

Wales National Travel Survey: Additional Sampling note

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Additional sampling estimates

Background and summary

Following delivery of the report on Sampling Approaches for the WNTS (11 September 2023) it was agreed with Transport for Wales and the Welsh Government that NatCen would produce some further estimates to help inform the final decisions around: i) the sampling/analysis unit to use for the WNTS (household or individual) ; ii) the approach to selection if using an individual level approach; and iii) the preferred approach to disproportionate sampling.

The additional estimates will firstly calculate the diary sample size required to meet a defined precision requirement.

Welsh Government published its second carbon budget plan, Net Zero Wales, in 2021. The Plan sets out how Wales will meet its second carbon budget and build the foundations for Carbon Budget 3 and the 2030 emissions reduction target, as well as net zero by 2050. This document includes a significant section on the reduction of carbon emissions in the Welsh transport sector, including key targets around mode shift towards the use of sustainable travel and a reduction in car mileage.

A number of these targets will be informed by the new WNTS. Two targets identified by Welsh Government in particular are:

- Increase % trip mode share undertaken by active travel (defined as walking and cycling) from a target of 33% in 2030 to 35% in 2040.
- Increase % trip mode share undertaken by public transport (rail and bus) from 7% in 2030 to 13% in 2040.

Of these, the first is the most statistically stringent. It is therefore essential that the survey is able to detect a two-percentage point difference in annual mode share across Wales as being statistically significant.

Secondly, both the survey and the diary are required to inform measures of for the Welsh Transport Strategy (WTS) Monitoring Framework. Although there are no fixed requirements around the precision-level of these estimates, Welsh Government strongly desires regional-level breakdowns.

Therefore, we will calculate the potential responding sample for each region and the associated margins of error for estimates of 5%, 10%, 20%, 30%, 40% and 50%. Because some of the WTS monitoring framework metrics rely on diary data (M1, M4, S5, S17) and some rely on survey data (M5, S11, S12, S15, S18, S20, S24) we will provide this breakdown for both survey estimates and diary estimates, general population, and that it meets the standards required to be badged as a National Statistic. As such, it is vital that it conforms to the principles of random probability sampling. (This rules out all non-probability sampling designs, such as quota sampling.)

Modal share precision requirements

As outlined above, the most stringent requirement of the survey when monitoring modal share is the ability to detect a year-on-year change in estimates from 33% to 35% as statistically significant. This will be for the whole of Wales and will use journeys recorded in the diary as the unit of analysis.

When setting a confidence level of 95% and a power of 80%, detecting a year-on-year change in estimates from 33% to 35% requires an effective sample size of c.8,800.

This is based on the following formula:

$$n = (Z_{\alpha/2} + Z_{\beta})^2 * (p_1(1-p_1) + p_2(1-p_2)) / (p_1 - p_2)^2,$$

where $Z_{\alpha/2}$ is the critical value of the Normal distribution at $\alpha/2$ (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96), Z_{β} is the critical value of the Normal distribution at β (e.g. for a power of 80%, β is 0.2 and the critical value is 0.84) and p_1 and p_2 are the expected sample proportions of the two groups.

Because the unit of analysis will be journeys, this means that when accounting for the design effects associated with both the survey and the travel diary, the WNTS needs to generate an effective sample of a minimum of 8,800 journeys.

A sample of this size will comfortably meet Welsh Government's other stated precision requirement – that is, to detect a year-on-year change in modal share of 7% to 13%. To illustrate, using the same assumptions and calculation stated above, this would require an effective sample of c.390.

The overall sample size required to achieve an effective sample of 8,800 trips is naturally reliant on a number of assumptions, around the number of productive cases per household, the average number of trips recorded per day, and the design effect of weighting the diary data. Given the novel nature of the proposed design of the new WNTS, there is little robust empirical data on which to base these assumptions. As such, we are reliant on estimates. For the number of productive cases per household, this is based on analysis of other web-first surveys and expert judgement; for the average number of trips recorded per day, this is based on figures recorded in the 2022 NTS (which uses a significantly different design, so should be used as a guide only); and for the design effect of weighting the data this is drawn from expert judgement.

The following table outlines these assumptions and, based on these assumptions how many productive surveys would be required to generate an effective sample of 8,800 journeys. Depending on the design, the number of productive surveys required ranges from c.3,500 to c.4,700.

This assumes that two days of travel data are recorded per productive interview. Increasing the number of diary days to three or four would reduce the overall sample size required but would add cost in requiring a follow-up survey to administer the further two travel days. The level of drop-off associated with this follow-up approach is unknown, so we recommend experimenting with collecting travel over further days to explore whether it is beneficial and cost-efficient.

Table 1. Sampling assumptions, effective sample size and productive surveys required

Assumptions	Household level	Individual level		
	All adults	1 adult (Quasi-random selection)	1 adult (Two-stage selection)	Up to 2 adults
Assumed survey DEFF	1.2	1.6	1.25	1.3
Assumed diary weights DEFF (2-day diary)	1.25	1.25	1.25	1.25
Required number of trips (NEFF) to detect 2-point difference (33% to 35%)	8,800	8,800	8,800	8,800
Average number of journeys day 1	1.89	1.89	1.89	1.89
Average number of journeys day 2	1.84	1.84	1.84	1.84
NEFF Diaries required	2,359	2,359	2,359	2,359
Productive diaries required/effective survey sample	2,949	2,949	2,949	2,949
Productive surveys required	3,539	4,718	3,686	3,834
Cost Per Interview	£165 - £195	£185 - £215	£190 - £220	£170 - £200
Illustrative cost	£640,000	£940,000	£760,000	£710,000

Regional-level precision estimates

The productive sample sizes outlined above – to meet the need to generate an effective sample of 8,800 trips – are relatively small and would limit the scope of regional level analysis. That is, they are based on achieving an effective survey sample of n=2,949.

However, if this was distributed proportionally across Wales, it would only generate an effective sample of n=200 in Mid-Wales, and around 650 in each of North Wales and South West Wales. This would mean that an estimate of c.50% would be accurate to +/- 6.9 percentage points in Mid-Wales and +/- 4 percentage points in North Wales and South West Wales.

Therefore, it is clear that to meet the requirement to conduct regional-level analysis of survey data a larger sample is required. (This, in turn, will increase the statistical power of the diary analysis.)

It has previously been discussed with Welsh Government and Transport for Wales that there is a desire to achieve a NEFF of 600 in Mid Wales, but also interest in a NEFF of 400, if the costs of achieving 600 is prohibitive. As outlined in the Sampling Approaches report, we recommend using disproportionate sampling to achieve these minimums – doing so would be more cost efficient than simply aiming for a proportionate sample.

The optimal amount of disproportionate sampling, and therefore the total target sample size, will be determined by balancing the available budget against the level of precision. It will require detailed costings to understand exactly what can be achieved within the budget and how that is most efficiently distributed across regions.

In the Sampling Approaches report (see Cornick, Aizpurua, & Howe 2023) we outlined potential sample size targets to achieve a NEFF of 600 in Mid Wales, and the associated indicative costs.

The table below outlines how generating a NEFF of 600 in Mid Wales might be achieved under each of the four designs under consideration and how the sample might breakdown by region. Please note that this assumes that the design effects would be the same across each region; in practice, the design effect will be different for each variable, so this is illustrative only.

Table 2. Options for achieving effective sample size of 600 in Mid Wales

	Household level	Individual level		
Assumptions	All adults	1 adult (Quasi-random selection)	1 adult (Two-stage selection)	Up to 2 adults
Assumed survey DEFF	1.2	1.6	1.25	1.3
Assumed diary weights DEFF (2-day diary)	1.25	1.25	1.25	1.25

Mid-Wales required base size (to achieve a NEFF of 600)	720	960	750	780
Suggested total base size required	5,500	7,400	5,800	6,000
Illustrative cost	£990,000	£1,480,000	£1,189,000	£1,110,000
Estimated achieved survey sample sizes by region				
North Wales	1,140	1,536	1,204	1,245
Mid Wales	720	960	750	780
South West Wales	1,149	1,547	1,213	1,254
South East Wales	2,491	3,357	2,632	2,721
TOTAL	5,500	7,400	5,799	6,000
Estimated effective survey sample sizes by region				
North Wales	950	960	963	958
Mid Wales	600	600	600	600
South West Wales	958	967	970	965
South East Wales	2,076	2,098	2,106	2,093
TOTAL	4,583	4,625	4,639	4,615
Estimated effective number of trips by region (region based on address of those making the trips)				
North Wales	2,835	2,865	2,874	2,858
Mid Wales	1,790	1,790	1,790	1,790
South West Wales	2,857	2,885	2,896	2,878
South East Wales	6,194	6,261	6,283	6,246
TOTAL	13,677	13,801	13,843	13,772

The table below outlines the potential margins of error for effective sample sizes achieved in the survey, assuming aiming for a total effective sample size of c.4,600. These are given for estimates in the region of 5%, 10%, 20%, 30%, 40% and 50%.

Table 3. Survey margin of error for effective sample size

Region	Estimated effective survey sample size	Margins of error for different estimate levels (95% confidence interval) +/- percentage point					
		5%	10%	20%	30%	40%	50%
North Wales	960	1.4	1.9	2.5	2.9	3.1	3.2
Mid Wales	600	1.7	2.4	3.2	3.7	3.9	4
South West Wales	965	1.4	1.9	2.5	2.9	3.1	3.2
South East Wales	2,100	0.9	1.3	1.7	2	2.1	2.1
TOTAL	4,625	0.6	0.9	1.2	1.3	1.4	1.4

The table below outlines the potential margins of error for the effective number of trips collected in the diary. These are given for estimates in the region of 5%, 10%, 20%, 30%, 40% and 50%.

Table 4. Diary margin of error for effective sample size

Region	Estimated effective number of trips	Margins of error for different estimate levels (95% confidence interval) +/- percentage point					
		5%	10%	20%	30%	40%	50%
North Wales	2,850	0.8	1.1	1.5	1.7	1.8	1.8
Mid Wales	1,800	1	1.4	1.8	2.1	2.3	2.3
South West Wales	2,900	0.8	1.1	1.5	1.7	1.8	1.8
South East Wales	6,200	0.5	0.7	1	1.1	1.2	1.2
TOTAL	13,750	0.4	0.5	0.7	0.8	0.8	0.8

This illustrates that, based on the stated assumptions, it should comfortably be possible to meet the precision requirements around modal share (detecting a year-on-year movement of 2 percentage points at the Wales level) while using a two-day travel diary (although it remains worth exploring the use of a third and fourth day).

Achieving a survey sample NEFF of 600 in Mid Wales would require disproportionate sampling and a total sample greater than is necessary to meet the minimum mode share precision requirements. However, this is feasible and would generate very low margins of error at the overall level.

Therefore, there is scope, if necessary, to reduce the overall sample size if required to meet the budget (therefore increasing the disproportionate nature of the sample), without significantly compromising the precision of estimates at the overall level.

Please note, however, that these estimates are highly sensitive. A slight difference in the design effect or the number of trips recorded per day could have a notable impact on the precision estimates. It is essential, therefore, that these assumptions are fully tested before the sample design is finalised and the survey launched.

At this stage it is necessary to make a decision on the two following design features:

- The preferred sample/analytical unit: household or individual;
- If individuals are selected as the preferred sampling/analytical unit, a preferred approach for within-household selection; and
- Number of diary days

Based on our knowledge of the Welsh Government's information needs, and our detailed assessment throughout the Review, Evaluate & Model stages of the study, we recommend the WNTS is an individual-level survey. We recommend that the up-to-two adult approach is used for selection purposes in the web element of the survey, but that the two-stage selection approach is experimented with to determine whether it offers benefits over the two-adult approach. Finally, we recommend collecting two-days of travel diary data per individual, while experimenting with options to collect data over a third and fourth day to understand whether it is beneficial or cost-efficient to do so.

Based on these decisions NatCen will produce a formal cost estimate to illustrate the cost of the survey (before all assumptions are tested in the experiment phase). If the cost is higher than budgeted, we will work with TfW and WG to explore ways to deliver the survey within budget, through smaller sample sizes or more disproportionate sampling, and outline the associated trade-offs around precision.

Reference

Cornick, P., Aizpurua, E., & Howe, S. (2023). *Wales National Travel Survey: Sampling Approaches Report*. Report prepared by NatCen Social Research for Transport of Wales.

