Final Report

Tourism Flows Model Methodology

Prepared for

Ministry of Tourism

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1. Introduction

1.1. Background

The Ministry of Tourism is leading a three year project that aims to forecast the demand tourism will place on New Zealand's publicly provided infrastructure. The first stage of the project investigated the mechanisms public sector agencies use to plan for growth in demand, with a view to determining:

(a) Whether these mechanisms take tourism into account; and
(b) What information agencies need to plan for the projected growth in tourism.

This work highlighted the need for a model that takes information from the core tourism dataset and brings it together with other relevant datasets to build a picture of current and future tourism flows in New Zealand.

The model needs to provide public agencies with robust, easily accessible information on future tourism demand at a sufficiently refined geographic level to make important infrastructure-related decisions. The model would ideally contain current and future information on transport infrastructure (road, air and other), as well as informing decisions on the provision of tourism-related services such as water, waste, toilets, information centres and land development administration.

Potential users of the model include, but are not limited to:

- Department of Conservation ("DOC")
- Transit New Zealand
- Transfund
- Land Transport Safety Authority ("LTSA")
- Local Government
- Ministry of Tourism

Understanding the impact of tourism growth on publicly-provided infrastructure will facilitate informed decision-making on where to invest and where to adopt pro-active policy, planning and resource allocation practices. This will ensure that future growth in tourism results in optimum outcomes for New Zealand.

The Tourism Flows Model (TFM), funded by the Ministry of Tourism, is a software tool developed by Covec Limited and Eagle Technology that responds to these needs.

The TFM was originally developed as an infrastructure planning tool for local government but has since grown beyond that as an all purpose tool for understanding tourism at the local and national levels.

1.2. Overview of the Tourism Flows Model

The TFM has two main components:

1. The tourism flows module (dynamic module) which provides past, present and future estimates of tourist *movements* in New Zealand
2. The tourism activity module (static module) which provides past, present and future estimates of tourism activity *within* specific areas of New Zealand

1.2.1. Tourism Flows Module (Dynamic Module)

The TFM uses detailed data collected from tourism surveys to model the movements of tourists around New Zealand. Each tourist implicitly makes the following decisions prior to travelling:

1. Where do I want/need to go?
2. How will I get there?

Where do I want to go?

From a tourism flows perspective this is the most important decision of all because it is the catalyst for all subsequent (downstream) tourism activity. The answer to this question is usually heavily influenced by:

(a) Where you come from; and
(b) What season you are travelling in.

The data shows quite clearly that just as different nationalities have different propensities to visit certain parts of New Zealand, New Zealanders' travel patterns are influenced very much by where they reside. Hence, the *origins* of tourists have a large bearing on the *destination(s)* they choose. The other key determinant of destination is the season – tourists have a much higher propensity to visit some areas during the spring/summer period than they do during the autumn/winter period, and vice versa (beaches in spring/summer and mountains in autumn/winter for example). There are other determinants as well, most notably *purpose* of travel, but the data does not support a purpose segmentation so we have concentrated on the most influential drivers of destination choice above.

The "where do I want to go?" question is complicated significantly by the ability of tourists to engage in multi-visit trips i.e. you may wish to go to Wellington, but could conceivably spend time in Matamata, Taupo, and Palmerston North on the way. Hence one trip can generate visits to multiple destinations.

The TFM is based on an origin-destination style model that models and projects the movements of domestic and international tourists within New Zealand.

The model uses 9 years of IVS data and 6 years of DTS data to answer the following question:

"What percentage of people from origin X will travel between locations Y and Z using transport mode A during period B?"

Where:

X = origin of traveller (Origin region for internationals, Regional Council for domestics)
Y and Z = 128 distinct locations/areas in New Zealand (called Tourism Flows Areas)
A = transport mode (road, air, other (not represented spatially))
B = season or annual period

Once we understand *where* and *how* people from various origins travel within New Zealand, we combine these patterns with forecasts of visitor growth to estimate how the demand for travel is likely to change in the future.

<u>How will I get there?</u>

The next decision that tourists have to make is how to get to their desired destination(s). There are two aspects to this decision:

1. What mode of transport will I use?
2. What route will I take?

We already know the former because the origin-destination analysis (described above) is segmented by mode of transport. We therefore need to answer to the following question:

"Given that I wish to travel from location Y to Z using transport mode A, what route should I take?"

Unfortunately there is nothing in the core tourism dataset that tells us which transport corridors are used by visitors i.e. we know where they go, and what their travel sequences are, but we don't know which transport corridors they use to travel between destinations.

The TFM takes the origin-destination analysis described above and overlays it with the main air and road transport corridors to determine which corridors are most likely to be used when travelling between destination pairs. This analysis has been conducted using ArcView (GIS software). This modelling completes the network flow analysis by converting travel demand to estimates of transport corridor usage.

1.2.2. Tourism Activity Module (Static Module)

In addition to the fundamental travel decisions of where to go and how to get there, the model also addresses the question:

"What will I do when I reach my destination?"

The key activity parameters included in the model at the RTO level are:

- Visits (by origin or purpose)
- Visitor nights (by origin or purpose)
- Expenditure (by origin or purpose)
- Accommodation type used
- Transport type used
- Activities undertaken
- Age group
- Travel style

For practical reasons the tourism activity module operates independently of the tourism flows module.

1.3. Dimensions of the Tourism Flows Model

Tourism Flows Module (Dynamic Module)

The tourism flows module has the following dimensions.

1. Traveller types (3)
    a. International traveller
    b. Domestic overnight traveller
    c. Domestic day traveller

2. Traveller origins (18)
    a. International (8)
        i. Australia
        ii. Americas
        iii. Japan
        iv. North-East Asia
        v. Rest of Asia
        vi. UK/Nordic/Ireland
        vii. Rest of Europe
        viii. Rest of World

A concordance showing the countries that make up these regions is presented in the Appendix.

   b. *Domestic (Regional Council Areas) (10)*
      i. Northland
      ii. Auckland
      iii. Waikato
      iv. Bay of Plenty
      v. Gisborne/Hawke's Bay
      vi. Taranaki/Manawatu
      vii. Wellington
      viii. Tasman/Nelson/Marlborough/West Coast
      ix. Canterbury
      x. Otago/Southland

3. Year and Season (2 per year)
   a. Spring/summer (combined March and December quarters of each calendar year)
   b. Autumn/winter (combined June and September quarters of each calendar year)

4. Transport Modes (see concordances in Appendix 1) (3)
   a. Road
   b. Air
   c. Other (not presented spatially due to the mix of transport types in this group)

<u>Tourism Activity Module (Static Module)</u>

The tourism activity module has the following dimensions.

1. Area type (1)
   a. Regional tourism organisation (RTO)[1]

2. Visitor type (2)
   a. International
   b. Domestic

3. Visitor Origin
   a. *International (8)*
      i. Australia
      ii. Americas
      iii. Japan
      iv. North-East Asia
      v. Rest of Asia
      vi. UK/Nordic/Ireland
      vii. Rest of Europe
      viii. Rest of World

[1] Static data is not produced at lower levels of disaggregation due to insufficient sample.

   b. *Domestic (Regional Council Areas) (10)*
      ix. Northland
      x. Auckland
      xi. Waikato
      xii. Bay of Plenty
      xiii. Gisborne/Hawke's Bay
      xiv. Taranaki/Manawatu
      xv. Wellington
      xvi. Tasman/Nelson/Marlborough/West Coast
      xvii. Canterbury
      xviii. Otago/Southland

4. Visit year (1)
   a. Annual only (1999 – 2012)

5. Measure
   a. Visits
   b. Nights
   c. Expenditure

The visits, nights and expenditure measures can be segmented by *either* visitor origin *or* purpose of trip (but not both at the same time).

1.3.1. Report Outline

The remainder of this document is set out as follows. Section 2 describes the process that we have used to define the spatial layers in the model. Section 3 outlines our data sources and how we handled the data to manage the impact of small sample sizes, and Section 4 provides more detail on the background modelling.

1.3.2. Additional Documentation

This document describes the development of the model itself. There is a separate user manual for the TFM which provides step-by-step instructions on how to use the model entitled "Tourism Flows Model User Guide" which can be downloaded from www.tourismresearch.govt.nz.

2. Establishing Spatial Units

2.1. Overall Process

The TFM is a spatial model that is designed mainly to estimate the volumes of tourists travelling down major transport networks in New Zealand. The flow information has been derived from the International Visitor Survey (IVS) and the Domestic Travel Survey (DTS). These surveys capture information on the trip itineraries of international and domestic travellers. The itinerary data allows each trip to be broken down into a series of trip segments, with each segment starting and ending with a stop of one hour or more in a new destination. For example, a road trip from Auckland to Wellington and back might have resulted in a stop in Taupo of 2 hours on the way down and an overnight stop in Palmerston North on the way back. This trip would generate the following trip segments: Auckland – Taupo; Taupo – Wellington; Wellington – Palmerston North; Palmerston North – Auckland. When viewed for all visitors, this information allows us to estimate the volumes of tourists travelling directly (i.e. with no stops of more than 1 hour) between distinct locations in New Zealand.

A major complication is that the locations in the IVS do not match the locations in the DTS. This makes it very difficult to validly combine data from the two surveys in a model of this nature. We therefore need to ensure that the spatial areas that we define for the IVS are the same as the spatial areas that we define for the DTS. This is a major exercise because there are around 185 distinct locations in the IVS and around 9,800 distinct locations in the DTS.

A further complication is that it is not practical to model flows between every possible location in New Zealand. It is therefore necessary to define a smaller number of locations or 'nodes' which are broadly representative of the main tourism origins and destinations in New Zealand. In reality each node represents a wider tourism catchment; hence there is just one node for each catchment. The dominant tourism destination in each catchment is designated as the node, and the node acts as the connection point into the various transport networks.

The catchments, henceforth referred to as tourism flows areas (TFAs), represent the most granular spatial units in the model. A major constraint in defining the TFAs is the need for them to aggregate easily to larger spatial units such as territorial local authorities (TLAs) and regional tourism organisations (RTOs). It is also possible to define TFAs so that they aggregate to regional council areas (RCAs), but the imperfect concordance between TLAs and RCAs means that the TFAs can only be defined to conform perfectly to one set of boundaries. Given the importance of the TFM as a local planning tool, it was decided that the TFAs should concord perfectly with TLA boundaries. This means that TFAs do not concord perfectly with RCAs. However, the match is perfect for all RCAs that don't have boundaries that cut across TLAs.

The following sections describe the method we have used to define the TFAs.

2.2. IVS

Data is collected at a less refined spatial level for international visitors (185 possible locations in the code frame) than it is for domestic visitors (circa 9,800 locations in the code frame). It is therefore necessary to define the TFAs around the IVS locations and then allocate each DTS location to the appropriate TFA.

When an IVS survey is conducted the respondent is asked to list all of the places he/she visited while in New Zealand. The respondent is shown a basic map of New Zealand, and a more detailed map if necessary, to assist with recall. If a respondent indicates a visit to one of the 185 IVS locations then the visit is immediately coded to that IVS location. However, if the location is not an IVS location there is no prescriptive method of assigning that visit to an IVS location. From what we can gather one of two things might happen: the interviewer will either code the visit to the nearest IVS location; or the interviewer will record the non-IVS location and it will be allocated to an IVS area at a later stage. This is problematic because it suggests that there is no consistent method for assigning visits to non-IVS locations to IVS locations, which implies that two separate visits to the same non-IVS location could be coded to different IVS locations. This in turn suggests that there is no consistent set of IVS catchments underlying the survey methodology.

We therefore had to develop IVS catchments around each of the 185 IVS locations that reflected as accurately as possible the treatment of past visits to non-IVS locations. The best way to do this was to observe how visits to non-IVS locations were assigned to IVS locations post-interview (we have no way of knowing how visits to non-IVS locations were treated during the interview). ACNielsen provided us with a list of non-IVS locations and the IVS areas to which they were assigned post-interview.

We took this information and mapped it to get a visual summary of the spatial relationships between the non-IVS locations and the IVS locations. We then defined catchments around each IVS location that (a) respected these spatial relationships; and (b) didn't cut across any TLA or RTO boundaries. The catchments were defined mainly as groupings of census area units, and occasionally as groupings of meshblocks in areas with multiple IVS locations.

During this process the number of IVS catchments/locations was reduced to 128. The reduction was due to the omission of several IVS locations which were redundant in the code frame, and through the aggregation of locations that were in close geographic proximity to one another and for which it was impractical and/or meaningless to measure tourist flows between (e.g. Paihia and Waitangi).

Each of the 128 TFAs is represented by a single "node" which corresponds to the most dominant tourism destination in that area. All tourist flows into and out of the TFA are attributed to the node. The node connects the TFA to the main transportation networks.

The maps below show the 128 TFAs as coloured areas, and TLA boundaries as darker lines.

Figure 1 North Island Tourism Flows Areas and TLAs

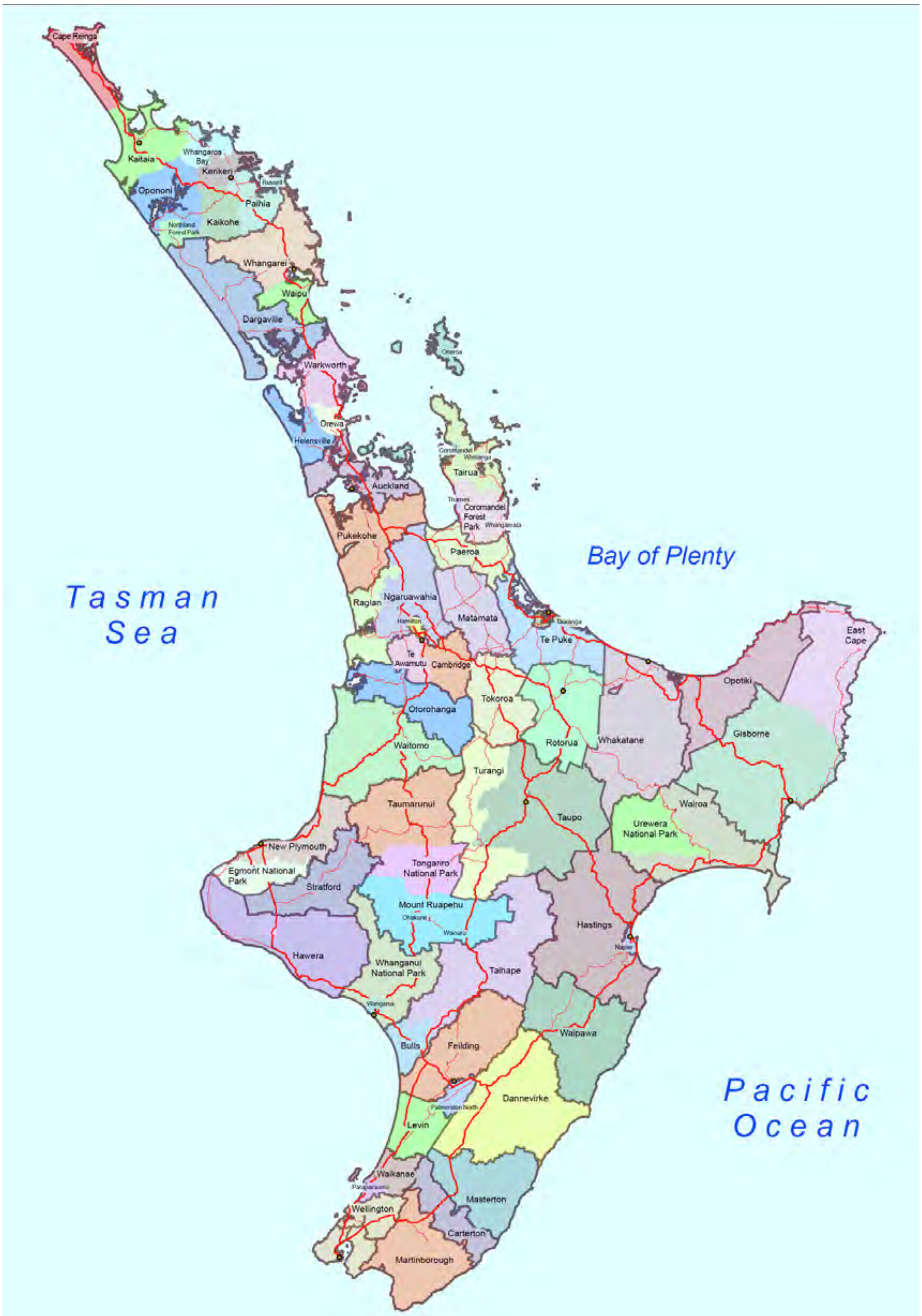


Figure 2 South Island Tourism Flows Areas and TLAs

2.3. DTS

Once the TFAs had been defined the next step was to assign each of the approximately 9,800 DTS locations to the appropriate TFA. This was done using geocodes which provide a northing and easting coordinate for each DTS location. The DTS locations were mapped using these coordinates and then assigned to the TFAs that they fell within.

A minor issue was encountered in this process when it was discovered that the original DTS geo-codes were only accurate to within around 2km of the actual location. This was problematic in tightly defined areas such as Arrowtown, because the DTS geocode for Arrowtown located it in the Queenstown TFA rather than the Arrowtown TFA. It was also problematic for DTS locations situated close to TFA boundaries because some DTS locations were being coded to the wrong TFA.

To overcome these problems we re-geocoded as many of the DTS locations as possible, which resulted in new and more accurate geocodes for around half of the DTS locations in the code frame. For those locations that could not be re-geocoded we retained the original geocodes and accepted the resulting error margin which we expect to be quite small.

3. Data

3.1. Tourism Flows Data

The raw IVS and DTS data has been sourced from SPSS files which are held by Covec. The data describes the number of visitor movements between each TFA node-pair, segmented by:

- Origin of visitor (international region; regional council area)
- Type of visitor (overnight visitor; day tripper)
- Transport mode (road, air, other (not presented spatially))
- Quarter
- Year

The sample sizes are generally insufficient to provide robust estimates of tourist flows at the finest level of segmentation. The sections below outline the methods we have used to reduce the sample errors in the data.

3.1.1. Seasonal Aggregations

The quarterly data has been aggregated to form summer and winter seasons. The summer season comprises the March and December quarters of each calendar year (e.g. March 1999 and December 1999) and the winter season comprises the June and September quarters (e.g. June 1999 and September 1999). The seasonal distinctions are designed to pick up the differences in travel patterns between warm (beach) and cool (mountain) periods.

3.1.2. Temporal and Geographic Aggregations

There is a clear and direct link between the accuracy of the tourism survey data and the accuracy of the TFM. When the tourism survey data is viewed at a highly segmented level the number of observations underlying each data point can be very small (often only 1-2 respondents), especially for origin markets that are not heavily sampled (e.g. the Tasman Region). The only way to overcome this problem is to aggregate the survey data temporally and/or geographically. The tourism survey data is more reliable for some origin markets than it is for others due to larger sample sizes. It is therefore necessary to develop a rule that determines how the data should be aggregated for each origin market.

The rule needs to aggregate the data as little as possible (so as not to suppress genuine temporal and geographic variations) subject to the constraint that the resulting outputs are statistically reliable. This requires us to define a *minimum acceptable sample size* (MASS) for each market segment in the TFM, where the MASS is set at a level that delivers statistically valid results. Any market segment that has a sample less than the MASS will need to be aggregated further until it equals or exceeds the MASS.

The rule that we have adopted requires us to:

1. Aggregate data across years within each origin x season x traveller type combination until we have equalled or exceeded the MASS using the smallest number of data aggregations possible; and if we cannot equal or exceed the MASS while maintaining at least two distinct data points, then
2. Aggregate geographically similar regions until the MASS is achieved.

Method of Determining the MASS

The tourism flows modelling is based on the premise that there is some underlying pattern or "conversion rate" between the initiation of a *trip* by a particular market segment and *visitations* to certain locations in New Zealand. For example, it may be the case that, on average, every 100 Australian arrivals to New Zealand generate 90 visits to Auckland, 40 visits to Wellington and 25 visits to Queenstown. In reality we expect these conversion rates to vary by:

- Origin market – different markets have different propensities to visit certain locations;
- Season – for example, conversion rates for Queenstown may be a lot higher in winter than in summer; and
- Year – for example, a lack of snow in Queenstown may have an impact on conversion rates in a given year.

While we do expect *some* variation in conversion rates over time, we don't expect a lot, unless there are some obvious "behaviour shifters" in action during that period (such as adverse weather conditions). This is particularly so for "mature" tourism destinations located on main tourist routes such as Auckland, Rotorua, Taupo, Wellington, Christchurch and Queenstown.

There needs to be some pragmatism in the final decision on MASS because each additional aggregation of data across years reduces the number of time series data points we have to use in the model, and each additional aggregation across geographic regions increases the degree of homogeneity in travel behaviour. We also need to be mindful of artificially "smoothing" out actual variations in the data by aggregating data across either years or geographic regions.

Our analysis examines annual conversion rates with a view to testing the "stability" of these conversion rates over time. The relative stability of the data is compared to the underlying sample size, which provides some guidance on what the MASS should be for the tourism flows modelling. This ultimately guides the way that we aggregate the data for modelling purposes.

Description of MASS Analysis

Our analysis is based on the premise that, on average, there is some consistent pattern or trend to the conversation rates when viewed at the annual and seasonal levels. This does not imply that the conversion rates are *constant* over time, but rather that the conversion rates demonstrate some discernable pattern or linear time trend.

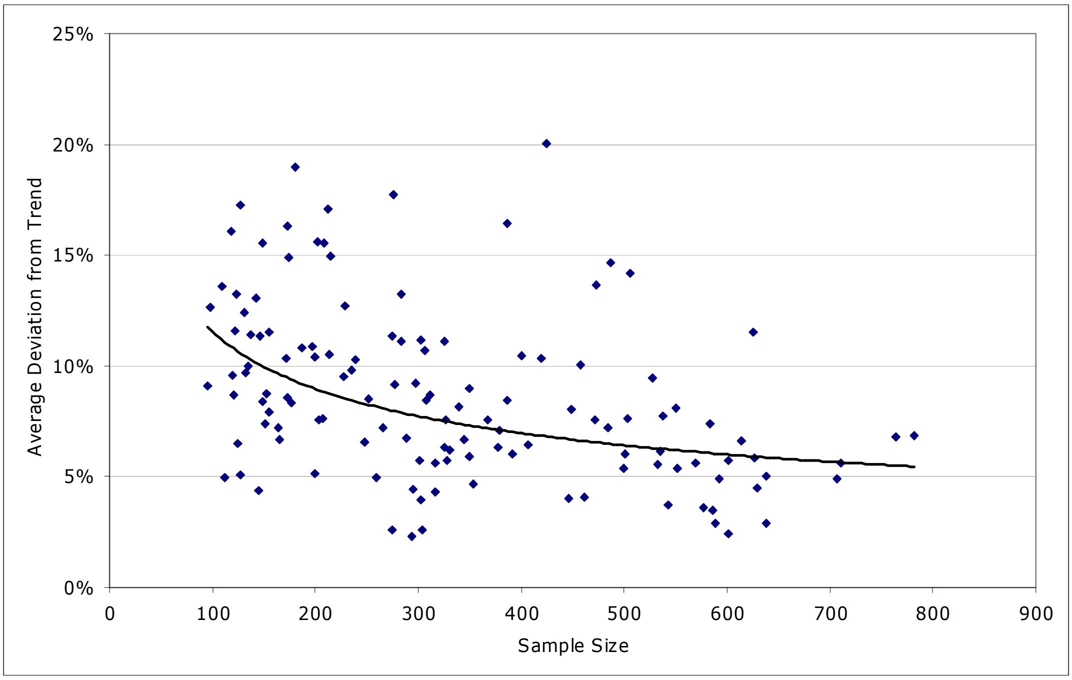
We have developed a measure of data reliability called *average deviation from trend* (ADFT). The ADFT measures the deviation of the conversion rate for each origin market in each time period and each season from the underlying linear time trend. The underlying trend has been estimated using regression analysis.

Determining an acceptable ADFT is not easy, as the threshold will depend on the degree of data variability that the researcher is willing to accept. *In this instance we feel that a maximum ADFT of 10% and an average ADFT of no more than 5% is acceptable for the purposes of modelling tourism flows in New Zealand*. The results of our analysis are shown below.

<u>International Data Aggregations</u>

There are wide variations in sample sizes when the international data is viewed annually, as shown in the graph below. The scatter plot shows that at the annual level sample sizes range from around 100 to 800. It is clear from the plot that the ADFT increases as sample size decreases, which is what we'd expect due to greater sampling error.

Figure 3 Sample Sizes and ADFTs for Annual (Seasonal) IVS Data



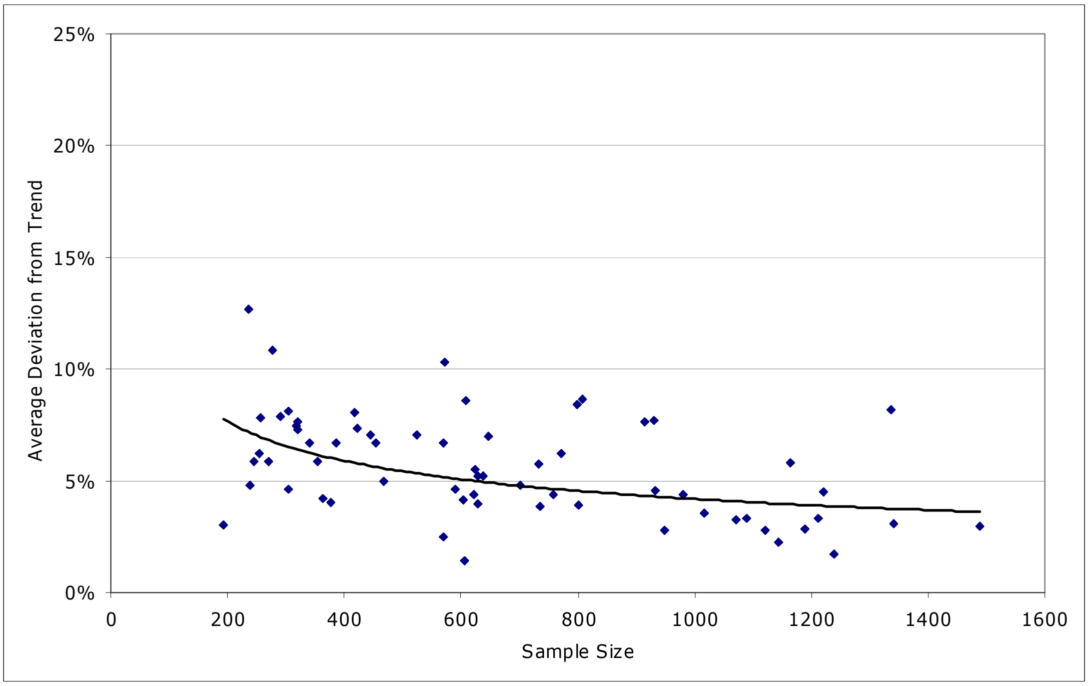
For the smaller sample sizes (100-200 trips sampled) the ADFT varies quite significantly between 5% and 20%. An ADFT of 20% indicates a high degree of variability in the data, and we do not have confidence in the data at that level. We therefore conclude that some of the data needs to be aggregated across time periods to achieve greater stability.

Bi-Annual Data

Grouping the data bi-annually reduces the ADFT quite substantially, with a maximum ADFT of around 13% as opposed to 20% in the annual data. The average ADFT is 5.6%. Bi-annual data provides more "stable" results than annual data (as expected with greater sample sizes and less time series points), but there are still several ADFTs close to or in excess of 10%, and the average ADFT is still above 5%.

A visual inspection of the scatter plot below indicates that all markets with a sample size of at least 600 fall below the ADFT threshold of 10%, and those with a sample size of at least 1,000 generally have ADFTs of less than 5% (with a couple of exceptions). We therefore conclude that, wherever possible, we should strive for sample sizes of at least 600. Given that almost half of the sample sizes at the bi-annual level are still significantly below 600, we need to aggregate the data further in some markets.

Figure 4 Sample Sizes and ADFTs for Bi-annual (Seasonal) IVS Data



Final Data Aggregations

The markets that have insufficient sample size (less than 600) when aggregated bi-annually are the "residual" regions of:

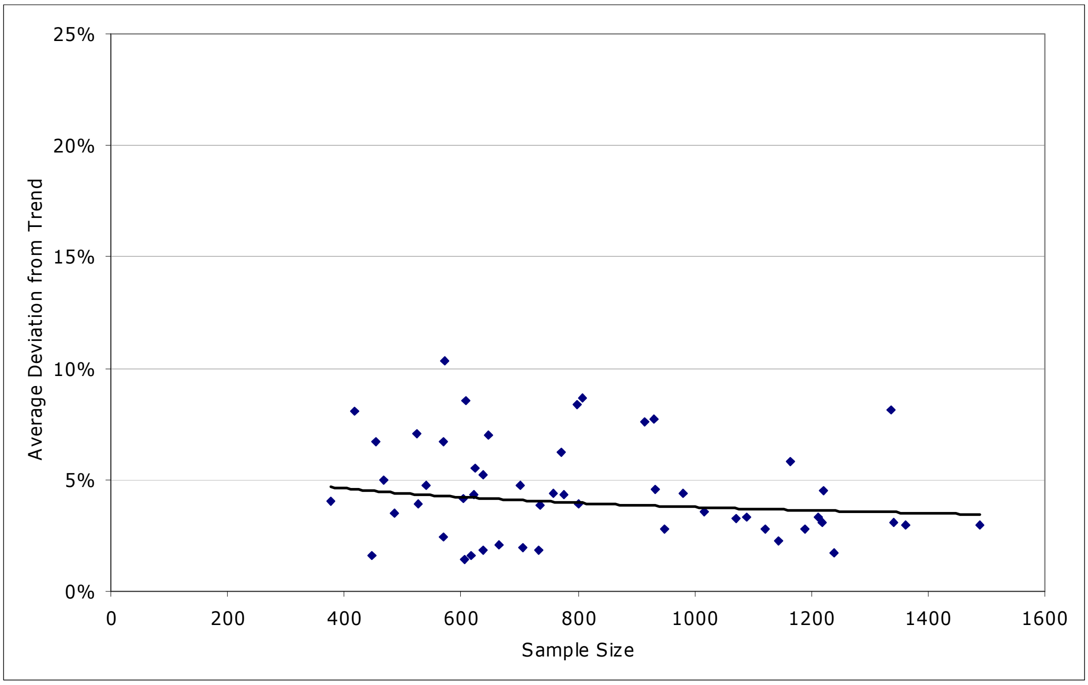
1. Rest of Asia;
2. Rest of Europe; and
3. Rest of the World.

We have therefore aggregated the data for each of these markets one step further, resulting in two time series observations with four years of data in each. This allows us to maintain a time dimension while bolstering the sample size.

The following scatter plot shows that with bi-annual aggregations for all non-residual markets and 4-yearly aggregations for residual markets, the sample sizes are generally in excess of 400, and the ADFTs are all less than 10% (with one marginal exception). The average ADFT at this level of aggregation is 4.5% which falls comfortably beneath our stated threshold of 5%.

We are comfortable that at this level of aggregation we are getting a relatively uniform degree of accuracy from the IVS data, as indicated by the slope of the trend line on the scatter plot below, which indicates that the ADFT is not strongly influenced by sample size at this level of aggregation.

Figure 5 Final Sample Sizes and ADFTs for Aggregated (Seasonal) IVS Data



Our conclusion from this analysis is that we should aggregate the IVS data for each market and each season as follows:

Table 1 Data Aggregations for IVS Data

Market (RLPR)	Data Aggregation
Australia	2 year increments
Americas	2 year increments
Japan	2 year increments
North-East Asia	2 year increments
Rest of Asia	4 year increments
UK/Nordic/Ireland	2 year increments
Rest of Europe	4 year increments
Rest of the World	4 year increments

The data has been aggregated according to these increments on a rolling basis e.g. in the case of a two year increment the 2004 estimates would be generated from 2003 and 2004 data, and the 2005 estimate would be generated from 2004 and 2005 data.[2]

Domestic Data Aggregations

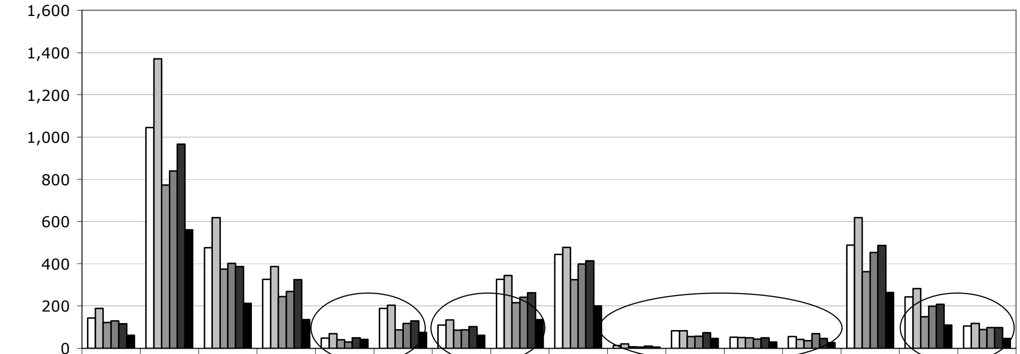
A close inspection of the DTS data reveals a relatively small number of trips sampled out of the origin regions of Northland, Hawke's Bay and Taranaki, and a very small number of trips out of Gisborne, Tasman, Nelson, Marlborough, the West Coast and Southland. To conduct a meaningful ADFT analysis we need to aggregate some of the origin regions *prior* to aggregating across time periods. The necessary aggregations are:

1. Gisborne + Hawke's Bay
2. Taranaki + Manawatu
3. Tasman + Nelson + Marlborough + West Coast
4. Otago + Southland

The Northland sample is also quite low, but we have chosen to express it as a separate origin region rather than combining it with the major source market of Auckland. The geographic aggregations are consistent across seasons and are shown in the graphs below.

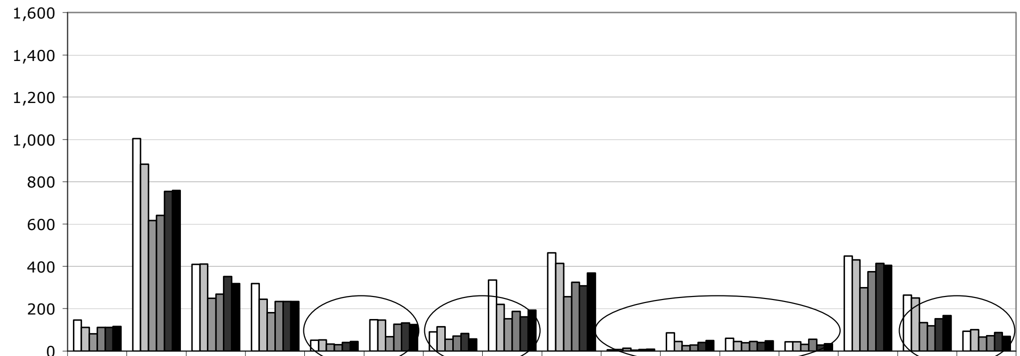
[2] Professor Pip Forer of the University of Auckland initially suggested the rolling method.

Figure 6 Trip Samples by Origin Region – Summer Season (October – March)



	NLD	AKL	WAI	BOP	GIS	HKB	TAR	MAN	WGN	TAS	NSN	MLB	WST	CAN	OTA	SLD
Summer 1999	143	1,046	476	326	48	189	110	327	444	14	83	52	55	488	244	105
Summer 2000	189	1,371	619	386	69	204	134	345	477	20	83	51	42	619	282	117
Summer 2001	122	773	374	245	40	87	86	216	325	8	55	49	36	363	149	88
Summer 2002	130	839	402	269	30	118	87	241	399	5	58	43	70	453	199	98
Summer 2003	116	967	387	324	50	130	102	263	413	10	73	49	46	487	208	98
Summer 2004	62	560	213	135	42	75	61	135	200	5	47	30	26	265	110	47

Figure 7 Trip Samples by Origin Region – Winter Season (April – September)

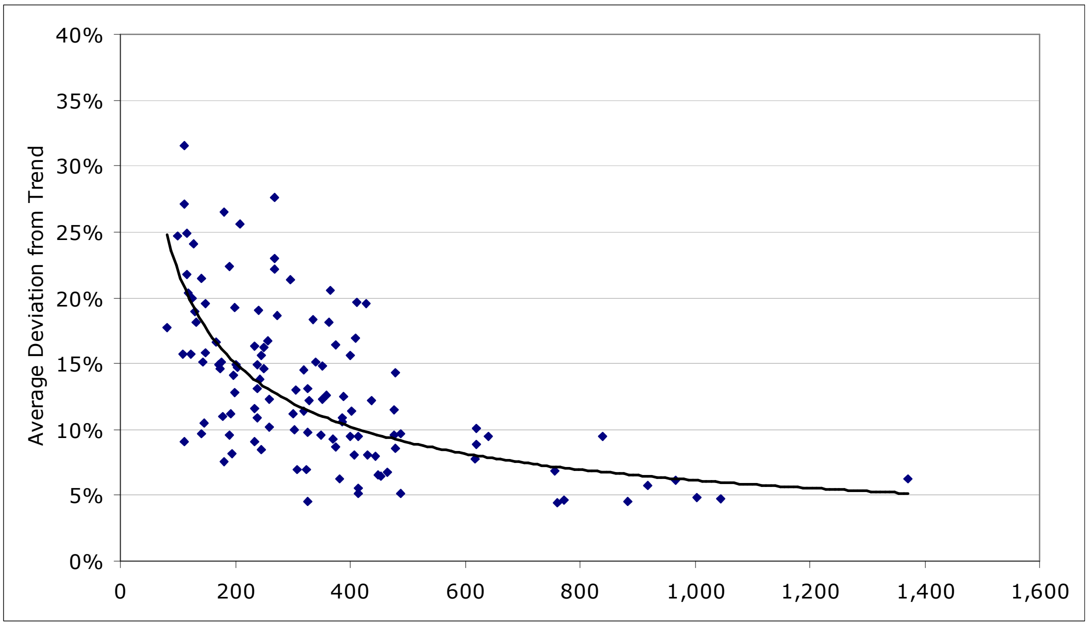


	NLD	AKL	WAI	BOP	GIS	HKB	TAR	MAN	WGN	TAS	NSN	MLB	WST	CAN	OTA	SLD
Winter 1999	146	1,004	409	319	51	148	91	336	464	6	86	59	44	449	265	93
Winter 2000	112	883	412	245	53	147	115	220	413	8	45	45	43	431	251	100
Winter 2001	81	617	249	181	32	67	56	153	256	14	25	38	31	300	134	65
Winter 2002	112	641	269	234	30	127	71	187	325	3	28	45	56	374	120	72
Winter 2003	112	755	352	233	41	133	82	161	308	7	41	40	29	413	153	87
Winter 2004	116	760	318	234	45	125	57	193	369	9	50	48	35	406	168	69

Annual Data

As with the international data, there are wide variations in sample sizes when the domestic data is viewed annually, as shown in the graph below. The scatter plot shows that at the annual level sample sizes range from around 60 to 1,400. It is clear from the plot that the ADFT increases as sample size decreases, which is what we'd expect due to greater sampling error.

Figure 8 Sample Sizes and ADFTs for Annual (Seasonal) DTS Data

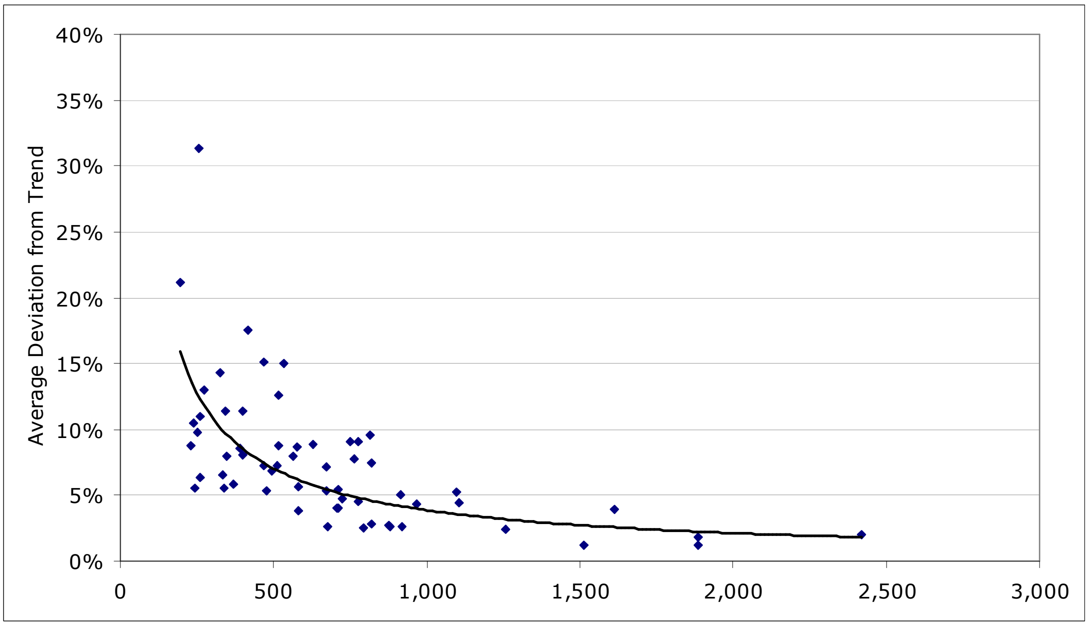


Grouping the data bi-annually reduces the ADFT quite substantially, with an average ADFT of 7.6% as opposed to 13.8% in the annual data. Bi-annual data provides more "stable" results than annual data (as expected with greater sample sizes and less time series points), but there are still several ADFTs well in excess of our stated maximum of 10%, and the average ADFT is still above 5%.

A visual inspection of the scatter plot below indicates that all markets with a sample size of at least 600 fall below the ADFT threshold of 10%, and those with a sample size of at least 1,000 generally have ADFTs of less than 5%. This is consistent with our analysis of the international data.

We therefore conclude that, wherever possible, we should strive for sample sizes of at least 600. Given that almost half of the sample sizes at the bi-annual level are still significantly below 600, we need to aggregate the data further in some origin regions.

Figure 9 Sample Sizes and ADFTs for Bi-annual (Seasonal) DTS Data



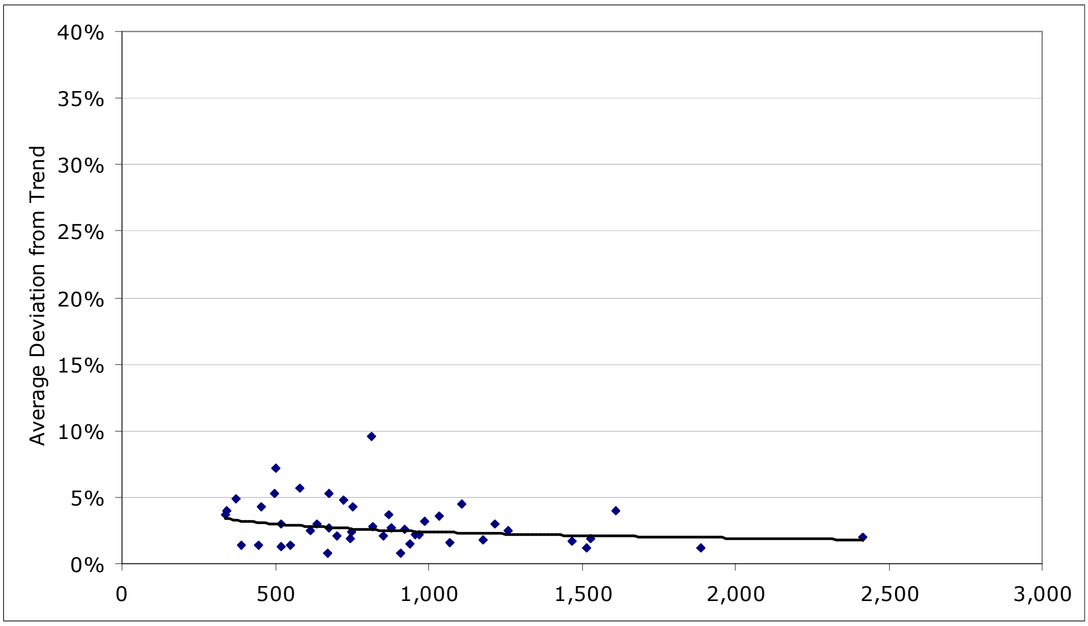
Final Data Aggregations

All origin regions except Auckland, Wellington and Canterbury have insufficient sample size (less than 600) at the bi-annual level. We have therefore aggregated the data for each of these markets one step further, resulting in two time series observations with three years of data in each. This allows us to maintain a time dimension while bolstering the sample size.

The following scatter plot shows that with bi-annual aggregations for Auckland, Wellington and Canterbury and 3-yearly aggregations for the other regions, the sample sizes are generally close to or in excess of 400, and the ADFTs are all less than 10%. The average ADFT at this level of aggregation is 3.0% which falls comfortably beneath our stated threshold of 5%.

We are comfortable that at this level of aggregation we are getting a relatively uniform degree of accuracy from the DTS data, as indicated by the slope of the trend line on the scatter plot below (this indicates that the ADFT is not strongly influenced by sample size at this level of aggregation).

Figure 10 Final Sample Sizes and ADFTs for Aggregated (Seasonal) DTS Data



Our conclusion from this analysis is that we should aggregate the DTS data for each region and each season on a rolling basis as follows,:

Table 2 Data Aggregations for DTS Data

Market (RLPR)	Data Aggregation
Northland	3 year increments
Auckland	2 year increments
Waikato	3 year increments
Bay of Plenty	3 year increments
Gisborne/Hawke's Bay	3 year increments
Taranaki/Manawatu	3 year increments
Wellington	2 year increments
Tasman/Nelson/Marlborough/West Coast	3 year increments
Canterbury	2 year increments
Otago/Southland	3 year increments

General Findings

In general both the IVS and DTS data showed a high degree of stability when the number of trips sampled from an origin market (international) or region (domestic) were in excess of 600. This has important implications for IVS and DTS surveying – trip sample quotas should be set for each origin market/region so that the data is more uniformly reliable across the country.

3.2. Static Tourism Data

The static tourism data has been taken mainly from the Ministry of Tourism's forecasting programme, with supplementary data sourced from other data held by the Ministry of Tourism. The regional component of the forecasting programme was reviewed and altered in 2005 to ensure that the outputs met the needs of the TFM. The base visits and nights data for the forecasting programme was sourced annually at the RTO level, segmented by origin of traveller and purpose of visit. The resulting visits, nights and expenditure forecasts were then used as inputs to the TFM.

The travel style, age, activity, transport type and accommodation data have all been sourced from the IVS and DTS.

3.3. Other Data

3.3.1. Transit Data

Transit New Zealand has provided us with data from its continuously monitored telemetry sites on state highways. We have sourced this data at an annual average daily level for each month and have converted these figures to seasonal totals (spring/summer and autumn/winter). The seasonal totals have been used to estimate the total traffic flow at the telemetry site location in each season, expressed in terms of vehicle movements. The vehicle movement data has been converted to estimates of passenger movements by multiplying total vehicle movements by the average number of occupants per vehicle. The average number of occupants per vehicle across all vehicle types has been estimated at 4.5[3]. The estimated tourist flows are divided by the estimates of total passenger movements from the vehicle count data to determine the percentage of total passenger traffic that is generated by tourists in the selected time period.

3.3.2. Air Route Data

The tourism data provides detailed information on the trip segments that tourists generate. However, the data doesn't say anything about the specific route they took. In most cases there is only one feasible route between two locations, but in some cases there are two or more possible routes.

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[3] This has been based on the ratio of passenger-km by cars and campervans (8,430 million pkm, both domestic and international) compared with coaches/buses (949 million pkm), and assumed occupancy rates of 2 passengers per light vehicle and 25 per heavy vehicle (see Becken, S. (2002). Tourism and Transport in New Zealand – Implications for Energy use. TRREC Report No. 54, July 2002; Becken, S. & Cavanagh, J. (2003). Energy efficiency trend analysis of the tourism sector. Research Contract Report: LC02/03/293. Prepared for the Energy Efficiency and Conservation Authority).

In the case of air travel there is often an indirect alternative to the direct route requiring one or more stopovers. To estimate the number of passenger movements down a particular air segment we required information on how people travel between destinations. For example, suppose 80% of the 100,000 passengers flying from Auckland to Christchurch fly direct while the remaining 20% fly via Wellington. The passengers flying from Auckland to Christchurch would therefore generate 80,000 passenger movements on the AKL-CHC segment (the direct movements) and 20,000 passenger movements on both the AKL-WGN and WGN-CHC segments (the indirect movements).

Air New Zealand was able to provide us with the information we required to route passengers down air segments in New Zealand based on their origin and final destination. In cases where Air New Zealand was not the only carrier they provided estimates of competitor behaviour. This allowed us to flow passengers through the New Zealand air route network as accurately as possible.

3.3.3. Sub-Annual Trip Forecasts

International

The Ministry of Tourism's forecasting programme generates monthly forecasts of international arrivals (trips) by origin region over a 2 year horizon. We used the same methodology to extend the forecasts a further 5 years to 2012, and have aggregated these forecasts to form seasonal totals.

Domestic

The Ministry of Tourism's forecasting programme generates annual forecasts of domestic day and overnight trips out to 2012. There is no reliable data collected in the DTS to indicate monthly demand patterns so we used monthly data from the Commercial Accommodation Monitor (CAM) to establish this pattern. The CAM collects monthly data by origin of traveller for most RTOs in New Zealand, and every 3 months for the rest. A notable omission in the monthly data is Auckland which captures around 15% of all domestic visitor nights in New Zealand.

We sourced data by origin of traveller for all RTOs that collected monthly data and aggregated this data across RTOs to derive a national estimate of monthly travel patterns. These patterns were very consistent across both RTOs and time which gave us a high level of confidence in the suggested monthly travel patterns. We used this data to form a seasonal distribution in percentage terms and applied these percentages to the annual estimates of domestic trips by origin from the Ministry of Tourism's forecasting programme.

4. Modelling

4.1. Data Aggregations

The data aggregations detailed in the previous section require a considerable amount of modelling. The first level of aggregation is from quarters to seasons. This is relatively straightforward as it is simply a case of collapsing the March and December quarters of each calendar year into the spring/summer season and the June and September quarters into the autumn/winter season. It is assumed that the seasonal travel *patterns* (as distinct from the travel *volumes*) are the same as the travel patterns in the quarters that make up the season.

The next level of aggregation is years. If an origin market is deemed to have insufficient sample in a given year then seasons are aggregated across subsequent years until the minimum acceptable sample size is reached. In this case data for the optimal number of seasons is added together across years and treated as being representative of the whole period for which data has been aggregated. The resulting annual *conversion rates* (discussed in the next section) will therefore be constant for a given origin market across the entire aggregated time period.

The final level of aggregation is geographic. If an origin market is deemed to have insufficient sample even after data has been aggregated across years then adjacent geographic regions are aggregated until the minimum acceptable sample size is reached. The resulting annual *conversion rates* will therefore be constant for all of the markets in the geographic aggregation within each aggregated time period.

4.2. Conversion Rates

The model uses *conversion rates* to translate trip numbers to estimates of passenger movements along trip segments. The conversion rate is influenced by the attributes of the trip such as what type of trip it is, who is taking it, what season they're taking it in and in which year.

Conversion rates are derived from the historical data by dividing the number of observed trip segment flows by the total number of trips. This calculation is done for every origin market x trip segment x time period x season x travel mode x travel type combination. The conversion rates derived from aggregated data are assumed to apply to every season, year and geographic region within the aggregation. The trip number data has been aggregated in exactly the same way as the trip segment data to ensure that the resulting conversion rates are valid.

The historical flows are derived by multiplying the appropriate conversion rates by the trips generated in the selected time period. For example, if the user wants to observe tourism flows for the season of autumn/winter 2003 the model calls the conversion rates for autumn/winter 2003 and multiplies them by the trips taken in autumn/winter 2003. If the user wants to observe tourism flows for the year of 2003 the model calls the conversion rates for each season in 2003 and cross multiplies these with the trips taken in each season of 2003 and sums them to get an annual total.

4.3. Forecasting Tourist Flows

The process used to *forecast* tourist flows is the same as that used to estimate historical flows – projected seasonal conversion rates are multiplied by projected seasonal trip numbers and aggregated to fit the selected time period. The forecasts of trip numbers are an extension of the Ministry of Tourism's forecasting programme and are readily available. However, it is more difficult to develop forecasts of conversion rates because:

1. There are a large number of them when all possible data segmentations are taken into account;
2. Changes in market research providers and survey methodologies have generated steps or trends in the data that may not be real. An example of this is the more stringent enforcement of the 80km round-trip threshold for day trips from 2003 onwards which significantly reduced the number of day trips observed from that point forward. Any forecast of this data would project forward a strong downward trend. However, in reality we know that this trend has been generated by a change in methodology and not a real shift in the data, so any forecasts generated from the historical data would be misleading.

Given that there have been provider changes and methodology changes in both the IVS and DTS we felt that the best way to forecast the conversion rates was to assume that they remain unchanged at the most recent observed value over the forecast period. We therefore assume that the travel patterns of each *market segment* remain unchanged over time relative to current values. This does not mean that aggregate travel patterns will remain unchanged over time, because market segments are expected to grow at different rates. Changes in travel patterns are therefore driven by changes in *market composition* over time and not by changes in travel patterns *within* market segments.

4.4. Travel Routes

The final step in the process is to assign the identified tourist flows between each location pair to specific transport routes. A prerequisite for routing is a comprehensive transport network for tourists to flow through. The road network includes all state highways as well as roads that are likely to be attractive to tourists (e.g. established tourist routes).[4] The air network includes all sectors served by Air New Zealand and Qantas as well as tourist sectors served by other airlines. The 'other' transport category captures all non-road/air modes of transport and does not have a specific network to flow tourists though; hence these flows have not been represented spatially in the model.

[4] There are still some gaps in the modeled transportation network which the Ministry of Tourism intends to fill over time.

The routing procedure starts with the estimated number of passenger flows between each location pair. In theory there are over 16,000 possible location pairs in the flows model (128 x 128), although in practice many of these location pairs have no direct flows recorded against them (e.g. Cape Reinga to Dunedin).

The next step is to take each location pair and decide which route(s) tourists will take to travel between the two points. In some cases there is only one possible route between two locations, and in other cases there are multiple routes. In the case of multiple routes there is often only one viable route, while in the remainder of cases there will be more than one viable route. In general the number of possible routes will increase with the length of the trip segment (all other things being equal). The choice of route will ultimately depend on the preferences of the traveller - some will opt for the fastest route while others will opt for longer scenic routes.

Unfortunately little is known about the road route behaviour of tourists in New Zealand. In the absence of better information we have developed an algorithm in ArcView that assigns road passenger flows to specific routes based initially on travel time (as estimated by ArcView based on factors such as distance, straightness of road etc) and 'tourist value' (represented by the attractiveness of popular tourist routes).

We acknowledge that this process is reasonably "blunt" when compared with the rest of the model. However, we still expect the road routing to be quite accurate because many of the trip segments are quite short and therefore only have one viable route. The majority of the error will therefore be associated with the routing of long trip segments.

The routing of air segments is much more accurate and has been based on detailed route information provided by Air New Zealand.

Appendix

Table 3 Concordance for IVS Transport Modes

IVS Transport Category	Final Transport Mode
Backpacker Bus Campervan Coach Tour/Tour Coach Company Car/Van Motorbike Private Campervan/Motorhome/RV Private Car/Van Rental Campervan/Motorhome/RV Rental Car/Van Scheduled Coach Service Taxi/Limousine/Car Tour	Road
Airline Helicopter Private Aeroplane	Air
Bicycle Don't Know Hitchhiking Other Refused Train Walking/Tramping Cruise Ship Interisland Ferry Other Commercial Ferry/Boat Private Yacht/Boat	Other

Table 4 Concordance for DTS Transport Modes

DTS Transport Category	Final Transport Mode
Army bus/truck, plane Backpacker bus Coach tour/tour coach Commercial bus/ferry Company car/van Motorbike/scooter Private campervan Private car/van Rental campervan Rental car/van Scheduled coach service between cities/towns School bus/private bus Taxi/ limousine/car tour Truck	Road
Domestic air Helicopter Private plane	Air
Air ambulance/ambulance Cycling Don't know Hitchhiking Horse Other (specify) Train Walked Cruise ship Inter island ferry (Cook Strait ferry only) Rental boat Yacht/private boat	Other

Table 5 Concordance for Countries and International Regions

Region of Last Permanent Residence (RLPR)	Country of Last Permanent Residence (CLPR)
Australia	Australia
Americas	Canada South America United States Americas nec*
Japan	Japan
North East Asia	China Hong Kong South Korea Taiwan North East Asia nec*
Rest of Asia	India Indonesia Malaysia Singapore Thailand Rest of Asia nec*
UK/Nordic/Ireland	United Kingdom Northern Europe Ireland
Rest of Europe	Euro 7 Germany Netherlands Switzerland Rest of Europe nec*
Rest of World	Pacific Islands South Africa Rest of World nec*

*'nec' stands for 'not elsewhere classified'