Waikato Regional Transport Model

Trip Attraction Model Calibration and Validation Update

Technical Note 26

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Technical Note 26

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1. Purpose

The purpose of this note is to document the procedure followed to re-calculate the model calibration regression equations developed for creating the attraction trip ends. This has been completed for both the vehicle driver (three-step) trip ends and the person (four-step) models. The purpose for the update is to take into account the changes in the number and size of zones in the updated 2013 model. The new Waikato Regional Transportation Model (WRTM) model has been expanded to approximately 2500 zones to create an improved level of land use precision. This change in zone detail has necessitated the recalibration of the attraction model.

2. Introduction

In this technical note the three-step and four-step model regression equations developed for generating the attraction trip ends are presented. These have been calibrated using trip end data across the WRTM zones inside the Household Interview Survey (HIS) Study Area from the 2008 Waikato Household Interview Survey. The location and extent of this HIS Area is presented in Figure 1. The 2013 WRTM model area is larger than the HIS area and includes Franklin, Tauranga, Rotorua and other Bay of Plenty areas.

Land use data has been taken from two sources. Firstly, land use data relating to both residential and commercial activity has been sourced from Statistics New Zealand's 2006 Census data and education sector data has been sourced from the Ministry of Education, namely School Roll and Tertiary Equivalent Full-Time Students (EFTS) data.

3. Data Used to Calibrate Attraction Equations

The trip end data, for which regression equations were fitted against, was sourced from the Waikato Region HIS (2008). For trips whose origin and destination both lay within the HIS portion of the Waikato Regional Transportation Model, the total trip ends are allocated to the following trip purposes:

- HTW = Home to Work
- HTE = Home to Education
- HTB = Home to Business
- HTSh = Home to Shopping
- HTSR = Home to Social/recreation
- HTO = Home to Other
- NHB = Non Home Based
- WTH = Work to Home
- ETH = Education to Home
- BTH = Business to Home
- ShTH = Shopping to Home
- SRTH = Social/recreation to Home
- OTH = Other to Home

The updated WRTM model has 2500 zones within it covering the HIS area, Franklin District, parts of Bay of Plenty and external zones. The total number of trip ends by WRTM zone, within the HIS area, were isolated for each purpose to cover the three periods of the day being morning peak (7-9am), interpeak (9am-4pm) and evening peak (4-6pm) for car driver trip mode only, which resulted in a total of 39 origin-destination pairs of trip ends (i.e. 13 purposes by 3 time periods) by WRTM zone.

This analysis has then been repeated for the four-step analysis and included in this report for all modes as 'person trips', which includes:

- Car driver
- Car Passenger
- Public transport
- Cycling
- Walking

The trip end data was regressed against a total of 24 land use variables as follows:

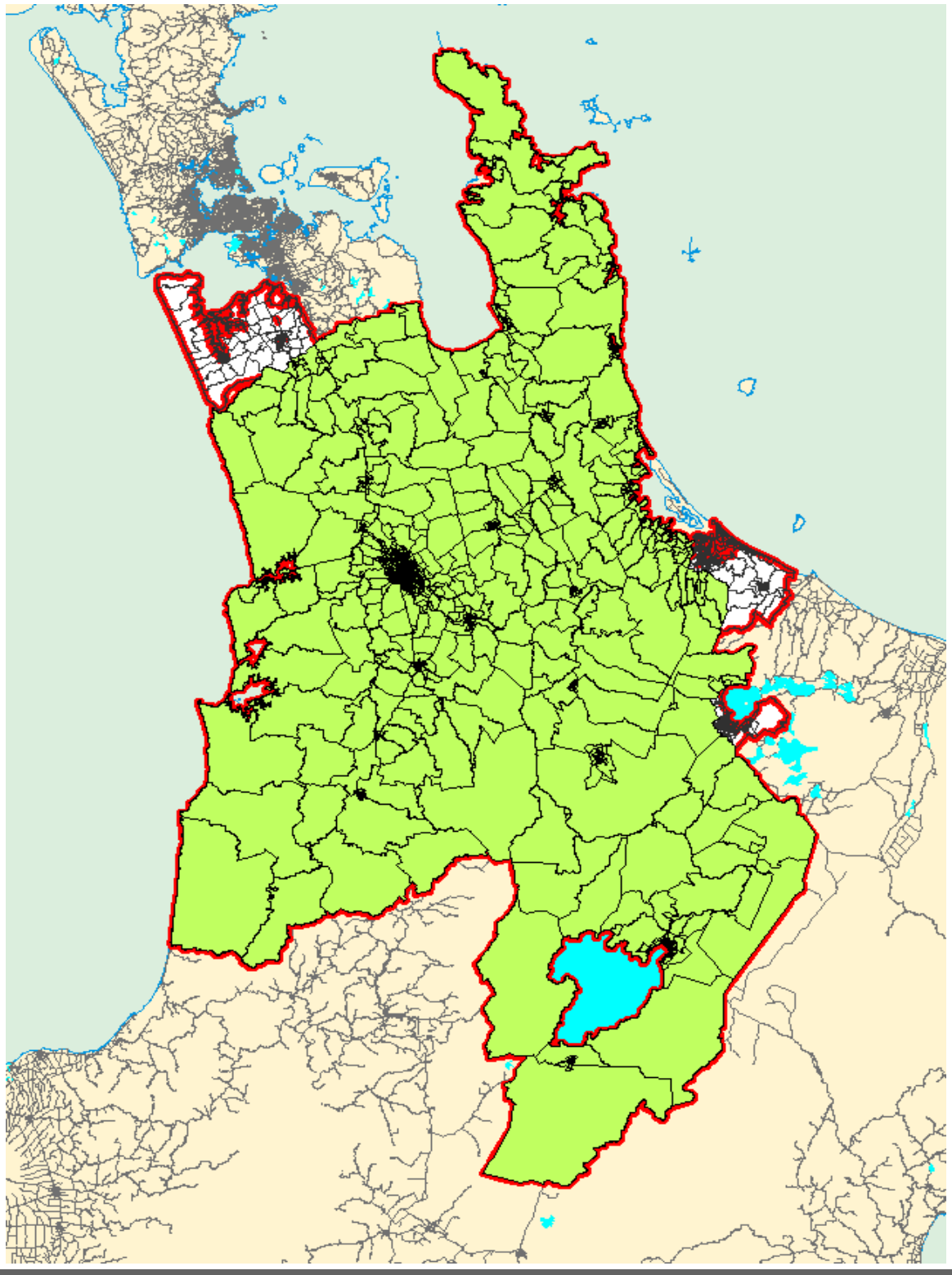
- Number of households in the HIS area (147717);
- School Roll – primary and secondary combined, totalling 78747 in the HIS area (source 2008 Ministry of Education July roll data);
- Tertiary Equivalent Full Time Students (EFTS), totalling 11888 in the HIS area (source 2008 Ministry of Education EFTS by campus by provider);

- University Equivalent Full Time Students (EFTS), totalling 8302 in the HIS area (source 2008 Ministry of Education EFTS by campus by provider);
- Number of jobs by workplace zone for all 19 ANZSIC06 job industry classifications plus total jobs (i.e. this is 20 variables).

Job industry classifications within the HIS area are defined in Table 1.

Classification	Number of Jobs
Agriculture, Forestry and Fishing	23,626
Mining	801
Manufacturing	18,414
Electricity, Gas, Water and Waste Services	1040
Construction	10,618
Wholesale Trade	6047
Retail Trade	17,113
Accommodation and Food Services	9774
Transport, Postal and Warehousing	4628
Information Media and Telecommunications	1651
Financial and Insurance Services	3341
Rental, Hiring and Real Estate Services	4545
Professional, Scientific and Technical Services	10,238
Administrative and Support Services	4334
Public Administration and Safety	5533
Education and Training	13,018
Health Care and Social Assistance	13,537
Arts and Recreation Services	3054
Other Services	6531
Total Jobs	**157,944**

Table 1: Job Industry Classification Totals within HIS Area



Waikato Regional Transportation Model
HIS Area

1

4. Correlation Analysis of Variables

The land use variables specified in section 3 above were checked for cross-correlations. This was necessary to gain an understanding of which variables were highly correlated and therefore could either be aggregated or used as a proxy for other variables.

Retail jobs have a high correlation with office and accommodation jobs. This occurs as a result of these types of jobs being centred in the commercial urban centres in the study area. There is also a high correlation between Manufacturing and Wholesale jobs again as a result of these types of activity being located within the same areas. The very high correlation results between Total Jobs and Accommodation, Office and Retail indicates a high degree of interrelationship between those land uses.

A high correlation shown in red (i.e. of over 0.8) exhibited between variables are shown in Table 2.

Correlation Matrix (R)

	Agriculture	anufacturi	onstructio	ommodati	Office	ommunit	Wholesale	Retail	Education	School	Tertiary	Uni	Transport	Total Jobs
Agriculture														
Manufactu	0.021													
Constructi	-0.050	0.279												
Accommo	-0.086	0.200	0.403											
Office	-0.042	0.236	0.449	0.878										
Communi	-0.113	0.295	0.334	0.693	0.710									
Wholesale	-0.066	0.896	0.344	0.378	0.430	0.433								
Retail	-0.126	0.429	0.433	0.847	0.898	0.676	0.600							
Education	-0.127	0.169	0.330	0.574	0.612	0.481	0.298	0.580						
School	-0.100	0.098	0.188	0.223	0.230	0.246	0.161	0.280	0.695					
Tertiary	-0.084	0.252	0.396	0.590	0.751	0.479	0.329	0.668	0.516	0.095				
Uni	-0.033	-0.019	0.007	0.122	0.042	0.018	-0.010	-0.003	0.503	0.092	-0.012			
Transport	-0.053	0.696	0.319	0.342	0.371	0.324	0.723	0.478	0.259	0.196	0.300	-0.019		
Total Jobs	0.028	0.594	0.483	0.827	0.892	0.794	0.729	0.918	0.614	0.295	0.664	0.059	0.600	

t Statistic

	Agriculture	anufacturi	onstructio	ommodati	Office	ommunit	Wholesale	Retail	Education	School	Tertiary	Uni	Transport	Total Jobs
Agriculture														
Manufactu	0.343													
Constructi	0.832	4.851												
Accommo	1.445	3.404	7.334											
Office	0.705	4.048	8.390	30.624										
Communi	1.898	5.157	5.910	16.043	16.830									
Wholesale	1.098	33.718	6.102	6.809	7.938	8.016								
Retail	2.120	7.929	8.012	26.612	34.020	15.311	12.491							
Education	2.135	2.854	5.829	11.673	12.913	9.151	5.207	11.882						
School	1.676	1.639	3.189	3.819	3.941	4.228	2.724	4.866	16.121					
Tertiary	1.401	4.334	7.190	12.170	18.964	9.101	5.807	14.962	10.043	1.595				
Uni	0.546	0.316	0.116	2.055	0.706	0.298	0.173	0.045	9.707	1.538	0.193			
Transport	0.892	16.156	5.614	6.068	6.659	5.701	17.467	9.069	4.474	3.340	5.253	0.312		
Total Jobs	0.463	12.310	9.189	24.573	32.923	21.763	17.751	38.524	12.953	5.151	14.789	0.979	12.512	

Table 2: Purpose Correlations

5. Methodology

The regression analysis was completed using StatistiXL version 1.10, a specialist software add-on to Microsoft Excel that includes a wide-range of statistical tools.

Each of the sets of trip ends (i.e. by purpose by period for both vehicle drivers and person models) was regressed against the land use variables in Section 3 of this technical note.

The regression was a forward stepwise regression with a constant of zero forced in each instance. The criterion for the inclusion of variables is a probability of a type one error being 0.05 (i.e. there is a 5% probability that a variable is selected within the analysis but it is not a significantly significant variable). Variables were only permitted to have non-negative coefficients in the analysis.

The first pass of the regression model included all 24 variables to see which were significant. Some variables were then discarded if they should not logically be included (e.g. Mining included in Home Based Education) and the analysis was revisited without such anomalies.

The resultant R-Squared values were then considered and where an R-Squared of less than 0.5 was noted the data was checked to see if there was sufficient sample data to establish a regression equation. The measure for this assessment was the mean cell size, which equates to the average number of expanded trip ends per Regional Model zone from the HIS data.

A number of other hypotheses were tested in the previous 2008 regression analysis. The jobs from the Health Care and Social Assistance; Arts and Recreation Services; and Other Services ANZSIC06 industry categories were aggregated from Statistics New Zealand 2006 census data to form a “Community Jobs” variable. Subsequent regression analysis found a better fit of data using the Community Jobs variable rather than applying the three individual ANZSIC06 variables and this was continued for this update.

Similarly the Information Media and Telecommunications; Financial and Insurance Services; Rental, Hiring and Real Estate Services; Professional, Scientific and Technical Services; Administrative and Support Services; and Public Administration and Safety ANZSIC06 industry categories were aggregated from Statistics New Zealand 2006 census data to form an “Office Jobs” variable.

Further tests were also undertaken in the previous 2008 analysis to confirm that the Education Jobs ANZSIC06 category was redundant. In all cases no deterioration in the fit of the regression model was introduced by regressing the trip ends against the three Ministry of Education variables (school rolls, tertiary EFTS and University EFTS) as opposed to a combination of these and Education Jobs.

The first pass analysis was undertaken at a zonal level of detail which reflected a near Meshblock detail involving all zones within the HIS area. Only zones that had HIS records were included in the regression analysis to ensure that results were not skewed by zero trip zones with relevant land use.

It was found that in many instances no statistically significant fit could be found at this level of detail. In order to improve the quality of fit of the attractions equations, it was necessary

to consolidate trip end and land use data into a Statistics NZ Area Unit (AU) level of detail. This better allowed for small inaccuracies in area land use composition and geo-coding of HIS trip end data.

A full re-analysis of the regression process for all trip purposes was undertaken at the AU level of detail. However, again a number of directional purposes did not produce results that were of satisfactory fit. In most instances this was as a result of the sample of trips being too small to create a statistically significant result. In some instances however it was due to the best regressed equation resulting in a plot of surveyed vs. modelled trips having a negative R^2 indicating no correlation.

The previous 2008 attraction equation analysis combined directional trips into Home Based trips and when necessary combined purposes over time periods. It was decided that this update analysis would attempt to keep trip attraction coefficients directional and not mix modelled time periods. However, due to the instances of unsatisfactory fit detailed earlier, some trip purposes were combined, within the same modelled time period, with “Home to Other” and “Other to Home” purposes.

The trip rates by purpose changed in version 3 of the WRTM when the external attraction model was modified to include attraction to Auckland jobs. To prevent a doubling up of trips near the northern externals the trip rates were recalculated from the Household Interview Survey data so that they include all internal and external trips that the Waikato households generate. Section 4 of Technical Note 21 describes the method in detail.

For the current model the additional resultant traffic generated by considering the Waikato household external trips has then been apportioned to the model trip attraction equations for the relevant trip purposes, as shown in the tables below (EXT denotes the external attraction for Auckland jobs). In light of relevant Journey to Work data, that would also consider Franklin district as part of the study area, the same 3300 jobs used in the previous version of the model have been apportioned to the northern externals on State Highway One (externals 2480 and 2481) and Great South Road to Papakura (external 2482) and the attraction equation coefficients modified to reflect the required number of additional trips.

6. Regression Analysis Results

The results of the regression analysis are summarised below. R^2 values to measure the goodness of fit between the HIS data trip ends and the regression equation trip ends are included for each equation.

T values for each accepted independent variable are included to indicate the extent to which each variable fits into the model. The values follow the Student's t-distribution curve and are indicative of the probability that the variable is significant in the equation. A value of 1.96 indicates a 95% probability. As these values become greater the probability that it is a significant variable increases.

The proportion of each land use variable included is indicated so that the relative impact of each variable coefficient can be considered.

The mean cell sizes are also reported which equate to the average number of expanded trip ends per Regional Model zone from the HIS data.

The trip purpose codes are detailed in section 3.

7. Three Step Model Regression Attractions

Morning Peak Vehicle Trip Attractions						R^2	Mean Cell
HTW	=	0.444MAN + 0.658RET + 0.207TOT + 0.479EXT				0.910	398
		T= 5.486	T=3.577	T=6.437			
		N=18414	N=17113	N=157944			
HTE	=	0.081SCH + 0.046TER + 0.042UNI + 0.049EXT				0.717	155
		T=4.733	T=2.151	T=3.151			
		N=76529	N=11655	N=8302			
HTB	=	0.040TOT + 0.071EXT				0.633	129
		T=7.306					
		N=157944					
HTSh	=	0.175RET + 0.052EXT				0.596	132
		T=6.536					
		N=17113					
HTO	=	0.120HH + 0.245RET + 0.202SCH + 0.45EXT				0.788	275
		T=5.268	T=4.853	T=6.700			
		N=147522	N=17113	N=76529			
NHB	=	0.063HH + 0.647RET + 0.113SCH + 0.070TOT				0.862	270
		T=2.712	T=5.041	T=3.738	T=3.338		
		N=147522	N=17113	N=76529	N=157944		
OTH	=	0.108HH + 0.116AG + 0.061OFF + 0.069COM + 0.071EXT				0.785	163
		T=9.274	T=2.649	T=3.648	T=2.401		
		N=147522	N=23636	N=29642	N=23122		
Interpeak Peak Vehicle Trip Attractions						**R^2**	**Mean Cell**
HTW	=	0.369AG + 0.120TOT + 0.356EXT				0.677	253
		T=4.407	T=12.952				
		N=23626	N=157944				
HTB	=	0.157COM + 0.083TOT + 0.255EXT				0.672	249
		T=2.068	T=5.160				
		N=23122	N=157944				
HTSh	=	1.499RET + 0.424EXT				0.772	412
		T=15.958					
		N=17113					
HTO	=	0.221HH + 0.480RET + 0.159SCH + 0.375EXT				0.757	348
		T=7.225	T=6.590	T=3.778			

		N=147522	N=17113	N=76529			
NHB	=	0.631HH + 7.027RET				0.851	1221
		T=7.588	T=25.061				
		N=147522	N=17113				
WTH	=	0.454AG + 0.249MAN + 0.251COM + 0.686RET + 356EXT				0.800	294
		T=5.992	T=4.173	T=4.391	T=8.355		
		N=23626	N=18414	N=23122	N=17113		
BTH	=	0.791ACC + 0.034TOT + 0.255EXT				0.637	227
		T=3.086	T=1.696				
		N=9774	N=157944				
ShTH	=	1.852RET + 0.424EXT				0.808	460
		T=18.919					
		N=17133					
OTH	=	0.214HH + 0.449RET + 0.161SCH + 0.108UNI + 0.367EXT				0.760	370
		T=6.691	T=6.047	T=3.5787	T=3.578		
		N=147522	N=17113	N=76529	N=8302		
Evening Peak Vehicle Trip Attractions						**R^2**	**Mean Cell**
HTSh	=	0.292RET				0.655	161
		T=8.143					
		N=17113					
HTSR	=	0.105HH + 0.195RET				0.843	150
		T=10.401	T=7.578				
		N=147522	N=17113				
HTO	=	0.077HH + 0.114COM + 0.035TOT + 0.615EXT				0.827	182
		T=5.978	T=3.111	T=4.391			
		N=147522	N=23122	N=157944			
NHB	=	1.171RET + 0.080TOT				0.829	312
		T=6.511	T=2.853				
		N=17113	N=157944				
WTH	=	0.319AG + 0.697MAN + 0.322COM + 1.388RET + 0.615EXT				0.909	423
		T=3.728	T=10.333	T=4.922	T=14.902		
		N=23626	N=18414	N=23122	N=17113		
ETH	=	0.098SCH + 0.036TER + 0.089EXT				0.759	131
		T=4.428	T=1.788				
		N=76529	N=11655				
BTH	=	0.283AG + 0.061COM + 0.116RET + 0.027EXT				0.716	138
		T=2.512	T=2.411	T=3.366			

		N=23626	N=23122	N=17113				
ShTH	=	0.818RET + 0.044EXT					0.743	312
		T=12.487						
		N=17113						
OTH	=	0.083HH + 0.143MAN + 0.114COM + 0.129RET + 0.079TER					0.781	203
		T=4.675	T=3.662	T=3.169	T=2.473	T=3.383		
		N=147522	N=18414	N=23122	N=17113	N=11655		
		+ 0.089EXT						

8. Four Step Model Regression Attractions

Morning Peak Person Trip Attractions						R^2	Mean Cell
HTW	=	0.243MAN + 0.634RET + 0.311TOT + 0.479EXT				0.933	446
		T= 2.994	T=3.441	T=9.669			
		N=18414	N=17113	N=157944			
HTE	=	0.632SCH + 0.097TER + 0.029UNI + 0.049EXT				0.702	493
		T=14.950	T=1.403	T=0.661			
		N=76529	N=11655	N=8302			
HTB	=	0.240AG + 0.433ACC + 0.007TOT + 0.071EXT				0.692	129
		T=7.306	T=3.013	T=0.619			
		N=157944	N=9774	N=157944			
HTSh	=	0.227RET + 0.052EXT				0.591	150
		T=7.109					
		N=17113					
HTO	=	0.220HH + 0.416RET + 0.362SCH + 0.045EXT				0.739	472
		T=4.968	T=4.170	T=6.141			
		N=147522	N=17113	N=76529			
NHB	=	0.105HH + 0.921RET + 0.218SCH + 0.076TOT				0.581	393
		T=2.711	T=4.273	T=4.277	T=2.151		
		N=147522	N=17113	N=76529	N=157944		
OTH	=	0.133HH + 0.131COM + 0.061SCH + 0.071EXT				0.720	212
		T=6.175	T=4.117	T=2.364			
		N=147522	N=23122	N=76529			
Interpeak Person Trip Attractions						**R^2**	**Mean Cell**
HTW	=	0.488AG + 0.133TOT + 0.356EXT				0.682	281
		T=5.317	T=13.132				
		N=23626	N=157944				
HTE	=	0.090SCH + 0.150TER + 0.243UNI				0.806	246
		T=2.267	T=3.302	T=9.201			
		N=76529	N=11655	N=8302			
HTB	=	0.461COM + 0.469RET + 0.255EXT				0.669	318
		T=5.604	T=4.285				
		N=23122	N=17113				

HTSh	=	2.006RET + 0.424EXT				0.778	505
		T=16.868					
		N=17113					
HTO	=	0.397HH + 0.819RET + 0.262TER + 0.375EXT				0.779	571
		T=8.365	T=7.205	T=3.966			
		N=147522	N=17113	N=11655			
NHB	=	1.039HH + 11.416RET				0.825	1913
		T=7.012	T=22.802				
		N=147522	N=17113				
WTH	=	0.556AG + 0.296MAN + 0.365COM + 0.668RET + 356EXT				0.793	332
		T=6.469	T=4.355	T=5.621	T=7.189		
		N=23626	N=18414	N=23122	N=17113		
ETH	=	0.566SCH + 0.077TER + 0.163UNI				0.621	493
		T=11.498	T=0.963	T=3.244			
		N=76529	N=11655	N=8302			
BTH	=	0.113TOT + 0.255EXT				0.544	273
		T=9.208					
		N=157944					
ShTH	=	2.460RET + 0.424EXT				0.848	569
		T=22.127					
		N=17113					
OTH	=	0.377HH + 1.200RET + 0.323TER + 0.367EXT				0.768	659
		T=6.499	T=8.688	T=3.945			
		N=147522	N=17113	N=11655			

There are a few instances where land use variables are included in some periods but not others. This often occurs because the nature of trip-making across the course of the day changes, depending on the hours of operation of various industry sectors and the business functions they serve at different times of day. Such results have been noted in other similar studies including the North Shore model calibration (from 1991 Auckland HIS) and model calibrations from Sydney's Transport Data Centre.

Where:

HH = Households (source Statistics New Zealand 2006 census)

SCH = School Roll (source 2008 Ministry of Education July roll data)

TER = Tertiary Equivalent Full Time Students (source 2008 Ministry of Education EFTS by campus by provider)

UNI = University Equivalent Full Time Students (source 2008 Ministry of Education EFTS by campus by provider)

AG = Agriculture, Forestry and Fishing Jobs (ANZSIC06 category from Statistics New Zealand 2006 census)

MAN = Manufacturing Jobs (ANZSIC06 category from Statistics New Zealand 2006 census)

WHO = Wholesale Trade Jobs (ANZSIC06 category from Statistics New Zealand 2006 census)

RET = Retail Trade Jobs (ANZSIC06 category from Statistics New Zealand 2006 census)

ACC = Accommodation and Food Services Jobs (ANZSIC06 category from Statistics New Zealand 2006 census)

OFF = Office Jobs (Information Media and Telecommunications; Financial and Insurance Services; Rental, Hiring and Real Estate Services; Professional, Scientific and Technical Services; Administrative and Support Services; and Public Administration and Safety ANZSIC06 industry categories aggregated from Statistics New Zealand 2006 census)

COM = Community Jobs (Health Care and Social Assistance; Arts and Recreation Services; and Other Services ANZSIC06 industry categories aggregated from Statistics New Zealand 2006 census)

TOT = Total Jobs (all 19 ANZSIC06 categories from (source Statistics New Zealand 2006 census)

9. Three Step Model Validation of Attraction Trip Ends

The resultant number of modelled trip ends predicted by the calibrated three step attraction equations have been compared against the HIS trips ends by Area Unit.

It should be noted that as the comparisons are made at AU level, there are a large number of zones with few survey households, meaning there will be a few outliers as a result especially for trip purposes with low levels of activity. The scatterplots for each modelled period are included in Figure 2 through Figure 15 for each trip purpose.

Each of the plots includes an R^2 statistic, which measures goodness of fit. In general terms an R^2 of over 0.5 indicates there is a significant level of correlation between the two variables. It is important, however, to reiterate that with results calculated at AU level and with many zones having only a few surveyed households, trip scaling factors can create incidences where there is apparently a large amount of activity with little land use.

In Table 3 the total number of expanded HIS trips are reported with those purposes with fewer than 100 sampled trips surveyed (based on an average expansion factor of 100) in the corresponding time period presented in bold. These are generally those with the worst fit in the following tables which is not altogether unexpected given that the scatterplot analysis has been undertaken over 280 AU zones, meaning the average number of sampled trips per zone is no greater than 0.5 in these instances.

THREE STEP MODEL (VEHICLE DRIVER TRIPS)			
Trip Purpose	**AM Peak**	**INT Peak**	**PM Peak**
Home to Work	55347	28537	**2990**
Home to Education	**3952**	**2296**	**565**
Home to Business	**4468**	**18167**	**2283**
Home to Shop	**4342**	**31275**	**5700**
Home to Social/Rec	**3843**	**20445**	**8352**
Home to Other	28818	**23889**	**5434**
Non Home Based	41709	215128	40111
Work to Home	**2282**	35019	54958
Education to Home	**291**	**4257**	**1837**
Business to Home	**842**	**14748**	**3709**
Shop to Home	**1322**	**39522**	**17022**
Soc/Rec to Home	**1505**	**17662**	**10668**
Other to Home	**8776**	**25119**	**11382**
Total All Purposes	**157717**	**476063**	**165012**

Table 3: Total Expanded HIS Trips by Trip Purpose and Time Period

The total modelled trips by trip purpose are reported in Table 4 and compared against the HIS trips in Table 5 below.

THREE STEP MODEL (VEHICLE DRIVER TRIPS)			
Trip Purpose	**AM Peak**	**INT Peak**	**PM Peak**
Home to Work	54330	30783	
Home to Education	**4247**		
Home to Business	**4330**	**17489**	
Home to Shop	**3956**	**28577**	**5307**
Home to Social/Rec			**8465**
Home to Other	27684	**46044**	**11243**
Non Home Based	38480	220325	42816
Work to Home		37128	55836
Education to Home			**1876**
Business to Home		**14538**	**4114**
Shop to Home		**36172**	**16257**
Soc/Rec to Home			
Other to Home	**14977**	**46485**	**21425**
Total All Purposes	**148003**	**477543**	**167339**

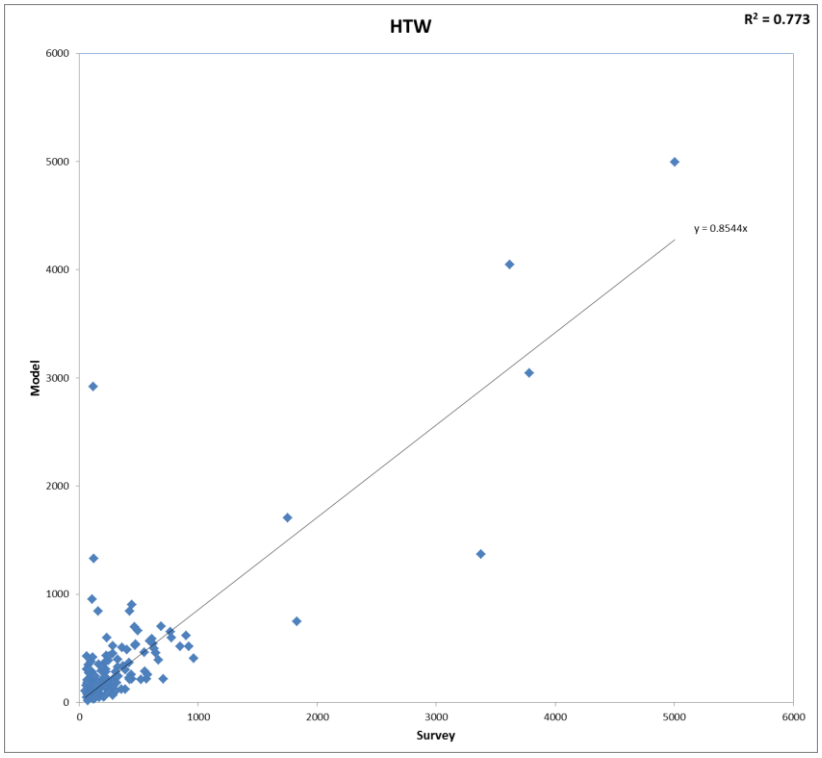
Table 4: Total Modelled Trips by Trip Purpose and Time Period

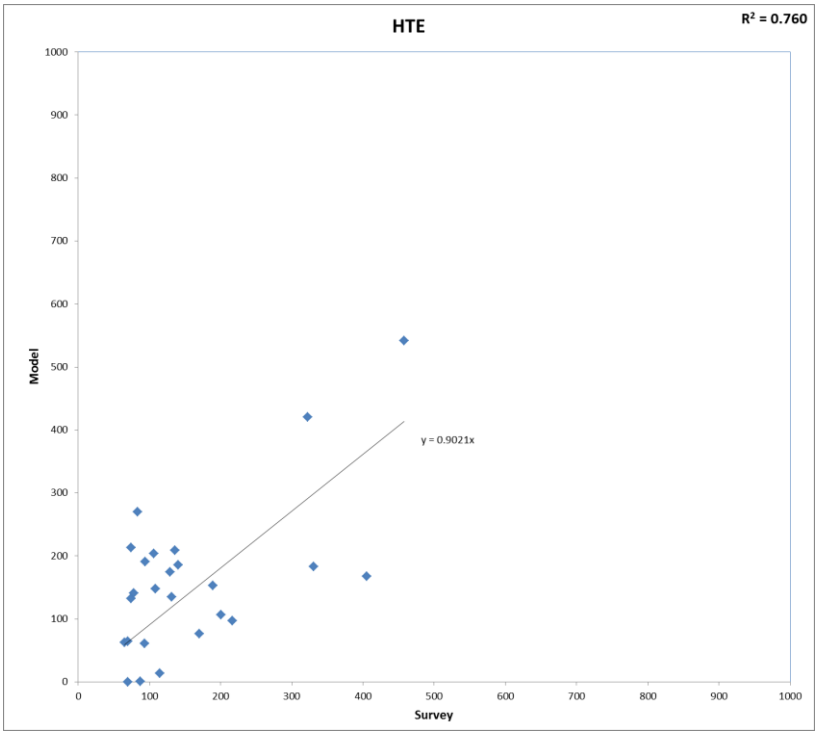
Note: Those purposes blanked out are added to the 'other' categories

THREE STEP MODEL (VEHICLE DRIVER TRIPS)			
Trip Purpose	**AM Peak**	**INT Peak**	**PM Peak**
Home to Work	-1.8%	7.9%	
Home to Education	**7.5%**		
Home to Business	**-3.1%**	**-3.7%**	
Home to Shop	**-8.9%**	**-8.6%**	**-6.9%**
Home to Social/Rec			**1.4%**
Home to Other	-15.2%	**-1.3%**	**-0.3%**
Non Home Based	-7.7%	2.4%	6.7%
Work to Home		6.0%	1.6%
Education to Home			**2.1%**
Business to Home		**-1.4%**	**10.9%**
Shop to Home		**-8.5%**	**-4.5%%**
Soc/Rec to Home			
Other to Home	**-0.3%**	**-1.2%**	**-2.8%**
Total All Purposes	-6.2%	0.3%	1.4%

Table 5: Modelled vs Surveyed Trips by Purpose and Time Period

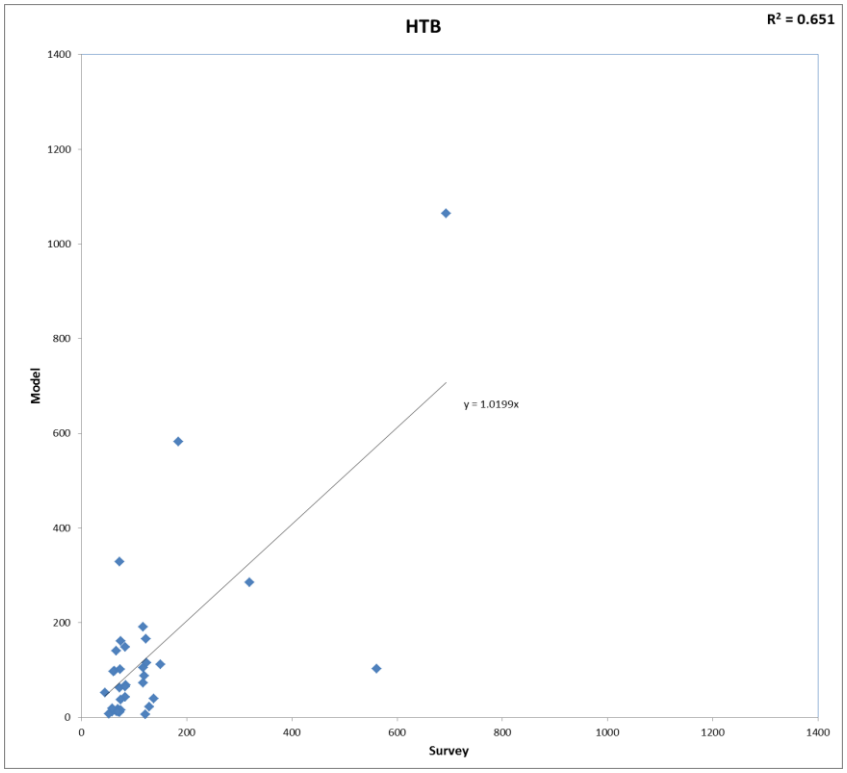
For those trip purposes with very few trips surveyed, the R^2 values may be low.

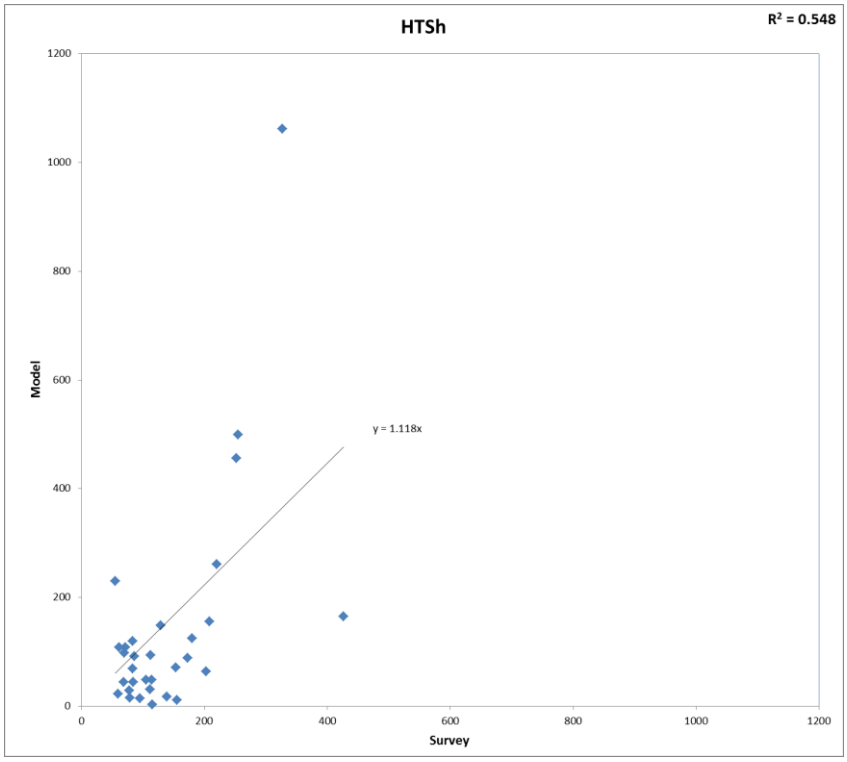




AM Attraction Trip End Validation Plots
3 Step Model

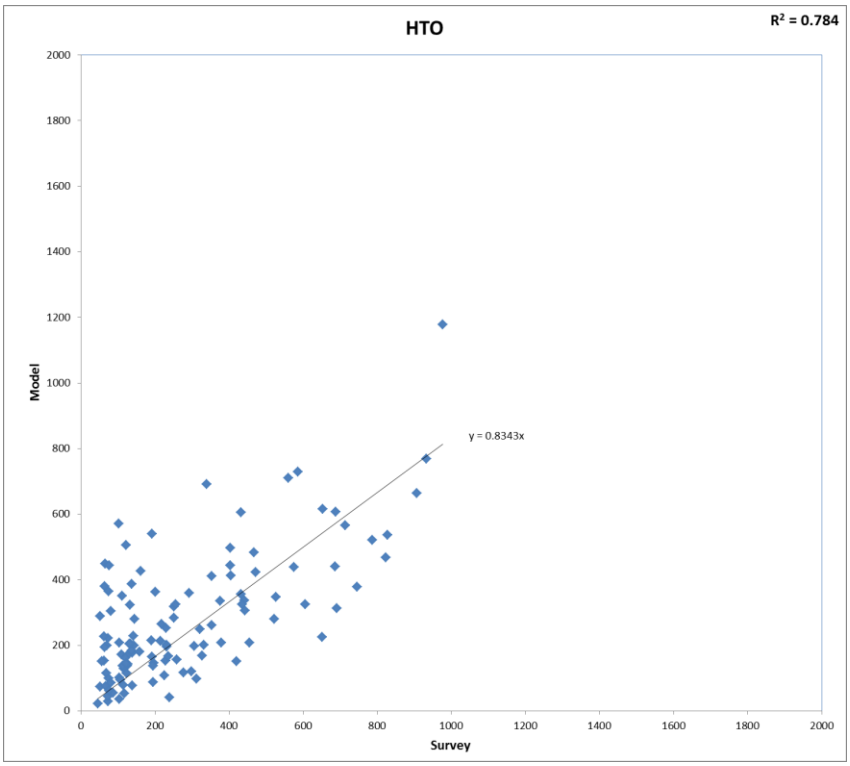
2

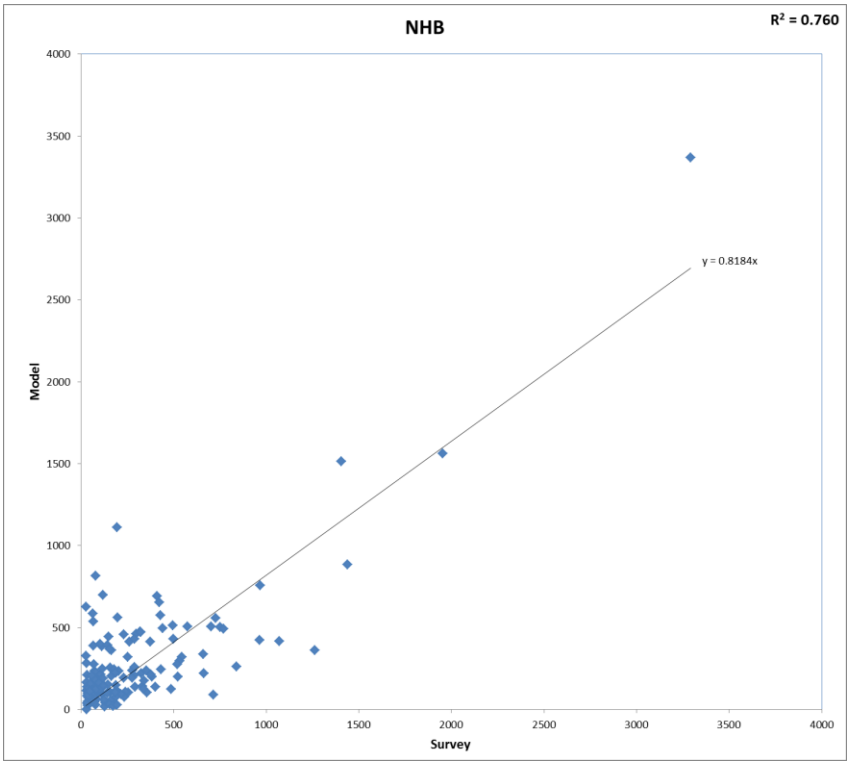




AM Attraction Trip End Validation Plots
3 Step Model

3





AM Attraction Trip End Validation Plots
3 Step Model

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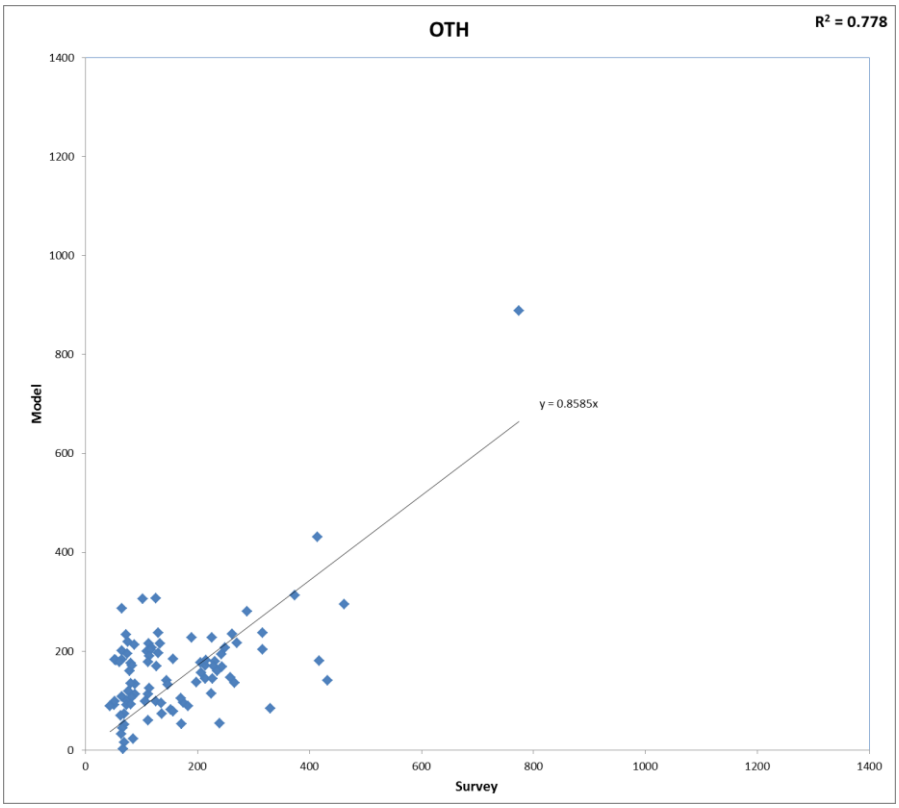
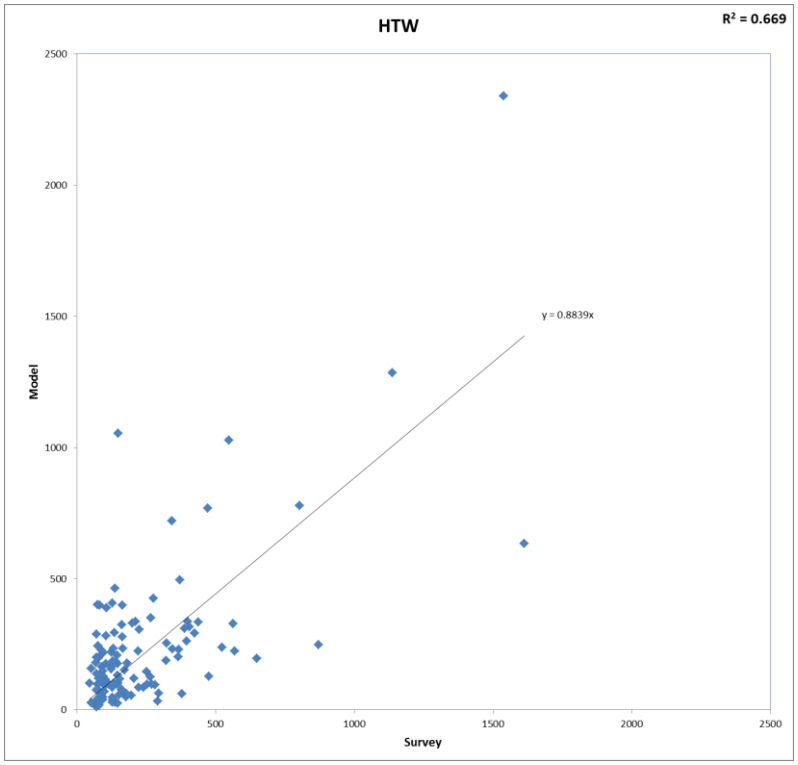
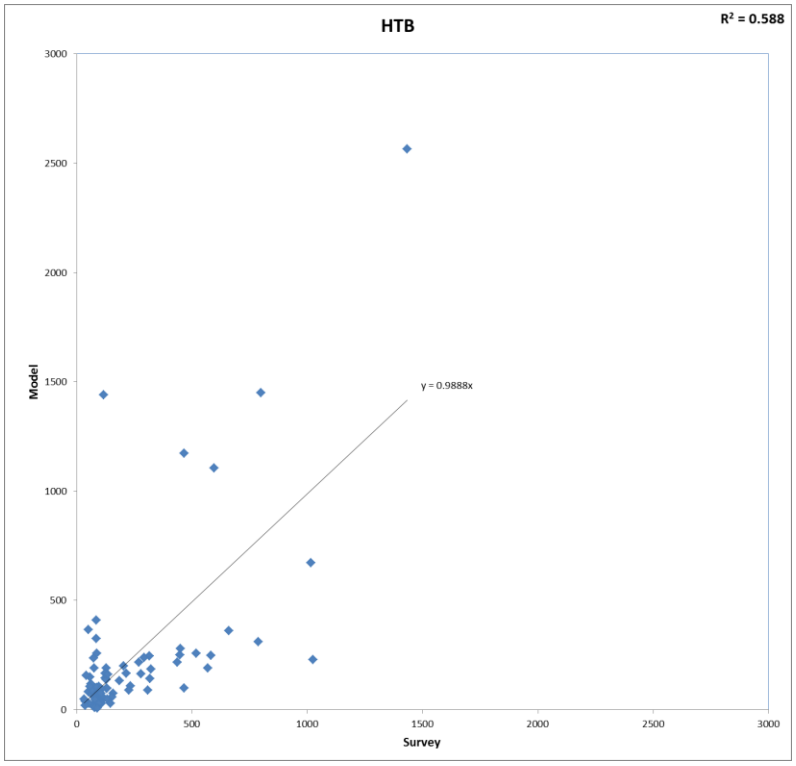


AM Attraction Trip End Validation Plots
3 Step Model

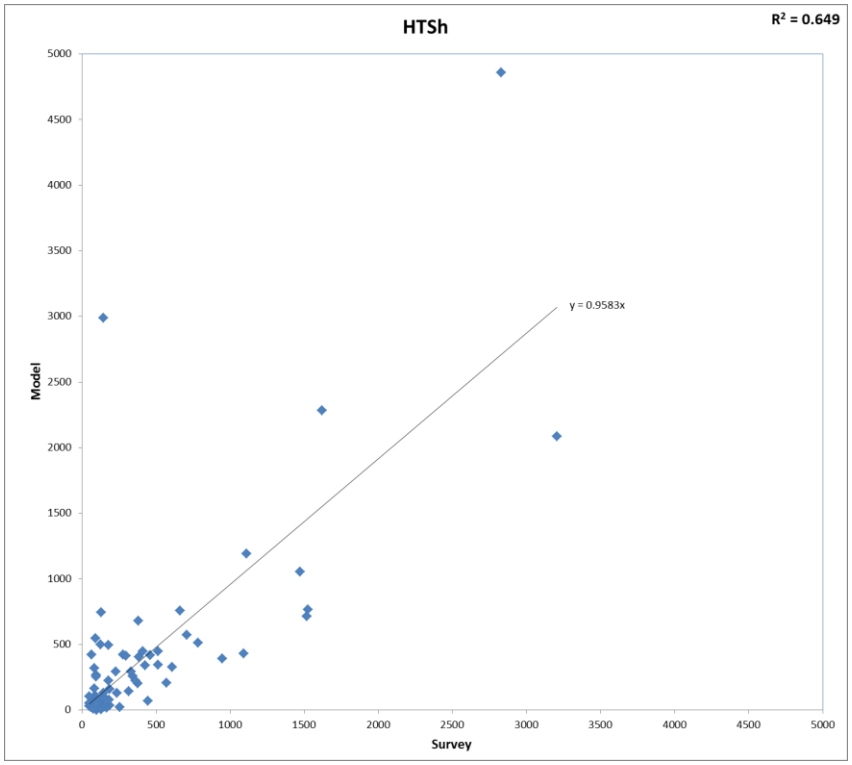
5

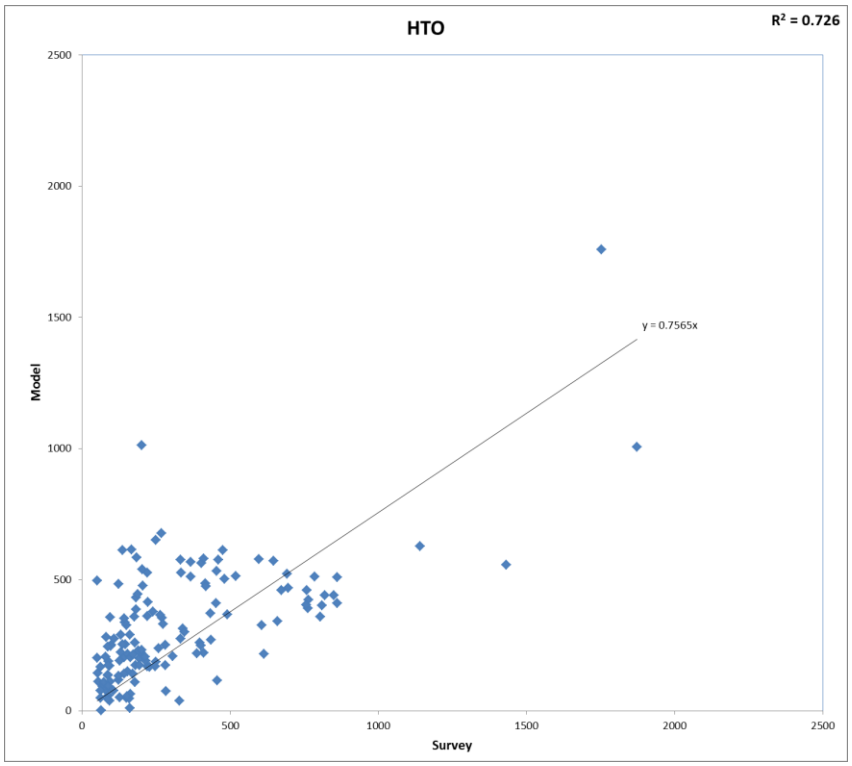




INT Attraction Trip End Validation Plots
3 Step Model

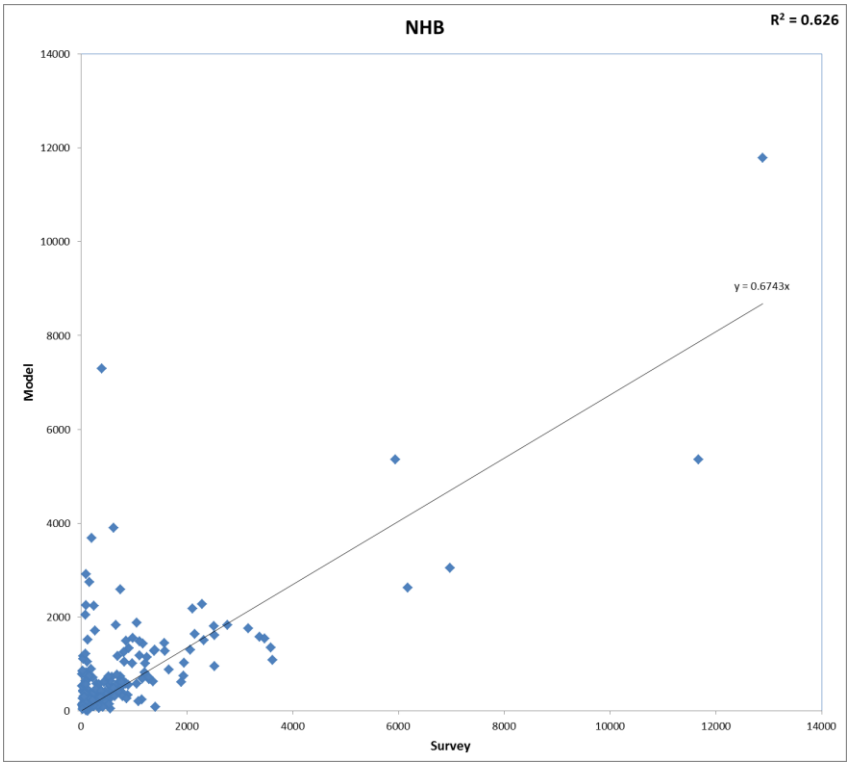
6

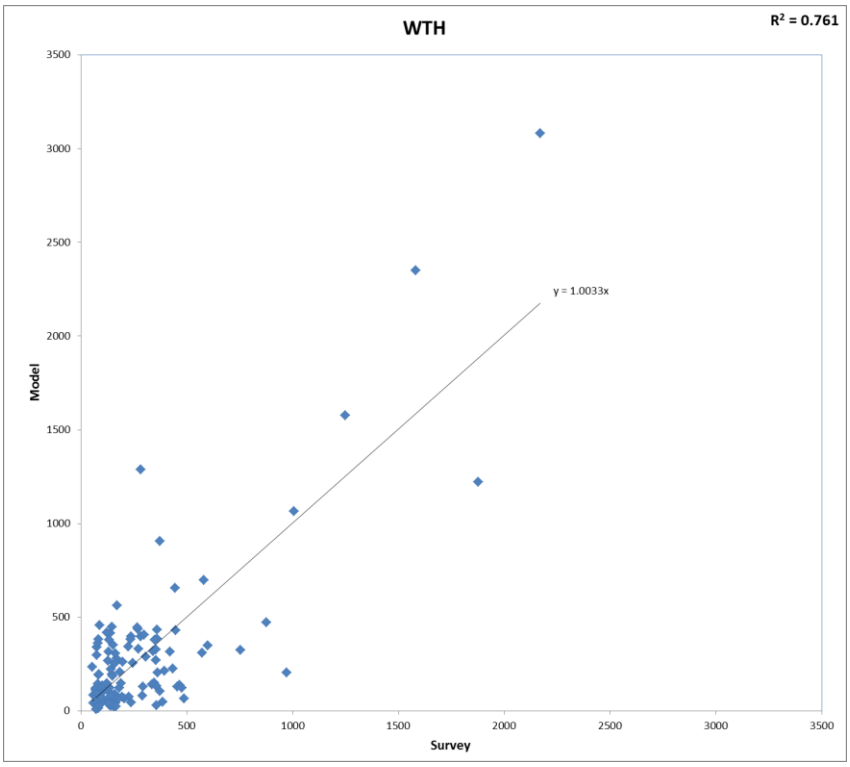




INT Attraction Trip End Validation Plots
3 Step Model

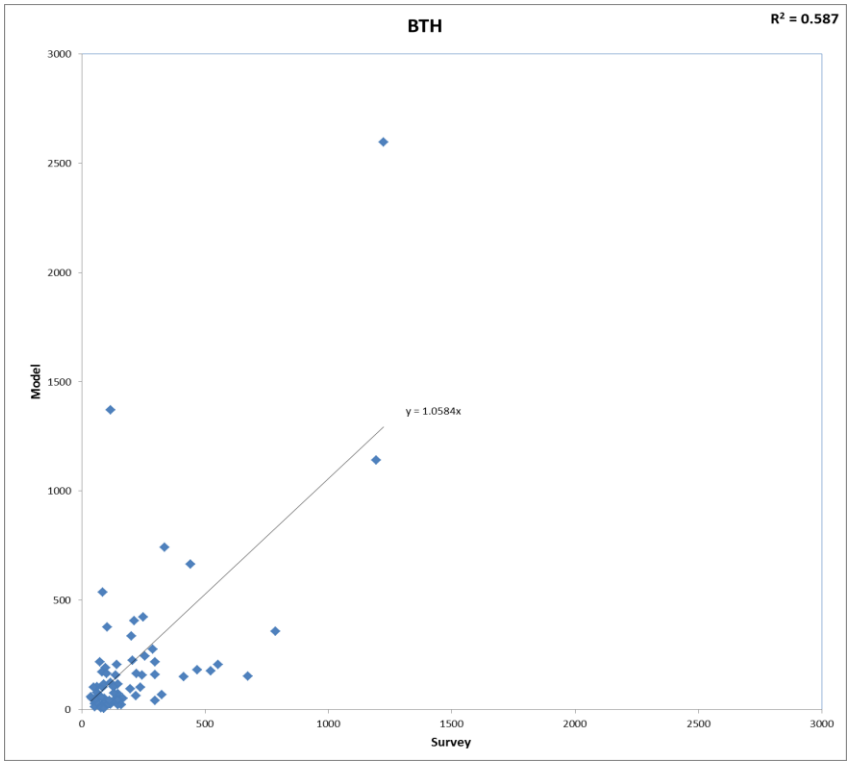
7

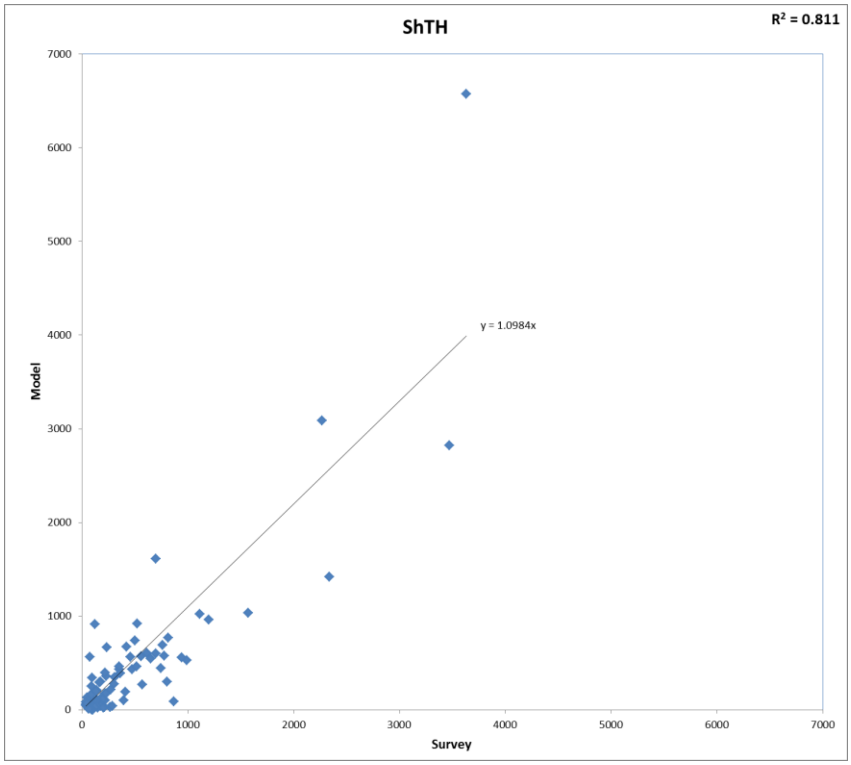




INT Attraction Trip End Validation Plots
3 Step Model

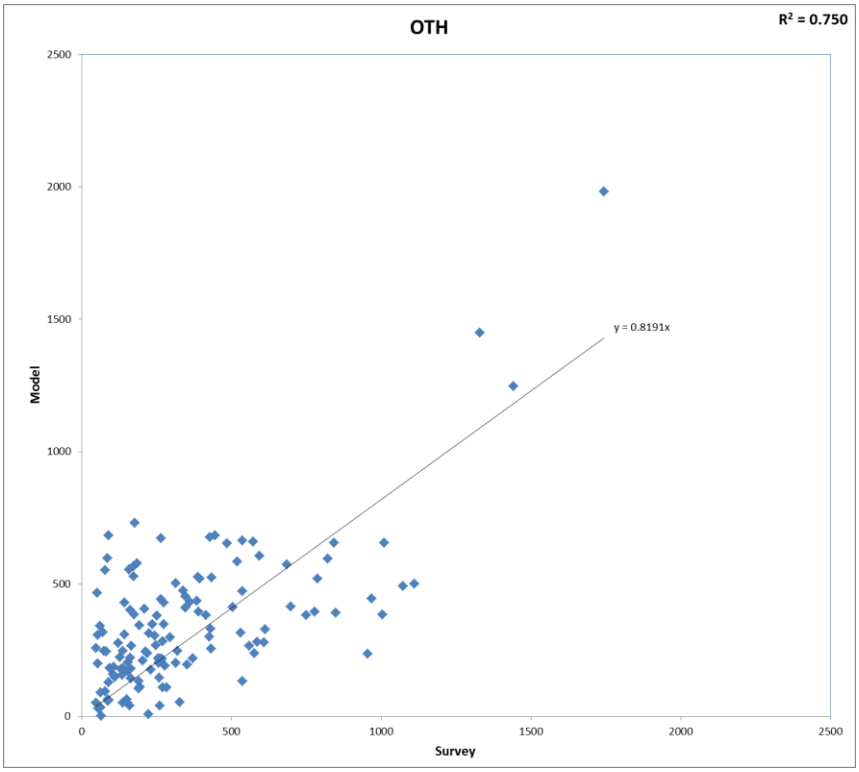
8





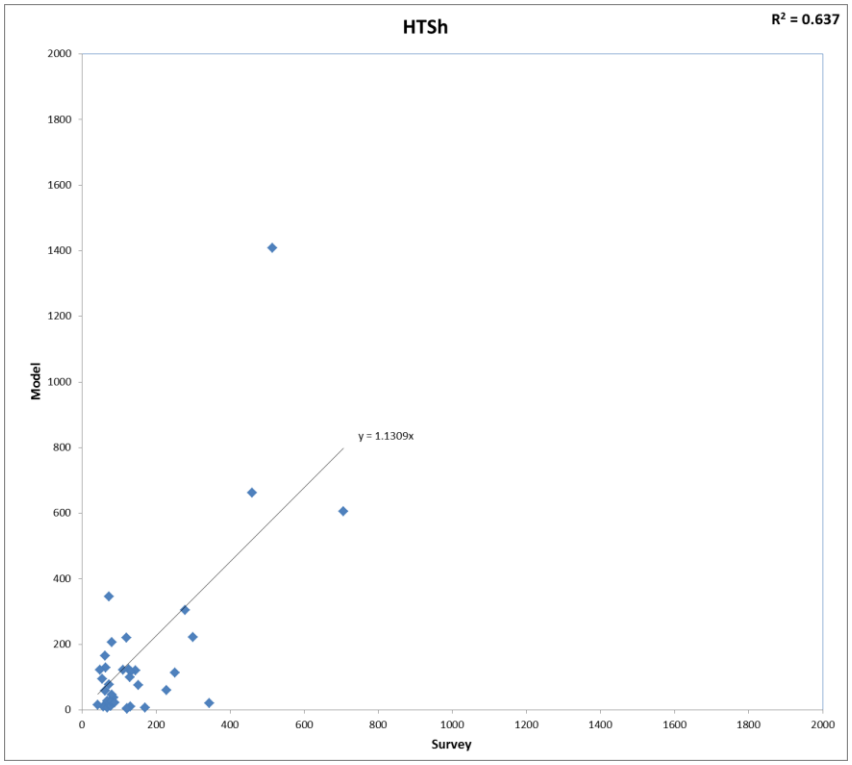
INT Attraction Trip End Validation Plots
3 Step Model

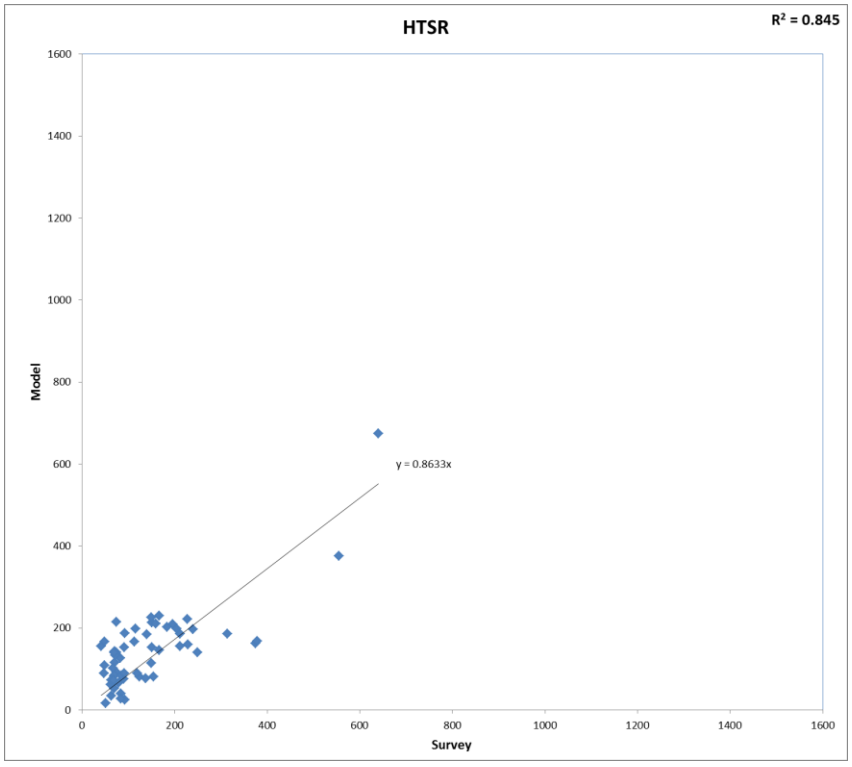
9



INT Attraction Trip End Validation Plots
3 Step Model

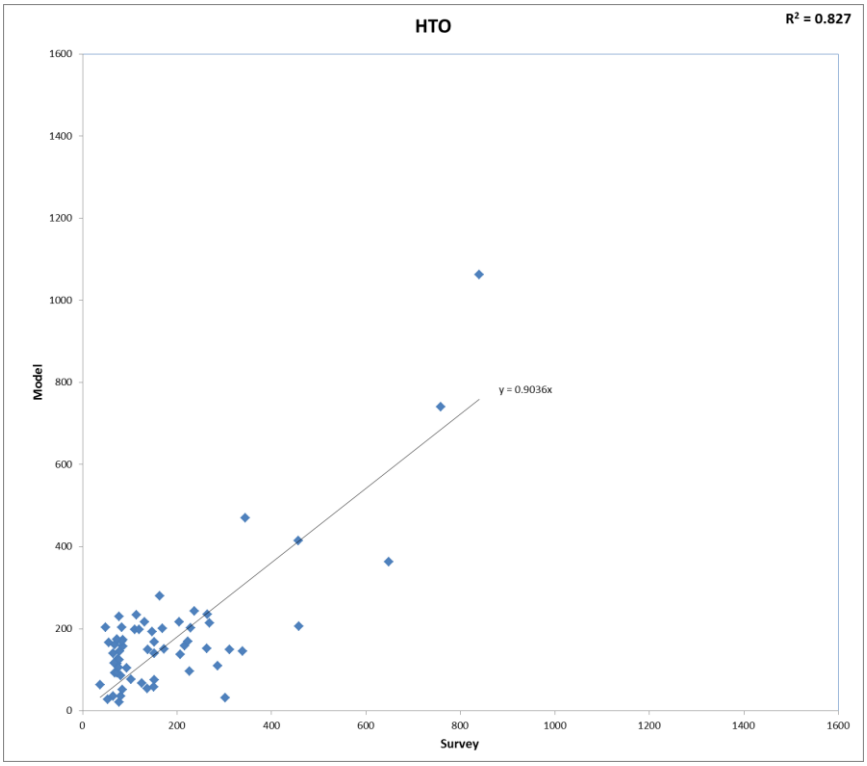
10

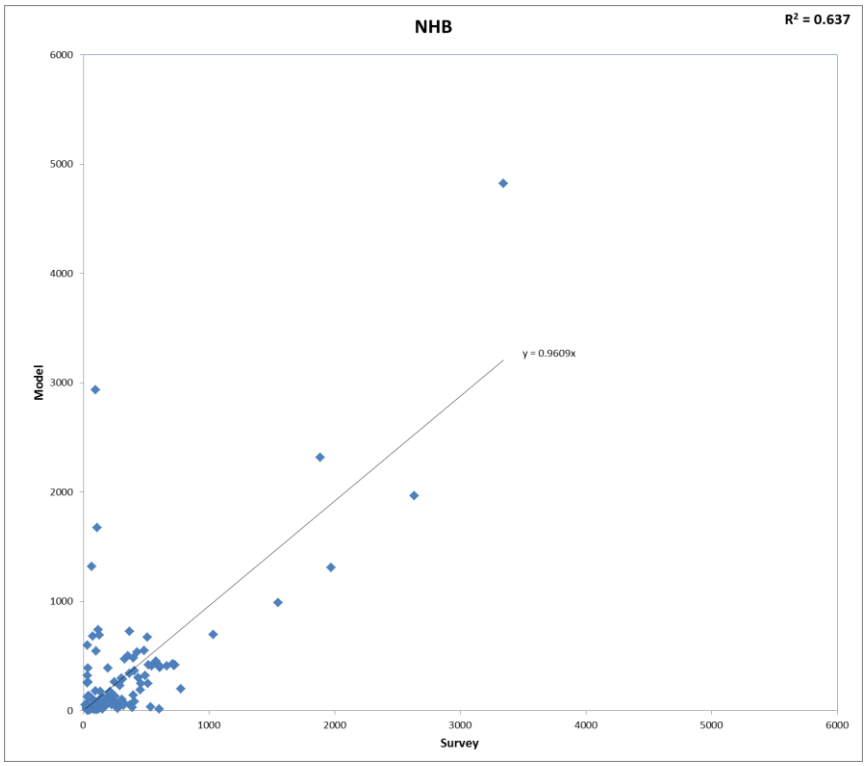




PM Attraction Trip End Validation Plots
3 Step Model

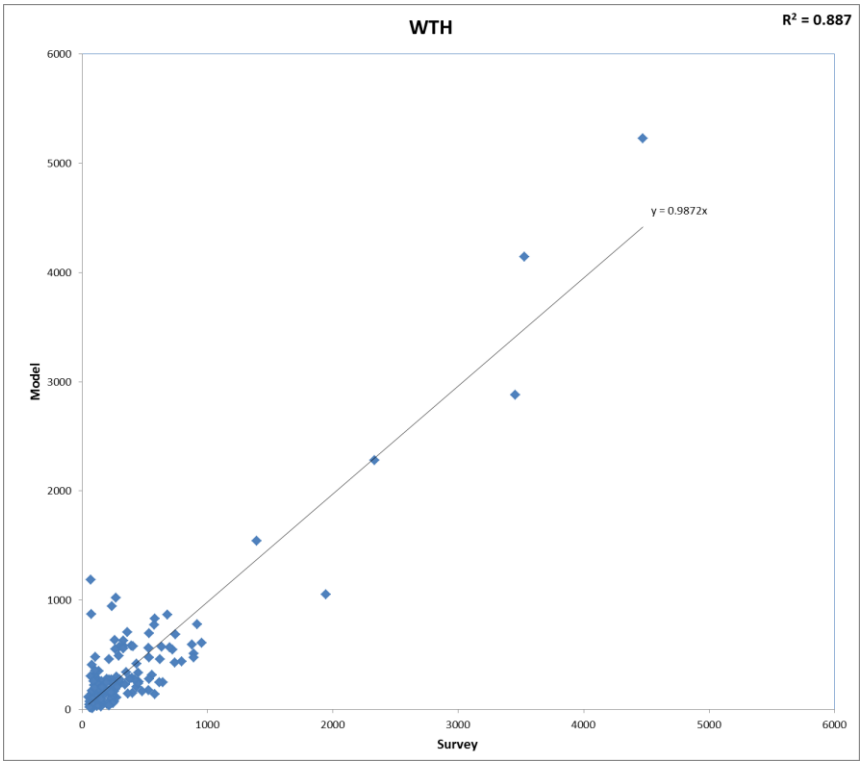
11

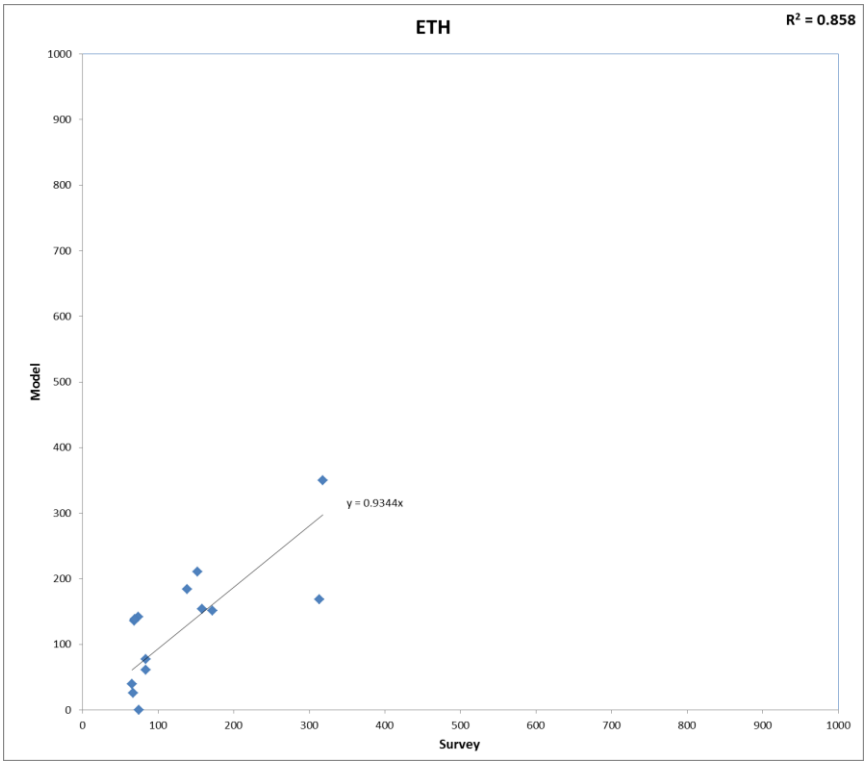




PM Attraction Trip End Validation Plots
3 Step Model

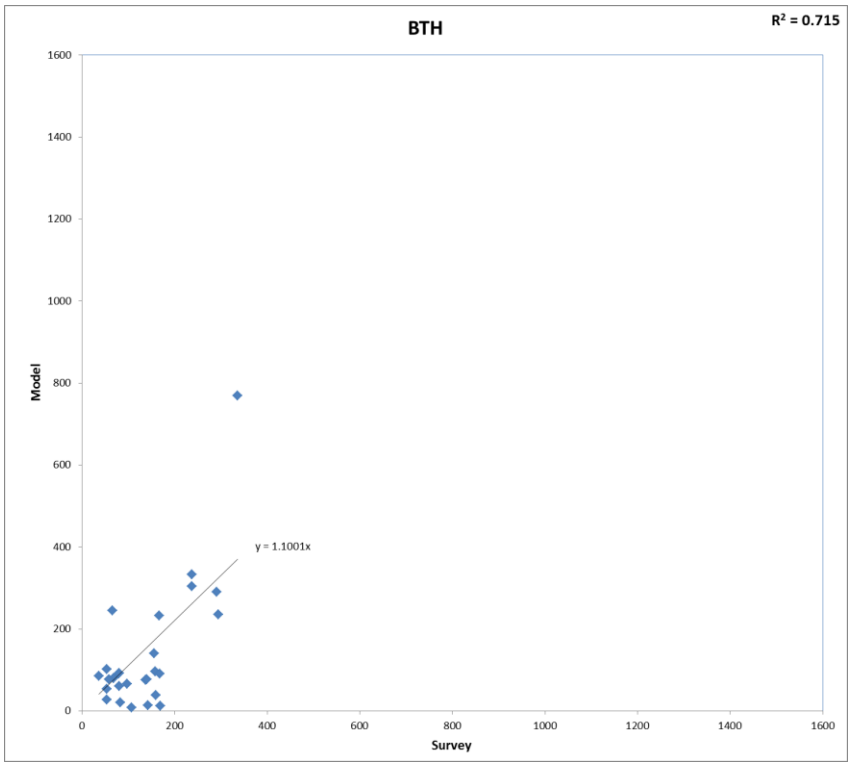
12

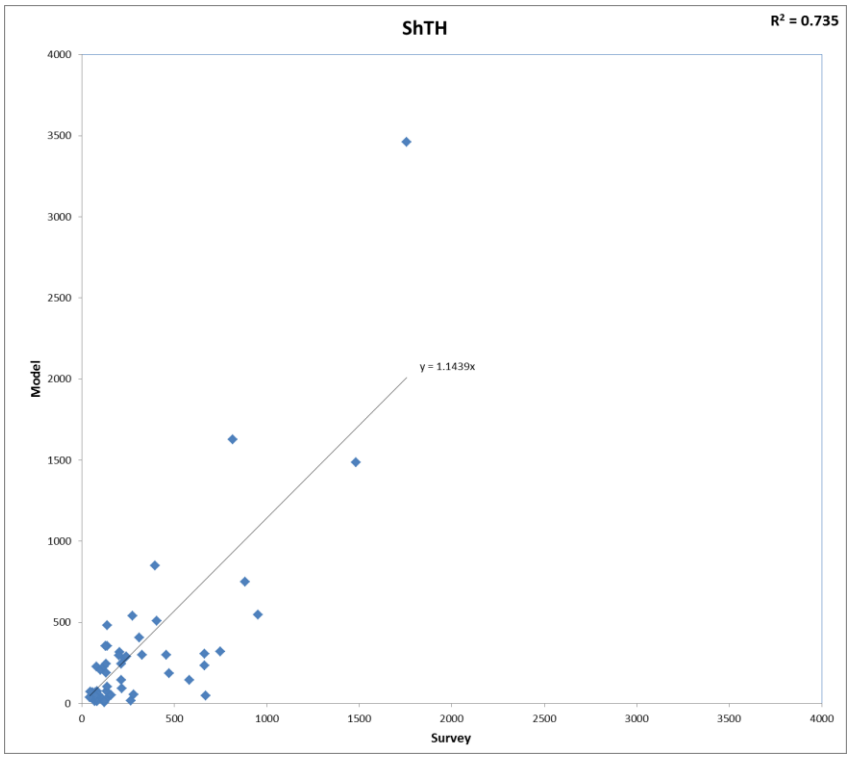




PM Attraction Trip End Validation Plots
3 Step Model

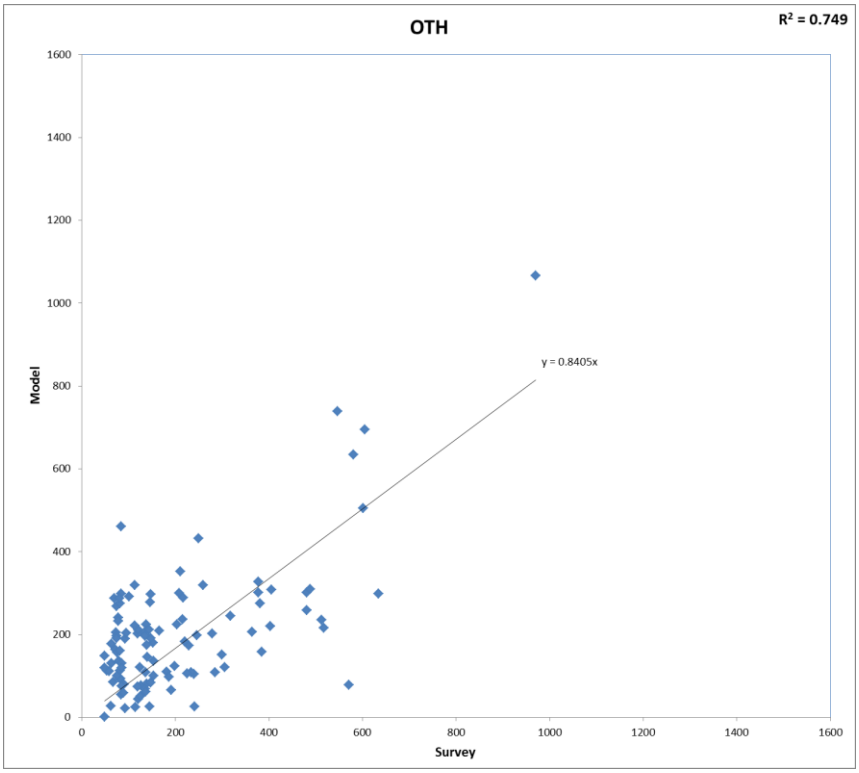
13





PM Attraction Trip End Validation Plots
3 Step Model

14



PM Attraction Trip End Validation Plots
3 Step Model

15

10. Four Step Model Validation of Attraction Trip Ends

The calibrated four step attraction equations have been included in the model and the resultant number of modelled trip ends by AU zone from the validated model have been compared against the HIS trips ends by AU zone. This comparison is intended to show how well the modelled trip ends validate against survey.

Note that given that the comparisons are included at AU zone level, there are a large number of zones with few survey households, meaning there will be a few outliers as a result especially for trip purposes with low levels of activity. The scatterplots for each modelled period (morning peak and interpeak only) are included in Figure 16 through Figure 25 for each trip purpose.

Each of the plots included an R^2 statistic, which measures goodness of fit. In general terms an R^2 of over 0.5 indicates there is a significant level of correlation between the two variables. It is important, however, to reiterate that with results calculated at zone level and with many of these zones having only a few surveyed households, it is difficult to address the issue of outliers.

In Table 6 the total number of expanded HIS trips are reported with those purposes with fewer than 100 sampled trips surveyed (based on an average expansion factor of 100) in the corresponding time period presented in bold. These are generally those with the worst fit in the following tables which is not altogether unexpected given that the scatterplot analysis has been undertaken over nearly 200 zones, meaning the average number of sampled trips per zone is no greater than 0.5 in these instances.

FOUR STEP MODEL (PERSON TRIPS)		
Trip Purpose	**AM Peak**	**INT Peak**
Home to Work	61092	34019
Home to Education	55674	**8118**
Home to Business	**4774**	**25092**
Home to Shop	**5387**	**41407**
Home to Social/Rec	**9002**	36244
Home to Other	49967	47634
Non Home Based	56171	340549
Work to Home	**2877**	41779
Education to Home	**291**	**53701**
Business to Home	**1139**	**19682**
Shop to Home	**1812**	**50646**
Soc/Rec to Home	**2491**	32550
Other to Home	11719	59057
Total All Purposes	**262395**	**790479**

Table 6: Total Expanded HIS Trips by Trip Purpose and Time Period

The total modelled trips by trip purpose are reported in Table 7 and compared against the HIS trips in Table 8.

FOUR STEP MODEL (PERSON TRIPS)		
Trip Purpose	**AM Peak**	**INT Peak**
Home to Work	60525	**37593**
Home to Education	**55946**	**9028**
Home to Business	**5103**	**23813**
Home to Shop	**5050**	**38493**
Home to Social/Rec		
Home to Other	58551	**80199**
Non Home Based	54940	350512
Work to Home		44847
Education to Home		**55039**
Business to Home		**20480**
Shop to Home		**47023**
Soc/Rec to Home		
Other to Home	**20307**	**88453**
Total All Purposes	260420	795481

Table 7: Total Modelled Trips by Trip Purpose and Time Period

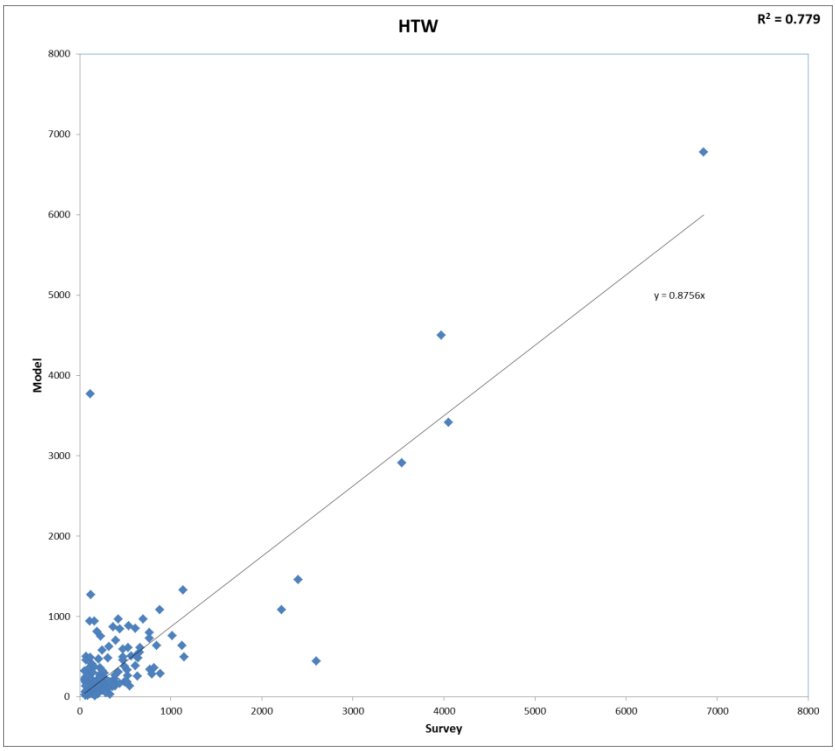
Note: Those purposes blanked out are added to the 'other' categories.

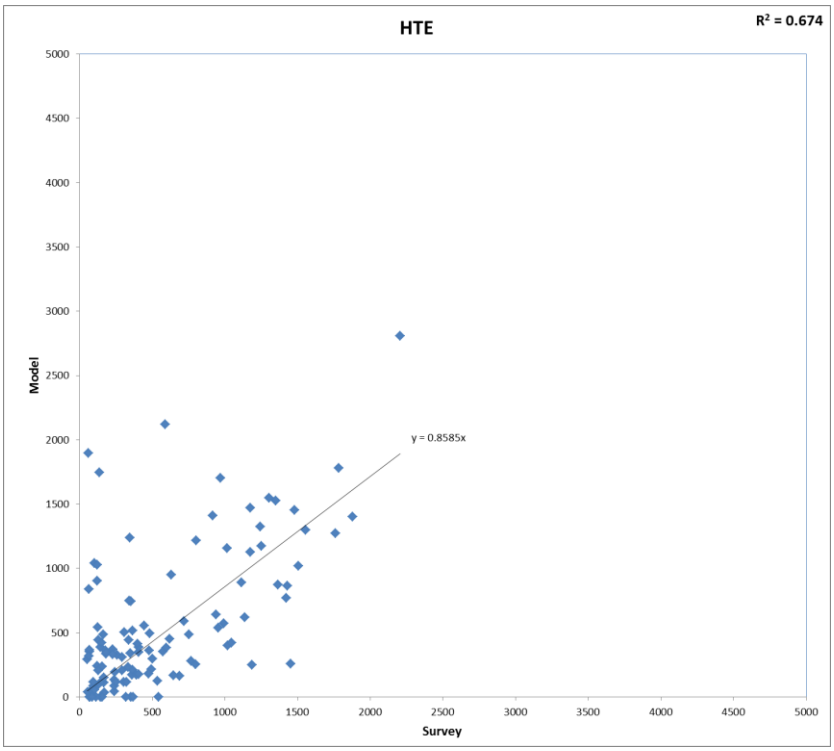
FOUR STEP MODEL (PEFRSON TRIPS)		
Trip Purpose	**AM Peak**	**INT Peak**
Home to Work	-0.9%	**10.5%**
Home to Education	**0.5%**	**11.2%**
Home to Business	**6.9%**	**-5.1%**
Home to Shop	**-6.3%**	**-7.0%**
Home to Social/Rec		
Home to Other	-0.7%	**-4.4%**
Non Home Based	-2.2%	2.9%
Work to Home		7.3%
Education to Home		**2.5%**
Business to Home		**4.1%**
Shop to Home		**-7.2%**
Soc/Rec to Home		

FOUR STEP MODEL (PEFRSON TRIPS)		
Trip Purpose	**AM Peak**	**INT Peak**
Other to Home	**-0.1%**	**-3.4%**
Total All Purposes	-0.8%	0.6%

Table 8: Modelled vs Surveyed Trips by Purpose and Time Period

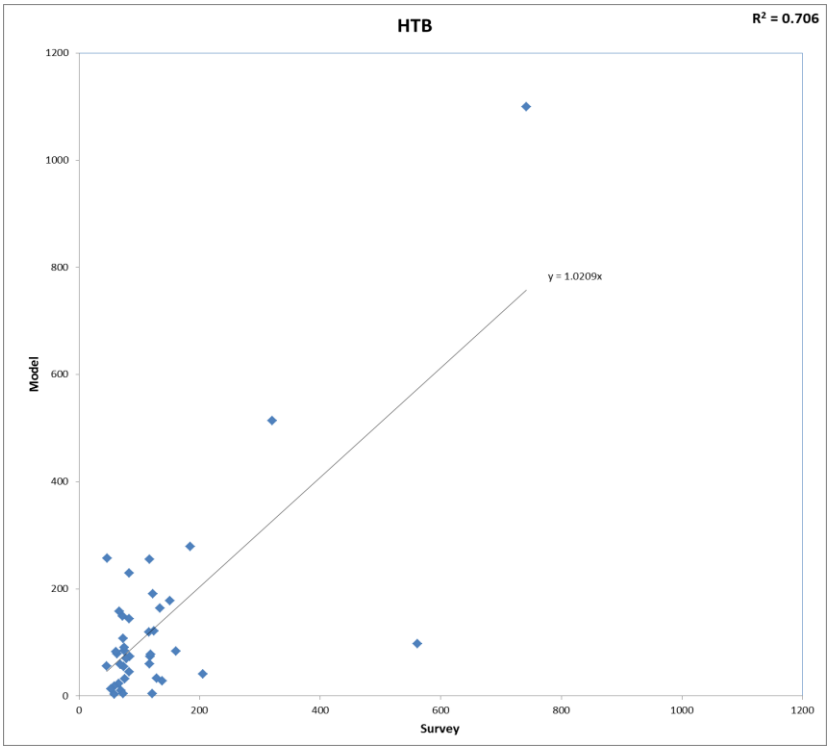
For those trip purposes with very few trips surveyed, the R^2 values are low.

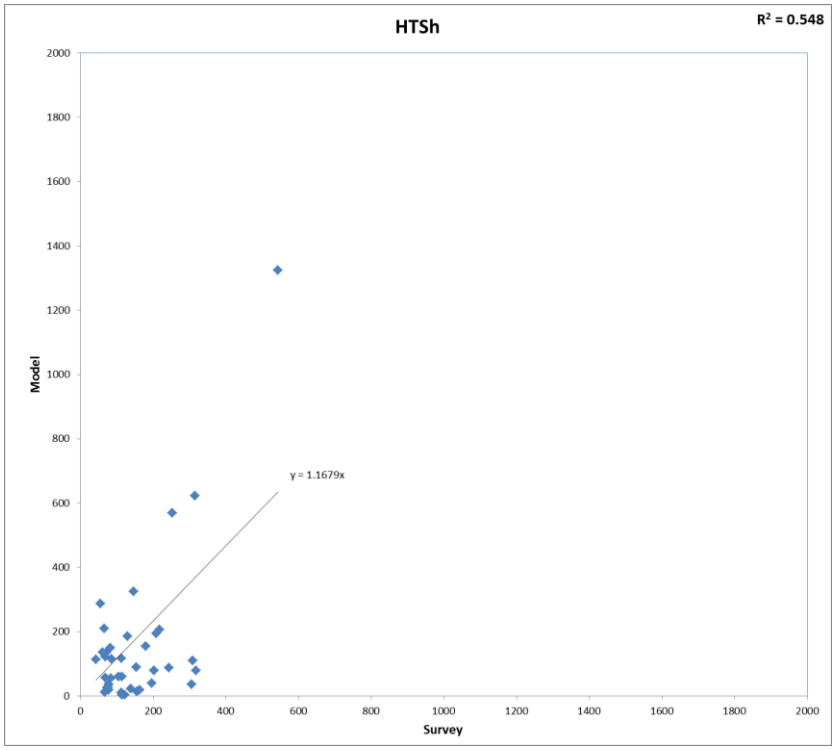




AM Attraction Trip End Validation Plots
4 Step Model

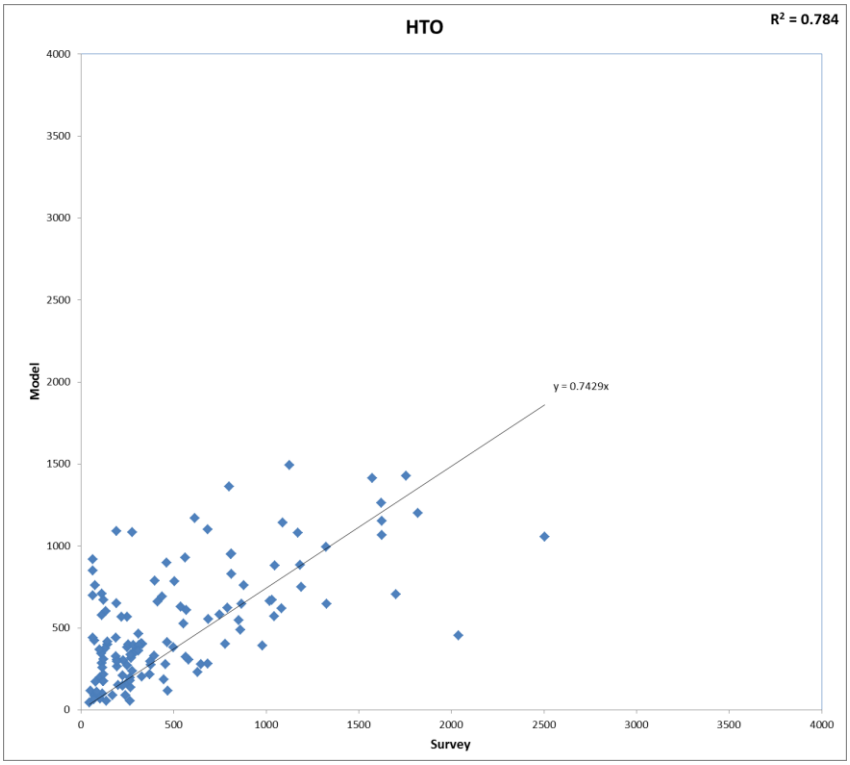
16

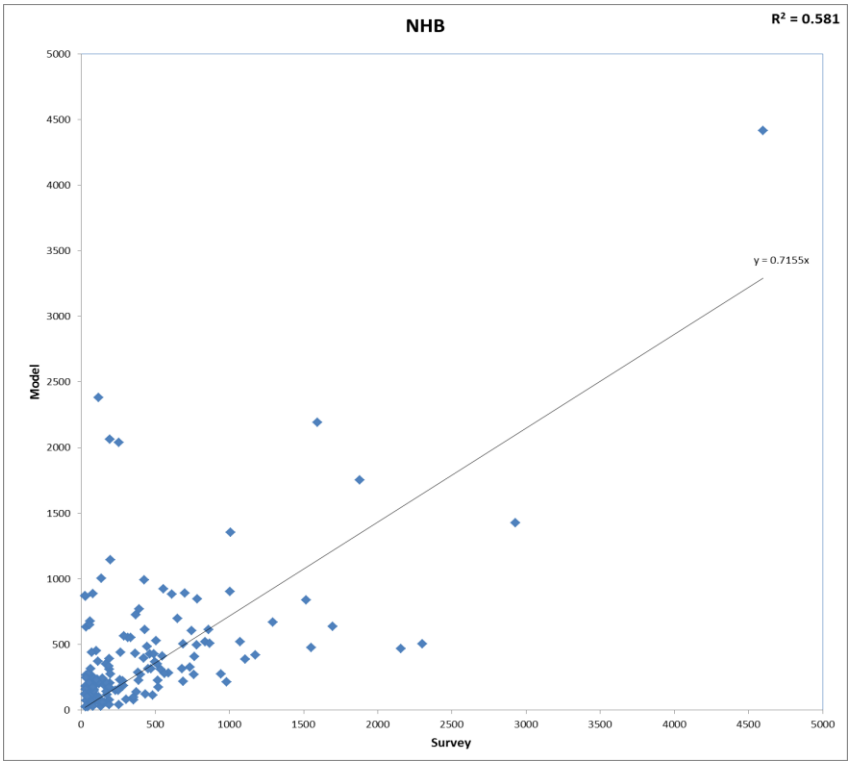




AM Attraction Trip End Validation Plots
4 Step Model

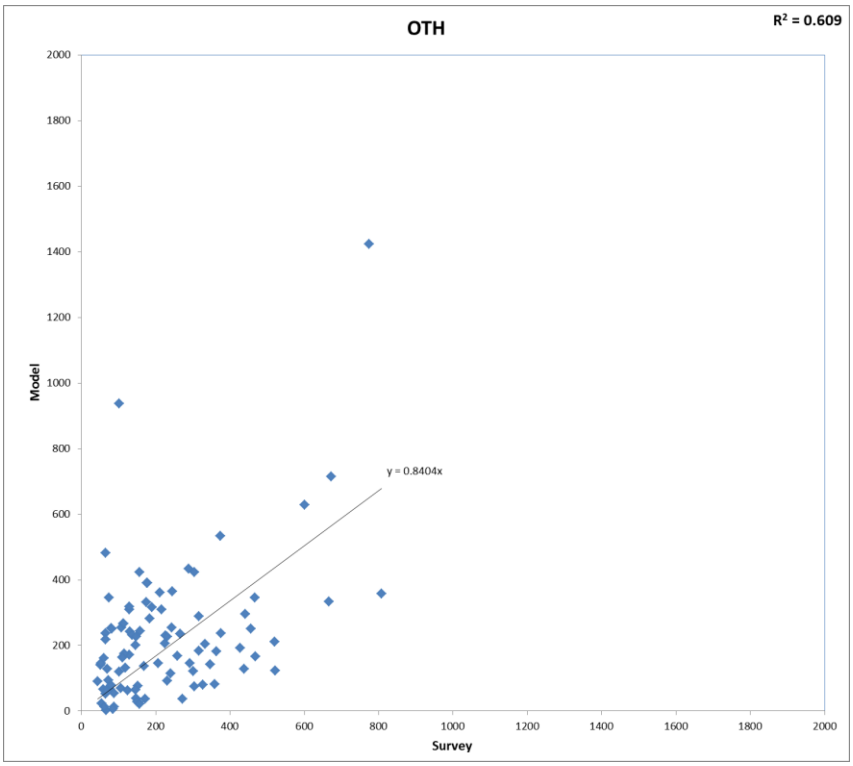
17





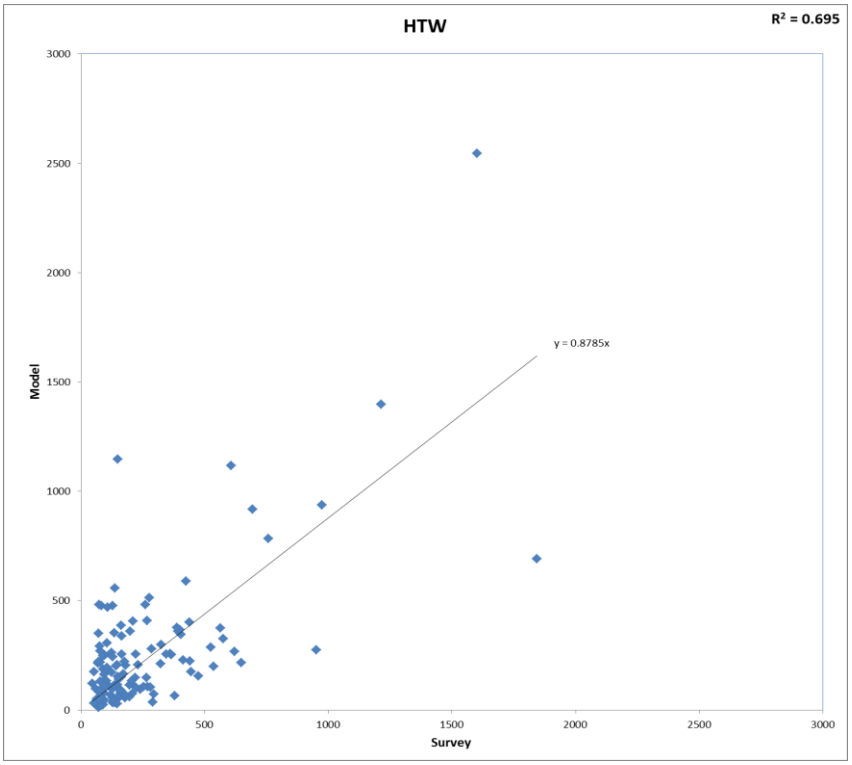
AM Attraction Trip End Validation Plots
4 Step Model

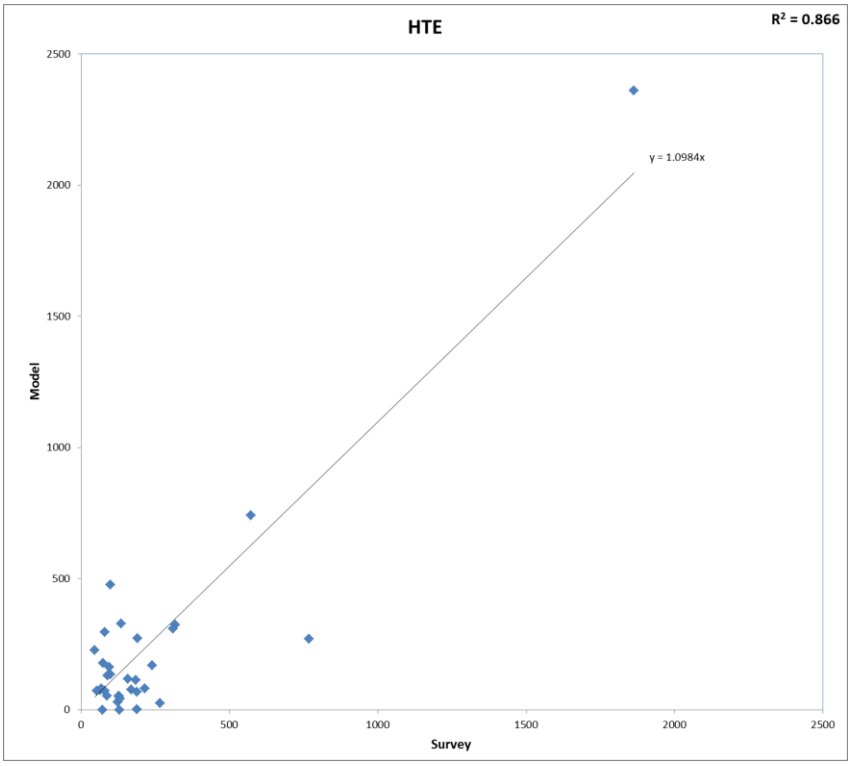
18



AM Attraction Trip End Validation Plots
4 Step Model

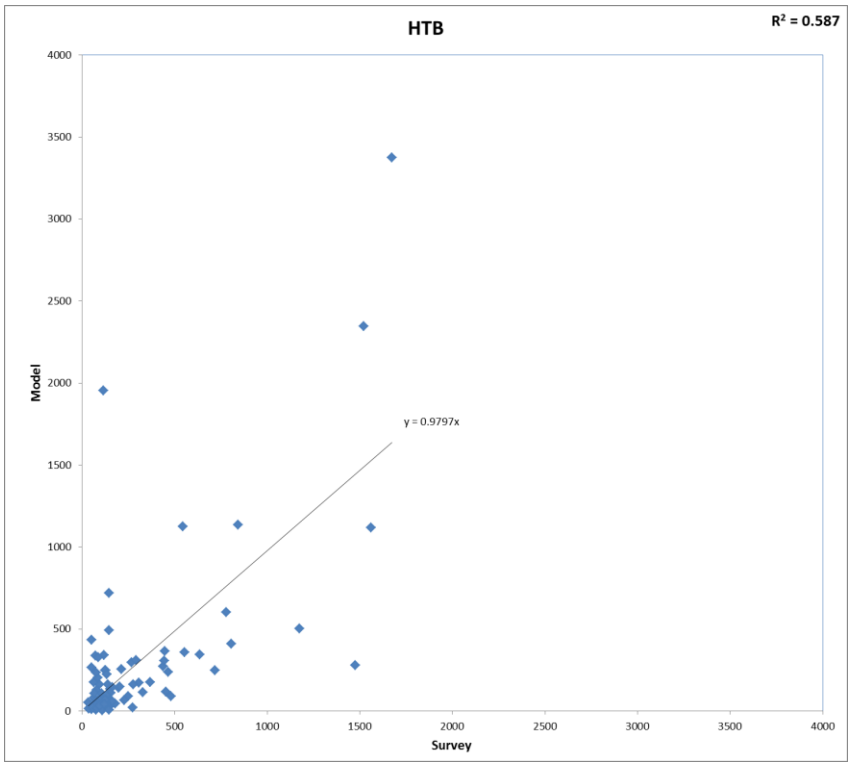
19

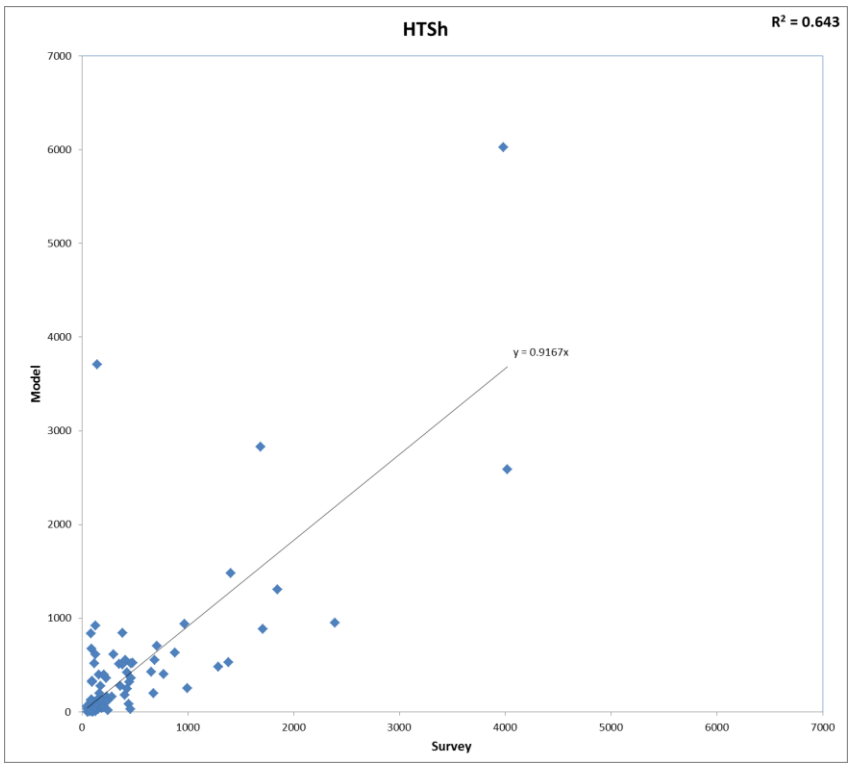




INT Attraction Trip End Validation Plots
4 Step Model

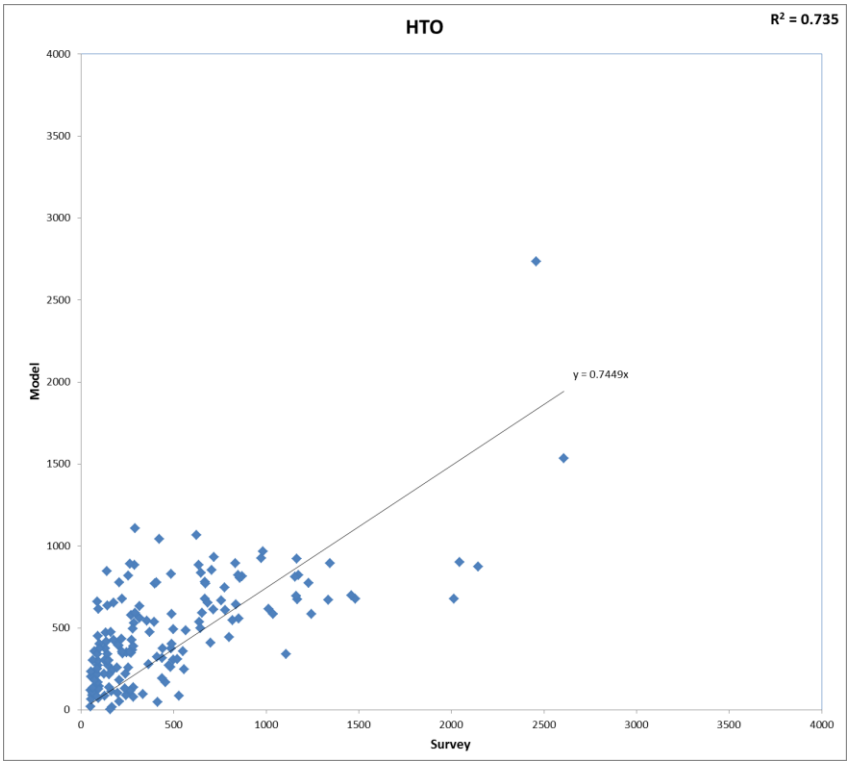
20

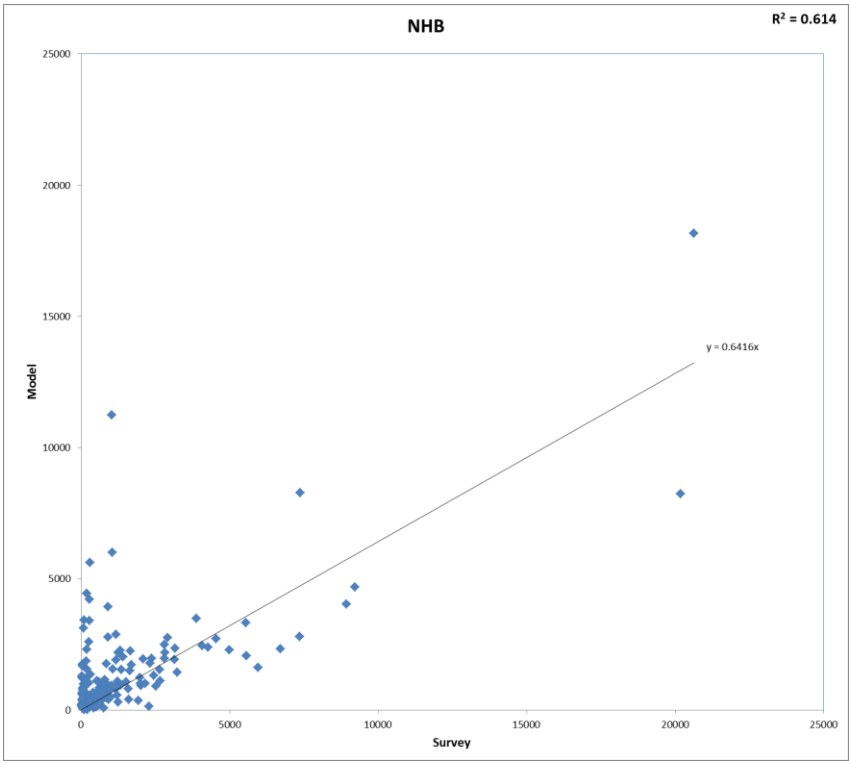




INT Attraction Trip End Validation Plots
4 Step Model

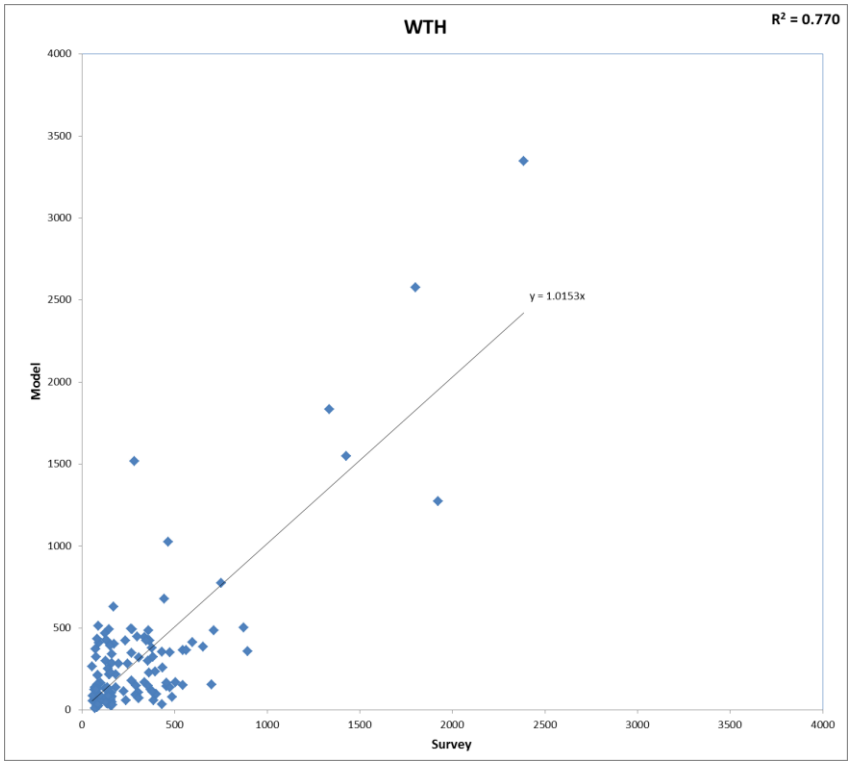
21

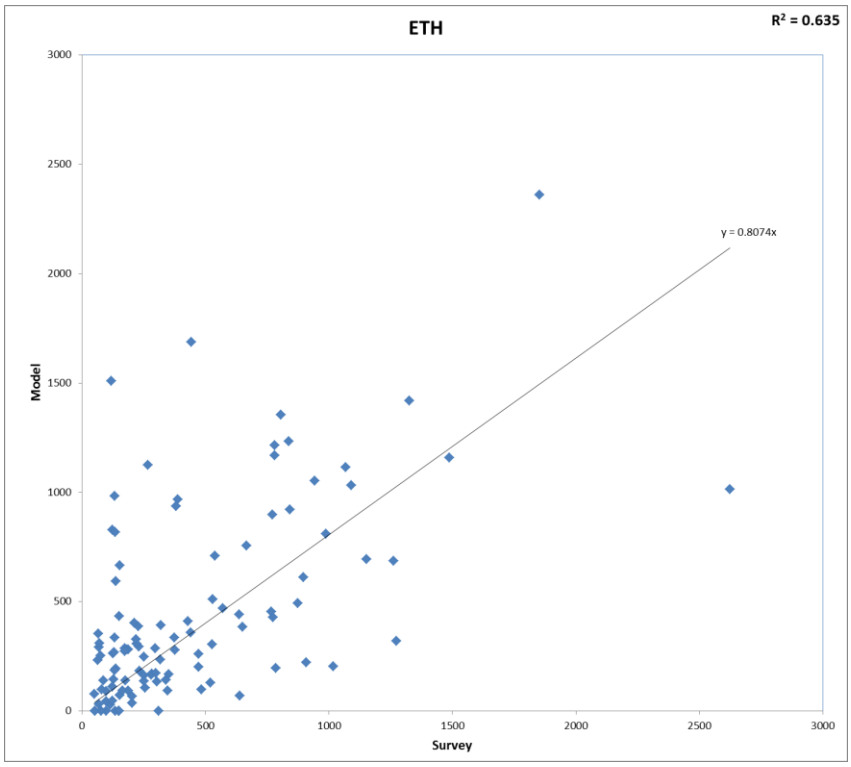




INT Attraction Trip End Validation Plots
4 Step Model

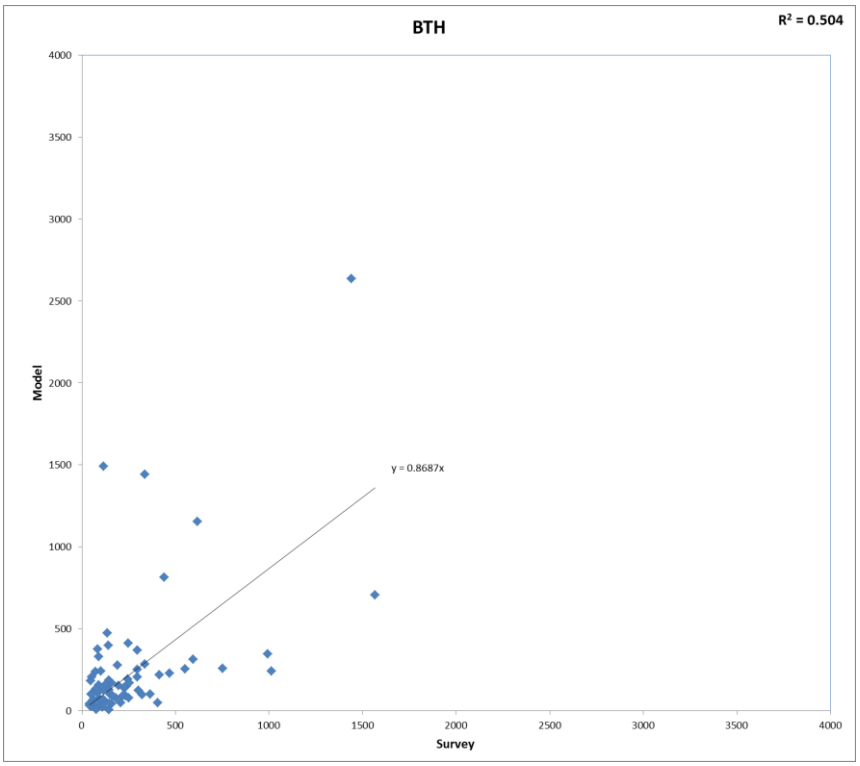
22

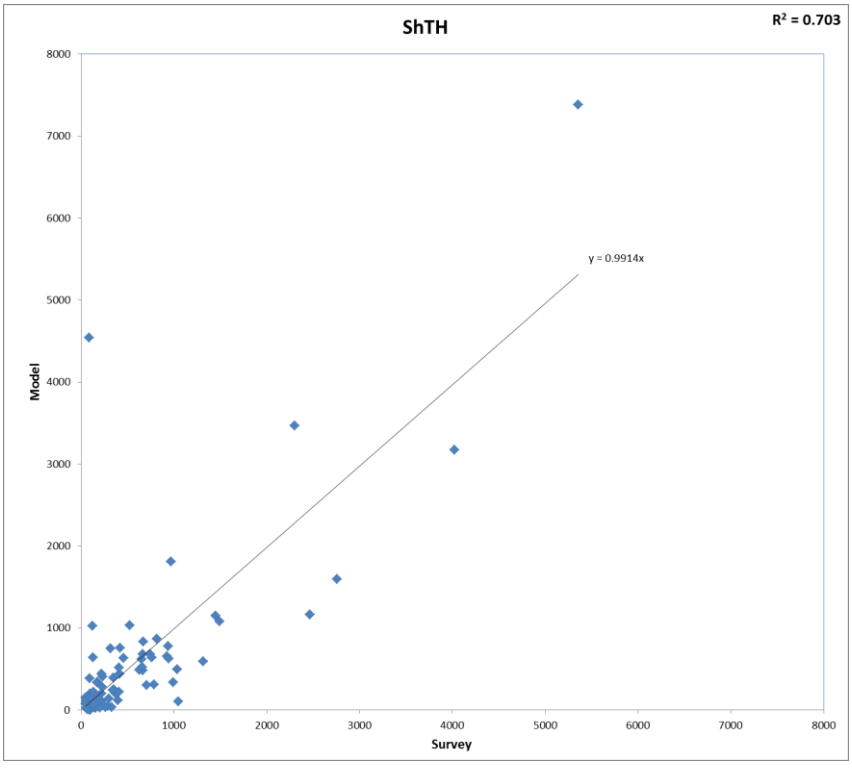




INT Attraction Trip End Validation Plots
4 Step Model

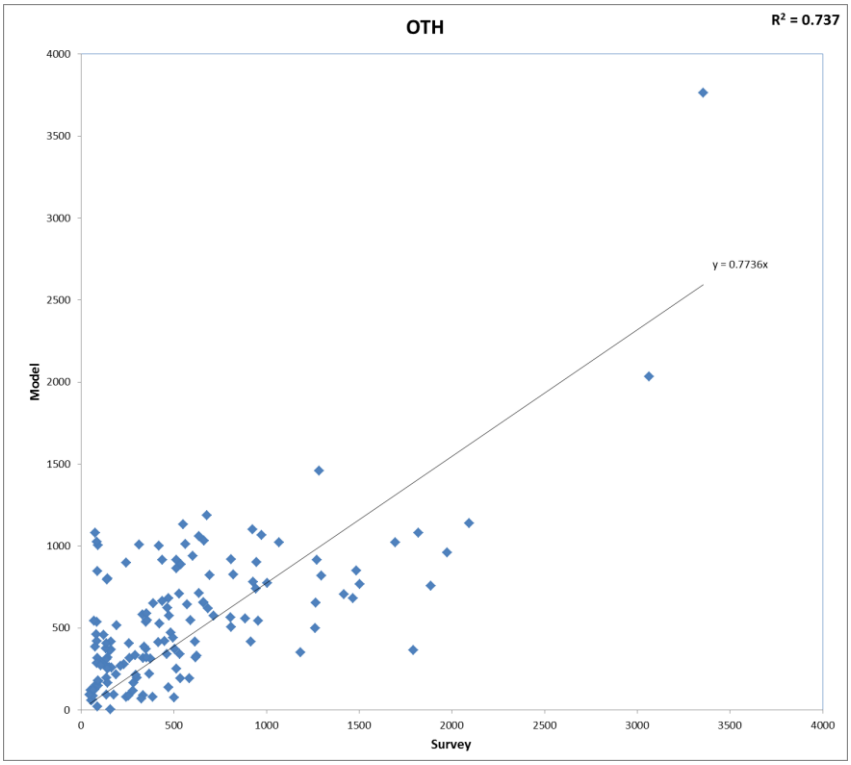
23





INT Attraction Trip End Validation Plots
4 Step Model

24



INT Attraction Trip End Validation Plots
4 Step Model

25