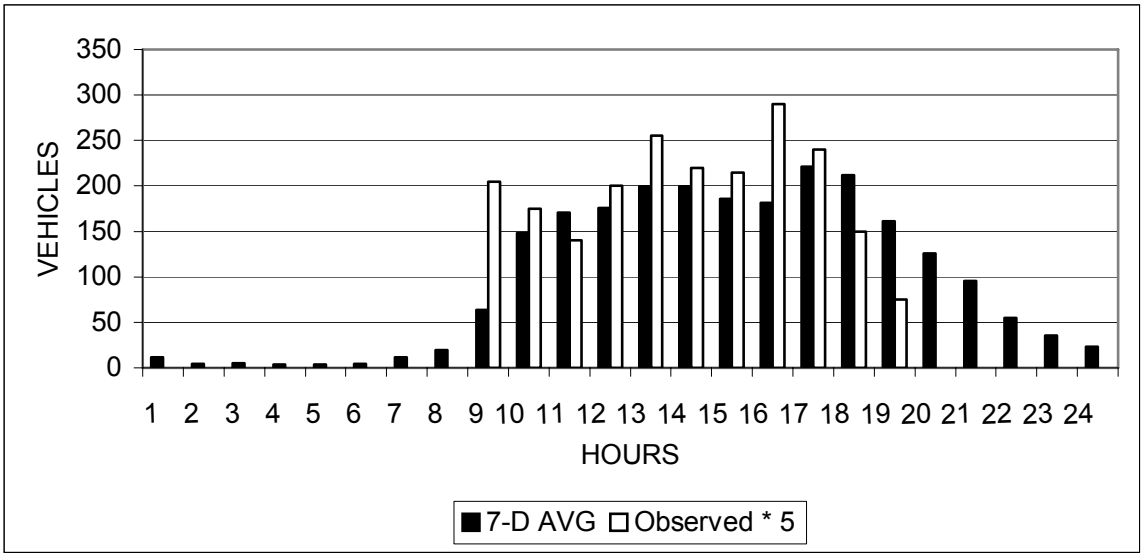


Figure 10
Estimated Numbers of Vehicles Entering Through the Northern Entrance Compared with Actual Numbers, March 30, 1997

3.4 The Percentage of Local Vehicles

Table 3 shows, by day and location, the percentage of the vehicles that were classified as local using the Motor Vehicle Registration Centre data. There was considerable variability across hours of the day. For example, for 27 November at 11.00am the sample had 22 per cent local vehicles but in the next hour it was 63 per cent. The Friday and Saturday figures for the same month at 8.00am show wide variation for each of the two measures: on Friday it was 44 per cent and on Saturday it was 0 per cent. In some cases this variation is due to the low number of observations, the last example has nine and three cases respectively, so small changes in number can result in large changes in proportion. Table 3 also reports averages for location (north or south) and for days (week or weekend). In terms of location, in nearly all cases the northern entrance has a higher proportion of local vehicles than the southern entrance.

Table 3
Percentage of Local Vehicles, November to March

Month	**November[1]**						**December[1]**		**January[1]**				**March[2]**				**March[2]**	
Date	**27**		**28**		**29**		**18**		**28**		**29**		**12**		**13**		**30**	
Day	**Thursday**		**Friday**		**Saturday**		**Thursday**		**Wednesday**		**Thursday**		**Thursday**		**Friday**		**Monday**	
Loctn	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**
Hour																		
700											75	0			79	90		
800			44	67	0	80			59	60					78	88	78	85
900			54	50	50	25			81	60					67	50	74	73
1000			55	43	70	33			50	29					56	48	57	58
1100	22	43			43	25	48	50	44	30			61	50			50	56
1200	63	50			54	10	41	63					33	71			55	37
1300	27	0			44	29	61	36	72	50			73	40			59	50
1400	36				54	36			67	29			64	58			58	65
1500					26	55	44	100	62	54			56	50			69	47
1600	54	50			63	40	53	31	52	71			69	85			48	38
1700	75	25			42						53	33	70	60			50	77
1800											45	78			54	42	33	20
1900									54	33								
Avg	46	34	51	53	45	37	49	56	60	46	58	37	61	59	67	64	57	55
Avg	40		52		41		53		53		47		60		65		56	
Avg	43						53		52				62				56	

Notes: 1. November, December and January samples were for six minutes and at the hour.
2. The two March samples were for 12 minutes and at the half-hour.

December reverses this pattern due to the unusually high proportion (100 per cent) of locals through the southern entrance at 3.00pm. There is thus some pattern to the average for the northern and southern entrances respectively and Figure 11 shows that the averages across all survey months for the northern entrance is, for most hours of the day, above that for the southern entrance. The overall pattern is consistent with the idea that locals would tend to use the northern entrance because it is closer to shops and services. The table shows that the pattern across months is variable. The overall average is 52 per cent.

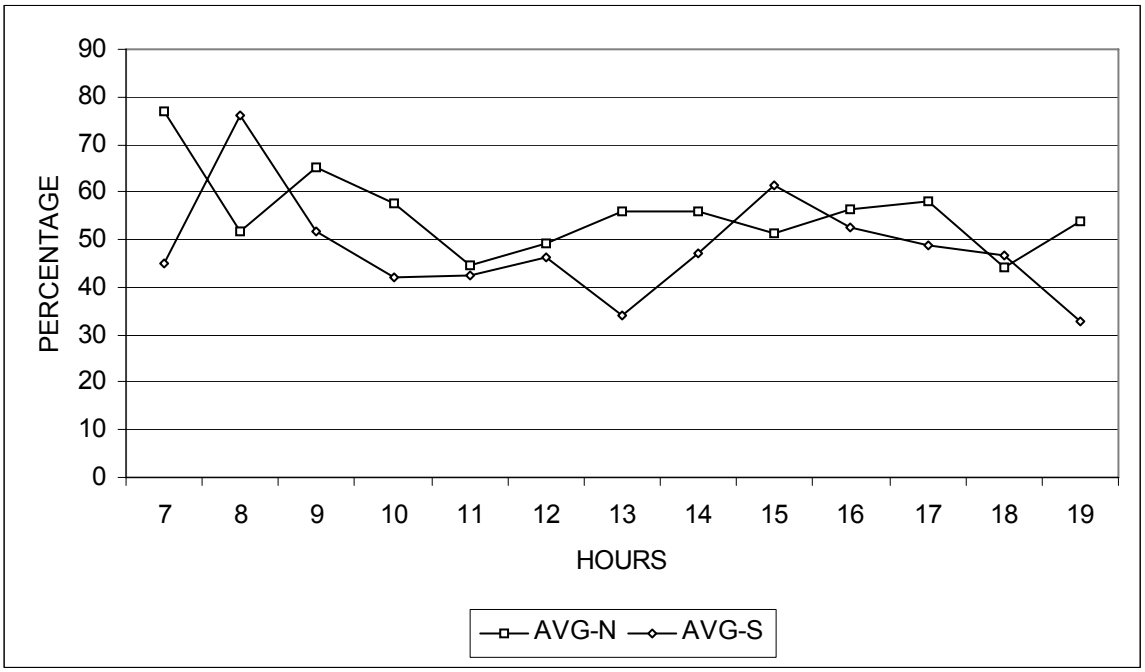


Figure 11
Average Percentage of Local Vehicles by Hour for All Survey Months

Generally then, aside from variations by location, hour of day, or day there is an approximately equal proportion of visitor vehicles and local vehicles. However, for the calculations in this study the actual proportions for each hour and month combination were used, not the overall average, and the above data were used to calculate the percentage of visitor vehicles. From this was calculated the estimated number of visitor vehicles by multiplying the percentage against the actual number of vehicles for each hour.

3.5 Correcting for Vehicles Which Crossed the Traffic Counters More than Once

So far the analysis has assumed that each vehicle crosses the traffic counters only once. It is quite likely that some vehicles make a number of visits to the township, and if no adjustment is made the vehicle counts will be too high and they will overestimate the actual number. A correction factor is needed and it needs to be developed separately for both local and visitor since it is likely that local vehicles make more multiple crossings.

For each day or days that the six or twelve minute samples were taken there is a transcribed list (from the tape recordings) of all the sample licence plates identified as local or visitor. Each list was examined in order to identify those cases where the same licence plate occurred more than once. The number of multiples was counted for local and for visitor vehicles, and the results are shown in Table 4. Typically, there were more multiples for local traffic and there were occurrences of a few triples.

Table 4
Number of Vehicle Multiples for Each Month Plus Correction Factor and Adjusted Number

Month		November		December		January		March 12/13		March 30	
		No.	%	No.	%	No.	%	No.	%	No.	%
Local	Doubles	18	5	5	3	10	3	57	8	63	10
	Triples	1	0	0	0	0	0	13	2	8	1
Visitor	Doubles	8	2	2	1	3	1	19	3	22	4
Correction Factor		5.5		5.5		5.5		3		3	
Adjusted No. Of doubles		44	11.4	11	5.4	17	5.2	57	8.1	66	10.7

The number of multiples shown in the table is for the sample period only and it is therefore an underestimate of the actual number. As the sample time increases there is likely to be relatively more multiples because there is a greater opportunity for a vehicle to be counted twice. In fact the table shows that when the longer samples were taken in March there were relatively more doubles

The correction factor needed to derive the estimated total number of multiples was derived in the following way. For each twelve-minute sample there are five possible sampling times for the survey hour. For the survey day or days there are then five possible groups of sampling times, but only one was used leaving four unused. Doubles can occur within Group 1 as well as between Group 1 and all the other groups (5); within Group 2 as well as between Group 2 and those remaining (4); within Group 3 as well as between all Group 3 and those remaining (3); within Group 4 as well as between Group 4 and 5 (2); and within Group 5 (1). By adding together all the possible sample combinations shown in the parentheses, the result is a total of 15 possible ways a double count can occur. More generally, the total count of doubles, if measures were taken continuously, is represented by:

$$N_D = \left(\frac{n+1}{2}\right) \text{ x } n \quad \text{where n = the number of groups}$$

For the 12 minutes sample, where n = 5, $N_D = 3 \text{ x } 5 = 15$

For the 6 minute sample, where n = 10, $N_D = \frac{11}{2} \text{ x } 10 = 55.$

The 15 possible counts derive from the five groups and each group's share of the total is 3/15 of the total. The measurement of multiples was only capable of picking up 1/15 of the total, so the actual number for the one group is the measured number multiplied by three. This is the number of multiples for one group. For the whole day, this number would have to be multiplied by the number of groups in the day, namely five. Looking at it another way, for the 12-minute sample there is an estimate of the number of doubles and the sample taken is $\frac{1}{n}$ of the total. The estimated number needs to be adjusted by the correction factor (C) where:

$$C = \frac{1}{n} \times \frac{n(n+1)}{2} = \frac{n+1}{2}$$

For the 12 minute sample, where n = 5, $C = \frac{6}{2} = 3$

For the 6 minute sample, where n = 10, $C = \frac{11}{2} = 5.5$

The correction factor is used to calculate an adjusted number of doubles for each group. This can be expressed as a percentage of the total number of vehicles over the time period measured, and this proportion can be used to adjust the estimated total number of visitor vehicles. The above correction factor takes into account those multiples which are doubles. While some triples were observed, they all occurred for local vehicles only.

Another adjustment needs to be considered to account for the fact that visitors visit for a limited period of time compared with locals who are potentially able to enter the township any day of the year. For example, it may be that visitors visit for two days on average. The samples were taken for one, two or three days. In the case of a sample of times that spread over two days, a visitor vehicle observed on the first sample day and on the second day of its visit will not be observed on the second sample day. The estimates of visitor vehicles that were doubles may need to be adjusted accordingly. However, the average length of stay was less than one day (see Results, Summertime Visitors to Kaikoura: Characteristics, Attractions and Activities, Report No. 3), so no adjustment was necessary.

Table 4 shows the correction factor and the adjusted number of doubles for each month. It also gives the adjusted number of doubles as a percentage and these percentages are carried forward to make adjustments to the final estimate of visitor numbers.

3.6 The Number of Visitors per Vehicle

Table 5 shows the number of visitor per vehicle, including adults and children. The overall average is 2.0 and for the northern and southern entrance for each observation period it is the same. There is some variation by hour of the day. The actual figure for each hour was used in estimating the number of visitors.

Table 5
Visitors Per Vehicle

Month	November[1]						December[1]		January[1]				March[2]				March[2]	
Date	27		28		29		18		28		29		12		13		30	
Day	Thursday		Friday		Saturday		Thursday		Wednesday		Thursday		Thursday		Friday		Monday	
Loctn	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
Hour																		
700											2	2			1.3	1		
800			1.8	2	1	2			2	1.7					1.5	2	1.7	2.3
900			1.5	2	1.2	4			1.3	1.5					1.9	4	1.9	3.8
1000			1.7	2	1.8	2			1.8	2.8					2.1	2.2	1.3	1.8
1100	1.9	2			2.1	2	1.8	3	1.9	1.7			2.1	2.6			2.2	2
1200	3	2			1.7	2	2.5	3.3					1.5	1.3			1.9	2.2
1300	1.4	2			2.4	2	1.9	2.3	1.6	2.2			1.5	1.9			2	2
1400	1.7				2.5	2			2.2	2.6			1.5	2.4			1.6	1.6
1500					2.3	2	2	0	2	1.5			3.2	1.7			1.9	3.3
1600	1.2	1			2.3	2	1.9	2	1.3	2			1.6	3.5			2.1	1.8
1700	4	1			2						2	2.3	2.2	2.3			2.1	1.7
1800											2	3.5			2.1	2.1	1.7	1.3
1900									2.7	2.3								
Avg	2	1	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2
Avg	1.8		1.8		2.1		2.1		2.0		2.2		2.1		2.0		2.0	

Notes: 1. November, December and January samples were for six minutes and at the hour.
2. The two March samples were for 12 minutes and at the half-hour.

3.7 The Estimated Number of Visitors

The final step in the procedure is to estimate the number of visitors. Table 6 shows the procedure that begins with the number of vehicles entering the township in November as obtained from the traffic counters at the northern entrance. The number of vehicles is based on the seven-day average. The focus for the calculation is the daylight hours between 8.00pm and 5.00pm. The second and third columns show the percentages of local vehicles measured over three days and these columns are used to give an average in column four. From this is derived the percentage of visitor vehicles (column 5). This figure is multiplied by column 1 to give the estimated number of visitor vehicles (column 6), which is then multiplied by the average number of visitors per vehicle (column 9) to give the estimated number of visitors (column 10)(unadjusted for doubles). Finally, the subtotals for the relevant hours are summed to give a total of 2,035.

Table 6
Estimated Number of Visitors Per Day, Northern Entrance, November

	7-D Avg Vehicles Entering	% LCL (Over 3 days)	% LCL (Over 3 days)	Avg	% Visitor Vehicles	Est No. Of Visitor Vehicles	Vst/Veh	Vst/Veh	Avg	Est No. Visitors
Column	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hour	4									
400	5									
500	22									
600	24									
700	65									
800	157	44	0	22	78	123	1.8	1	1.4	172
900	180	54	50	52	48	86	1.5	1.2	1.4	117
1000	196	55	70	63	38	73	1.7	1.8	1.8	129
1100	185	22	43	33	68	125	1.9	2.1	2.0	250
1200	206	63	54	59	42	86	3	1.7	2.4	201
1300	185	27	44	36	65	119	1.4	2.4	1.9	226
1400	178	36	54	45	55	98	1.7	2.5	2.1	206
1500	218		26	26	74	161		2.3	2.3	371
1600	214	54	63	59	42	89	1.2	2.3	1.8	155
1700	167	75	42	59	42	69	4	2	3.0	208
1800	123									
1900	115									
2000	93									
2100	58									
2200	30									
2300	17									
Sum	**2458**					**1030**			**2.0**	**2035**

The procedure illustrated above for the November data was repeated for the other survey months. The results shown in Table 7 gives the estimated total daily number of visitors for the northern and southern entrances for each month. The table shows the number of visitors derived from calculations for each hour not multiplying the overall number of visitor vehicles by the average visitor per vehicle as reported in the table. The corrected numbers of doubles from Table 4 are shown here in the totals section, and the numbers are apportioned between the northern entrance and the southern entrance according to the ratio of visitor vehicles. The number of doubles for each month is multiplied by two (the average number of visitors per vehicle for each month, see Table 5) and this product is subtracted from the number of visitors to give the adjusted number of visitors for each entrance. These subtotals are added to give the monthly daily totals. These data are displayed in Figure 12.

Table 7
Estimated Daily Number of Tourists, Northern Entrance, Southern Entrance and Totals, Adjusted by the Doubles Correction Factor

Month	Tst Veh	Tsts	Dbls	Adj Veh	Adj Tsts
	Northern Entrance				
					North
Nov	1030	2035	117	913	1800
Dec	1060	2154	57	1003	2040
Jan	981	1831	51	930	1729
Mar12/13[1]	856	1668	69	787	1529
Mar 30	848	1599	91	757	1418
	Southern Entrance				
					South
Nov	506	946	58	448	831
Dec[2]	598	1290	32	566	1225
Jan	625	1342	33	593	1277
Mar12/13[1]	404	948	33	371	883
Mar 30	380	827	41	339	746

Month	Tst Veh	Tsts	Dbls %	Dbls No.	Adj Veh	Adj Tsts
	Totals					
						Total
Nov	1536	2981	11.4	175	1361	2631
Dec[2]	1658	3444	5.4	90	1569	3265
Jan	1606	3173	5.2	84	1522	3006
Mar12/13[1]	1260	2616	8.1	102	1158	2412
Mar 30	1228	2426	10.7	131	1097	2163

Notes: 1. March 12/13 data estimated using March 30 data.
2. December data for the Southern entrance estimated from November and January

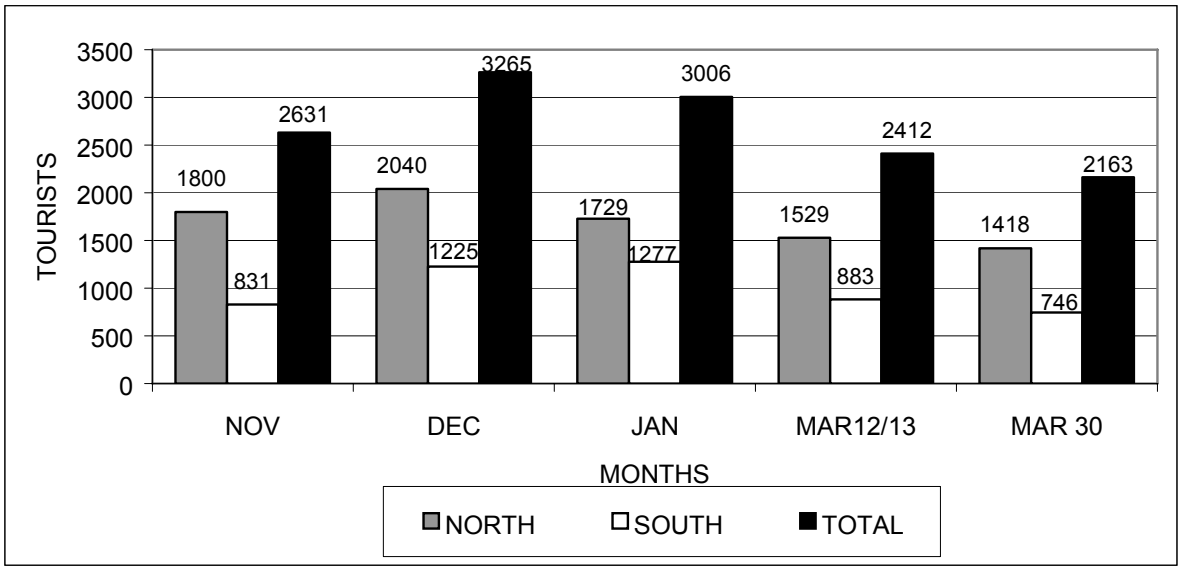


Figure 12
Estimated Daily Number of Tourists, Northern Entrance, Southern Entrance and Combined, For Each Month

Finally, the annual estimated total number of visitors is estimated from the five survey months. For each week in which there was a survey the daily number of visitor vehicles was multiplied by seven to give a weekly total. These figures were regressed using $y = a + bx + cx^2$ to estimate the total vehicles for the remaining weeks. The regression equation was used to estimate the number of vehicles for each week which summed to 419,815 for the year, and this number when multiplied by two (the average number of visitors per vehicle) gives the estimated yearly total of visitors to Kaikoura as 839,629. This procedure was repeated using the number of visitors (adjusted for doubles) and the annual estimate was 840,159 visitors. The estimations approximately equal 840,000.

To calculate the error term of this estimate, the variances for the proportion of visitor vehicles and the number of visitors per vehicle were calculated and sequentially combined to yield ±7,009 at the 95 per cent confidence limit. Table 8 shows the calculations for the northern and southern entrances respectively. This error term is about one per cent of the total.

Table 8
Calculation of Overall Confidence Limit

		Over 5 Months	
		A **% Visitors**	**B** **Visitors/Veh**
North	Avg For Day	0.45	2
	SD	0.15	0.45
	SD Sqd	0.0225	0.2025
	Hours	13	13
	Hours Sqd	169	169
	Variance	3.8025	34.223
	(=SD Sqd * Hrs Sqd)		
	Variance A*B	23.01	
	(=Avg A* Var B) + (Avg B* Var A)		
South	Avg	0.52	2
	SD	0.264	0.77
	SD Sqd	0.070	0.5929
	Hours	13	13
	Hours Sqd	169	169
	Variance	11.779	100.200
	(=SD Sqd * Hrs Sqd)		
	Variance A*B	75.66	
	(=Avg A* Var B) + (Avg B* Var A)		
Total	Variance	99 Per Day	
		2,219,994.56 Per 5 Months	
		12,787,168.68 Per Year	
	Sqrt	3,576	
	1.96 Conf Limit	7,009	
	Prop Of Total	1%	

The vehicles data were used to compare the yearly pattern with the flow recorded each day at Hapuku for 1996. The regression derived from each data source provided weekly totals that showed remarkably consistent changes over time, and a subsequent regression of the differences between the two series provided negligible improvement in the Kaikoura regression. The similarity of the Kaikoura regression with the Hapuku regression suggests that the interpolation for the winter months may be quite a reasonable estimate of visitor numbers since it matches existing traffic flow patterns on Highway 1. Figure 13 shows the regression data for Hapuku and Kaikoura. It should be noted that the peak at weeks 14 and 15 for the Hapuka regression are associated with Easter, but the estimate of the actual number of Kaikoura vehicles in the 14th week was not at Easter.

The Hapuku data have relevance to the error term of the estimate discussed earlier. It must be noted that the estimate of the error is conservative because it is based on analyses of the variation in two measures used to derive daily totals. It does not account for natural variation in the traffic flows to which the measures were subsequently applied. However, the traffic variation is not likely to be a major factor because, as the Hapuku data show, there is little variation between the two series.

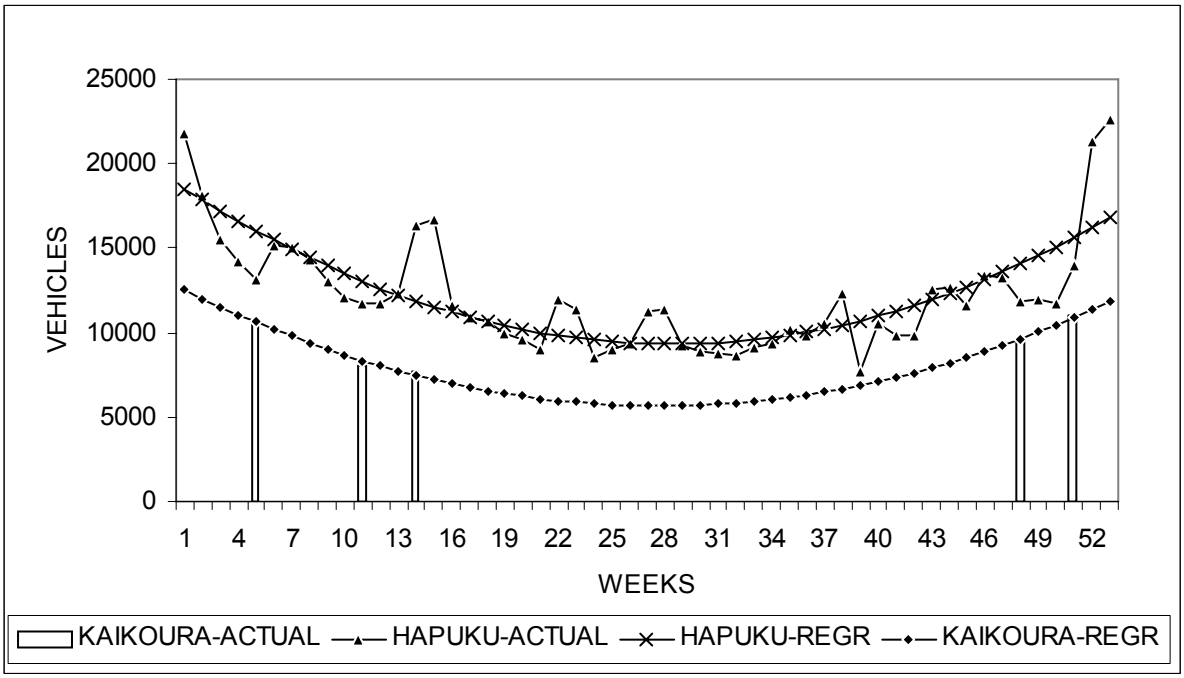


Figure 13
Comparison of Kaikoura and Hapuku Vehicles, Actual and Regression

The above calculations have focused exclusively on visitors travelling by car, van, campervan or other vehicle but excluding buses. This was done because the occasional bus included in the samples distorted the visitors per vehicle estimate. In the absence of an alternative source of information on bus travellers, the bus data would best be included in the analysis. However, an alternative source of information on bus travellers was available. Each bus company servicing Kaikoura was asked to provide monthly totals of passengers to Kaikoura. Most of the major bus companies provided an annual total of passenger to Kaikoura, although one major company had access to data for only two months. Annual data for another company that had similar numbers of passengers in those two months in the previous year were used as a rough estimate of the annual total. Of the six shuttle-bus companies, only two provided data and these were used to estimate the data for all six shuttle-bus companies, assuming they carried similar numbers of passengers. One shuttle-bus company is patronised mostly be Kaikoura residents and it was excluded from these estimations. Finally, Transrail provided data for people arriving by train. In all cases it is assumed that people arriving by bus or train are visitors. The grand total of visitors is 33,243 or 33,000. When added to those arriving by non-bus vehicle, the combined total is 873,000 visitors per year.

Chapter 4

Conclusion

The objective of the research reported here was to estimate the total number of visitors entering Kaikoura over one year. This was achieved by using a method which involved four key steps: counting all traffic entering Kaikoura, observing a sample of vehicles to record licence plates and the number of people in each vehicle, identifying vehicles from outside of Kaikoura, and then estimating visitor vehicle numbers and numbers of visitors.

Generally, the method worked well in terms of providing results for a modest expenditure of effort, although the vehicle counting and vehicle observations were not simple exercises. Each required the development of expertise to overcome practical problems. Within the data collected, it was a straightforward data management exercise to derive the final estimates. Again, some qualification is warranted. There were a number of considerations that arose, mainly concerning probabilities and random sampling, which had to be handled to improve the accuracy and validity of the estimates. The confidence limits in the final estimates were reasonable.

The limitations to the research design (noted at the end of the methods chapter) mean that the final estimate is not a complete assessment of visitor numbers. In fact, the final assessment is conservative because it does not include visitors who visit Kaikoura (typically for a short period of time) by stopping only on the northern strip of Highway 1 and do not enter the township. While techniques were developed for assessing their numbers, time limitations precluded these assessments from being completed.

There is potential error in basing the final estimate on five sample months that included most of the summer months, that is, the high season. It may be that visitor numbers in winter drop off more significantly than the level indicated by the interpolation from the sampled months (November to March). The comparison to the Hapuku vehicle regression suggests that this is not the case but the issue can only be resolved by including traffic measurements and observations in winter.

The method used in this report made some approximations that simplified the procedure while allowing the production of useful results. For example, the daily observations were used to estimate visitor vehicles by taking the seven-day average daily flow of vehicles entering Kaikoura township. Further research could refine this analysis by focusing on weekday or weekend day flows, or even specific daily flows, and use these data to make improved estimations of visitor vehicle totals for the day. However, this improvement would require vehicle observations from 8.00am to 6.00pm on the chosen day, and this requirement would entail more time consuming field observations and use of more research personnel. Further, for each survey week it would be necessary to include a number of days in order to assess daily differences, and this requirement would further enhance resources requirements.