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## NovaTRAC: A Multi-year Travel Survey Data Collection Program

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**Abstract**

This paper presents a multi-year travel survey initiative from Halifax Regional Municipality (HRM), Canada. The surveys titled the Nova Scotia Travel Activity (NovaTRAC) surveys, were conducted from 2015–2018 in partnership with the province of Nova Scotia and HRM. These surveys focus on household characteristics, member information, health and attitudinal information, and typical weekday travel activity. These characteristics were examined using mailed and online questionnaires and telephone surveys. A custom Computer Assisted Web Interviewing (CAWI) survey tool was developed for data collection. Utilizing this method, approximately 12,000 households were contacted during the 2017–2018 NovaTRAC survey and the completion rate was 19.4%.

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**Keywords:** Household Travel Survey; Computer Assisted Web Interviewing Tool; Long-term survey program.

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**1. Introduction**

This paper presents an overview of the design, conduct and results of the Nova Scotia Travel Activity (NovaTRAC) surveys, with a primary focus on the 2018 NovaTRAC Halifax survey. The NovaTRAC surveys were initiated in 2015 by the Dalhousie Transportation Collaboratory (DalTRAC) in partnership with the Province of Nova Scotia. In 2015 and 2016, the surveys were conducted as a province wide initiative in Nova Scotia. The 2018 NovaTRAC Halifax Survey, however, was funded by the Halifax Regional Municipality (HRM) and began in 2017 with the goal of gathering information on how HRM residents travel to better understand and improve the region's transportation systems.

Although HRM has taken significant steps in recent years to promote sustainable transportation and integrated mobility planning, the region has a significant gap in travel data collection, visualization, and analysis. Although most major cities in Canada undertake travel surveys regularly, none have been conducted in the Halifax area since the mid-1980s. DalTRAC has initiated a comprehensive approach to fill this gap.

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The 2018 NovaTRAC Halifax Survey is the first randomly sampled travel survey in HRM with a large sample size. Approximately 12,000 households were contacted, of which 2,333 completed the survey. The first phase of the survey, a cellular phone-based sample, invited about 2,000 households. The second phase utilized a land line-based sampling approach in which 10,000 survey invitation packages were distributed by mail. The survey asked respondents to provide information about their household and each person who lived there. In addition, each household member was asked to record their travel activities for a 24-hour period of a typical weekday. Respondents could complete the survey online through a Computer Assisted Web Interviewing (CAWI) survey tool developed by DalTRAC, or by mail with a supplied return envelope. Follow-up calls were made to each household by a telephone interviewer, providing an opportunity to respond by phone.

This project offered an opportunity to build a partnership between Dalhousie University and HRM to develop a household travel survey for benchmarking travel behaviour to use in transportation network modelling. More importantly, it establishes a survey methodology, tools and data which will be useful for transportation professionals at the municipal and provincial levels for years to come.

## **2. Background**

### *2.1. Literature Review*

Travel surveys collect data to represent the travel behaviours of a population. These surveys capture respondents' movement across time and space, providing an empirical understanding of a region's travel patterns and promoting better land-use and transportation planning decisions (Inbakaran and Kroen, 2011). Travel behaviour analyses offer insights into choices that households and individuals make daily, such as frequency of trips, mode choice, route choice, and places visited. This type of information is critical in benchmarking current behaviours and monitoring progress against community sustainability goals (Krizek, 2003).

Travel surveys are also critical to developing transport network models. Travel information at an individual level (including origins and destinations) is required to develop travel demand forecasting models that generate key transportation indicators for the assessment of transport investment decisions and their impact on communities. Travel surveys and models have become essential policy analysis and decision-support tools for regional and local transportation planning in many cities across North America. Particularly, technological advancements and visualization techniques have provided tremendous opportunities for the use of travel information in evidence-based policy and decision-making (Habib, 2017).

Many regions in North America conduct travel surveys on a regular basis and use travel demand forecasting models for plan-making and evaluation. For instance, municipalities in the Greater Toronto and Hamilton Area have partnered with the University of Toronto to collect travel behaviour information through the Transportation Tomorrow Survey (TTS) since 1986. The City of Toronto actively develops, maintains, and improves transportation network models using the TTS data. The State of Oregon and City of Portland have developed innovative initiatives in travel behaviour data collection, visualization, and modelling to assist transportation decision-making processes.

### *2.2. Best Practice Review*

Prior to developing the 2018 NovaTRAC survey, a review of best practices and methods for surveying the subject population was conducted. This review focused on multiple travel surveys such as the 2016 Transportation Tomorrow Survey (TTS), the 2015 Edmonton and Region Household Travel Survey (HTS), the 2008 Chicago Regional Household Travel Inventory (CRHTI), and the 2010 Oregon Household Activity Survey.

The 2016 Transportation Tomorrow Survey (TTS) survey was conducted on behalf of 22 local, regional, provincial and transit operating agencies in the Greater Toronto and Hamilton Area (GTHA) and surrounding regions (TTS Transportation Information Steering Committee, 2018). The 2016 TTS is the seventh in a series of comprehensive travel surveys conducted every five years in the GTHA and surrounding areas. The TTS contains detailed demographic information on all members of a surveyed household and a ledger of travel information for an entire weekday (TTS Transportation Information Steering Committee, 2018). This survey used telephone subscriber

directories from 1986-2006 and was conducted by telephone. Currently, the survey utilizes telephone interviewing, mailing, and online platforms, while it uses Canada Post's database of mailable addresses for mailing purposes (TTS Transportation Information Steering Committee, 2018). In 2016, 36% of participating households completed the survey via telephone interview and 64% completed the survey online (TTS Transportation Information Steering Committee, 2018).

The Edmonton and Region Household Travel Survey (HTS) 2015, was administered to determine the nature of travel patterns (City of Edmonton & R.A. Malatest & Associates Ltd., 2018). Previous surveys conducted in 1994 and 2005 served as a significant resource for understanding travel behavior of the region. Survey participants were selected based on residential mailing addresses within the Edmonton Region. Those households who agreed to participate in the survey were assigned a travel day and each member of the household was asked to record their travel log. Household, person, and travel information were collected either online or via phone interviews with trained surveyors. Overall, approximately 21,000 survey completions were obtained after data validation which corresponds to an overall sample of 4.1% of households in the survey area (City of Edmonton & R.A. Malatest & Associates Ltd., 2018).

The Chicago Regional Household Travel Inventory (CRHTI) is a comprehensive study of the demographic and travel behavior characteristics of residents in the Chicago Metropolitan area (Bricka, 2007). The primary objective of the study was to provide data for the continuing development and refinement of the regional travel demand forecast models. Data were obtained using standard travel survey methods through the Travel Tracker Survey (Bricka, 2007). A dual frame sampling approach, combining the strengths of Random Digit Dialing (RDD) with the complete coverage of the Directory/Address-based samples, was employed in this study. This approach provided a more comprehensive coverage of the study area, more accuracy in locating the survey universe, and higher efficiency in contacting the households in the survey universe (Bricka, 2007). The full study ran from January 2007 through March 2008. In total, 25,845 households were recruited to participate in the study and 14,390 provided travel data. The overall response rate was 11% (this included a 19% recruitment rate and a 56% retrieval rate) (Bricka, 2007).

The Oregon Household Activity Survey is a multi-year comprehensive study of travel behavior within the State of Oregon. Although the survey focuses on the entire State of Oregon, it is broken down into five study areas. The primary objective of the full study is to obtain travel behavior data from residents throughout the state of Oregon to update the regional and state transportation models (Oregon Modelling Steering Committee, 2011). The survey utilized a mailed household travel diary for all trips occurring over a 24-hour weekday period (beginning at 3 am and ending at 2:59am). The travel day for each household was preassigned. This allowed for retrieval interviews to be scheduled to retrieve the travel data recorded for the household (Oregon Modelling Steering Committee, 2011). To ensure data confidentiality, the data files used a 7-digit unique identifier to link each household's data together and all identifying information was stripped prior to the release for public use. The survey focused on four key variables: household data, person data, vehicle data, and trip data (Oregon Modelling Steering Committee, 2011). The Oregon Household Activity Survey used a stratified sampling method which made assumptions based on the study universe, sampling frame, and target number of completes (Oregon Modelling Steering Committee, 2011).

### 2.3. Overview of NovaTRAC

Nova Scotia Travel Activity (NovaTRAC) was developed in 2014 by DalTRAC in collaboration with the Province of Nova Scotia and Halifax Regional Municipality. Since then, the NovaTRAC surveys have continued to build and improve on the results of each completed survey.

Building on the feedback and results of the first NovaTRAC survey conducted in 2015, the 2016 version collected information Province wide regarding when, where and how people traveled to assist in measuring and monitoring sustainable transportation and emission indicators for the province. It also included health status and personal attitudinal questions to assist in investigating the effects of transportation choice on health and wellbeing. This survey was delivered as a web survey through the DalTRAC Computer-Assisted Web Interviewing (CAWI) survey software only. A comparative study for 2015 and 2016 surveys reveals that although Nova Scotia's predominant mode choice of work and non-work trips is auto, there is an increase in people using active

transportation modes (i.e., walk and bike). The 2016 survey also included an Energy use and Emission study to assist the province in monitoring emission indicators such as greenhouse gas (GHG) and six Criteria Air Contaminants (CAC) emissions.

In 2018, the course of the NovaTRAC surveys changed with the development of the 2018 NovaTRAC Halifax survey. Unlike its other counterparts, the 2018 NovaTRAC survey focused only on the Halifax Regional Municipality. The 2018 NovaTRAC survey also adjusted the method in which the survey was delivered. The CAWI survey software remained in use but was updated so that online household responses, as well as telephone interviews and mail in data could all be entered into the same software. This survey also focused heavily on telephone interviews accompanied by mail-in survey packages to obtain a higher percentage of individuals who complete the survey.

In 2022 the NovaTRAC Halifax survey has been rebranded as the Halifax Travel Activity (HaliTRAC) survey, which will be launched in April of 2022. This survey is further building upon the success of the 2018 NovaTRAC survey and will be reaching to achieve an even higher volume of households (approximately 30,000 households). The methodology for the 2022 survey will be similar to that of 2018 but will also experiment with social media-based sampling strategies to reduce the cost and reach more of the younger demographic. It will also help gauge the success of some recently implemented sustainability initiatives within HRM such as the Integrated Mobility Plan.

### **3. Methodology**

This section outlines the activities DalTRAC undertook to prepare the NovaTRAC Halifax survey, in alignment with the technical objective of the project. It details the processes of questionnaire design, development of a web survey instrument, deployment of the physical infrastructure to conduct the survey, communication with the public and training of survey personnel. It also details the utilization of social media in the upcoming 2022 HaliTRAC survey, an extension of the 2018 NovaTRAC survey.

#### *3.1. Development of Questionnaire and Travel Log*

The study designed a survey questionnaire and travel log based on best practice review, lessons learned from previous DalTRAC surveys and consultation with HRM. The questionnaire was widely tested by DalTRAC staff and Dalhousie students, practicing planners and engineers, and others. The questionnaire was designed to collect information about household characteristics, household members' information, their health and attitudes, and their travel behaviour over a 24-hour period. The inclusion of health and attitude information is a unique feature of the NovaTRAC survey and will allow for a greater understanding of the social and health-related impacts of travel behaviour in HRM. Due to the nature of this study, DalTRAC sought Ethics Approval from the Dalhousie University Research Ethics Board prior to deployment.

#### *3.2. Survey Instruments*

The 2018 NovaTRAC Halifax survey utilized a multi-instrument data collection approach. DalTRAC created three survey instruments for use in the survey: a paper questionnaire, a telephone survey script, and a web survey tool. The range of survey options was designed to allow respondents flexibility in how they preferred to respond to elicit better participation. All three instruments used the same questionnaire including the travel log, and data from each was integrated automatically as the survey proceeded.

#### *3.3. Development of web survey instrument*

DalTRAC developed a custom computer assisted web interviewing (CAWI) instrument for this project. While a CAWI software package from a commercial vendor was initially explored, an in-house customized solution was preferred which will allow flexible mapping, map search and automatic geocoding. The CAWI system also helped us to collect, store, and maintain the data within the lab server, firewalled by the university. DalTRAC built a

prototype web survey tool in 2015 which was tested in a pilot survey, then developed the first version of the current web survey during the 2016 NovaTRAC survey. The feedback from these developments allowed us to improve the survey tool for the 2018 Halifax survey, considering user interactions, map display issues, geocoding errors, data storage considerations and efficiency in configuring the software. The resulting 2018 CAWI tool was used for all data entry. A customized version was made available to telephone interviewers and to lab staff to enter mail-in surveys. In this way, all data irrespective of the instrument used could be stored, managed, and evaluated on a single platform administered by the DalTRAC team.

### *3.4. Front-end survey site*

The web survey instrument consists of a front-end website built in the PHP language. The tool uses the Bootstrap framework to provide a flexible grid layout and ensure the compatibility of the site with desktop and mobile browsers (e.g., on iPhone or Android phones). Survey questions are stored in CSV data files, allowing non-programmers to change the survey without modifying the underlying program. Custom JavaScript functions were developed for interactive features, such as allowing users to add additional trips to their travel log.

Different versions of the web survey instrument were available for each type of user. For respondents entering the survey directly, a household code was required. This code allowed tracking of survey completions from sampled households. It also allowed respondents to return to complete an unfinished survey. The survey tool generated a page for the individual details and travel log of each household member. Telephone interviewers used a version of the survey that required an interviewer access code and displayed the telephone interview script. DalTRAC staff who entered mail-in surveys used a similarly modified version. The survey recorded the method used to enter data.

As a key aim of the NovaTRAC Halifax was to collect information about travel behaviours, DalTRAC put a great deal of effort into ensuring respondents could enter information about their trips easily and accurately. Selection of trip destinations was done using Google Maps. Integration with Google Places API allowed the respondent to search for a location by address or business/place name. Once the location name is entered, the location is shown on the map for verification; users can also drag a pin on the map to change the location. The location information is immediately stored as an address and latitude-longitude pair. The automatic geocoding and verification of addresses by respondents saved time and improved the quality of data relative to surveys geocoded after data entry.

### *3.5. Back-end database*

Data entered from the survey was stored in a relational MySQL database which comprised three linked tables: households, individuals, and trips. The households table contained household-specific information such as home location. Each row in the household table related to one or more rows in the individuals table, which stored information about the individual such as age, gender, and attitudes. Each individual related to zero or more rows in the trips table, which stored trip-specific information such as departure time and destination. Relations between the three tables were ensured by linked ID fields generated at the time the survey was taken. Name and contact information for the prize draw was collected in a separate table and not linked to the survey data.

For data analysis and export, DalTRAC created a view of the NovaTRAC database that automatically filtered out test data and incomplete surveys. Test surveys were conducted to train telephone interviewers, and the data was flagged as such and filtered before analysis. Due to Dalhousie ethics requirements, incomplete responses were excluded from analysis.

### *3.6. Survey Infrastructure*

All data was collected and kept on a dedicated server owned by and physically located at Dalhousie University and provided in-kind for the project by DalTRAC. The server also hosted the web survey interface, which was only available via a secured (HTTPS) connection for encrypted data transmission. The DalTRAC server has a dual 2.0 GHz Intel Xeon (x64) processors and 32 GB of RAM and runs on the Windows Server 2012 R2 operating system.

with an IIS 8 web server. Access to the server and database was controlled by an IP filter which granted access only to workstations in the physically secured DalTRAC lab.

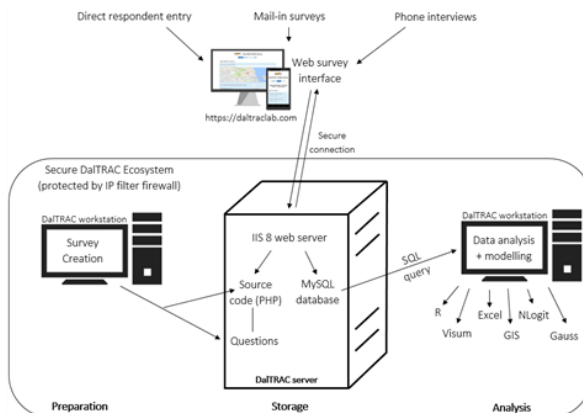


Fig.1. Survey Infrastructure

### 3.7. Public Outreach

To promote participation among selected households, DalTRAC publicized the NovaTRAC Halifax survey in several ways. Promotional tools included webpages, social media accounts, a promotional video, news articles, a radio interview and survey incentives. Earlier NovaTRAC surveys have experienced low response rates in part due to an unfamiliarity of travel surveys in HRM, so communications were designed to inform the public about the survey, including who was conducting it and why it was useful. Informational materials were also available in the survey package to raise confidence in the survey and improve the quality of completed surveys.

To help incentivize potential respondents to participate in the survey, DalTRAC offered participants the chance to be entered to win a \$200 VISA gift card or one of ten \$50 VISA gift cards. The survey incentive was communicated to recipients in the survey materials and through social and traditional media promotions. Respondents could enter the contest by submitting their name and contact information after completing the survey. The draw information was stored separately from survey responses.

### 3.8. Conduct of the Survey

The NovaTRAC Halifax survey invited a random sample of 12,000 households across HRM in two phases. Phase 1 consisted of approximately 2,000 households contacted via a random-digit dialing cellphone sample. Phase 2 consisted of 10,000 households contacted by random address and home phone number selection. In total, the survey sampled 6.4% of HRM's nearly 190,000 households recorded in the 2016 Census.

DalTRAC contracted a third-party CATI (Computer Assisted Telephone Interview) service provider to conduct telephone interviews for both survey phases. DalTRAC established the survey methodology while the third party administered the interviews in consultation with our team. As discussed in Section 3.3, telephone interviewers used the NovaTRAC web survey interface to enter respondent data. Although the third-party vendor employed their own CATI software to assign calls and track calls made, they did not enter any survey data into their system. To obtain the highest probability of reaching respondents at home, calls were made on evenings and weekends. Callers would start an interview by ensuring the respondent was eligible for the survey (resident of HRM age 18 or over), then describing the survey and asking if the respondent consented to participate. If the household could not be reached, interviewers scheduled up to five calls, over the course of a few weeks, until they received a response indicating whether the household wanted to complete the survey. In two months, the service provider completed calling for samples of 5,000 numbers.

### *3.9. Phase 1: Cellphone sample*

The first phase of data collection was conducted October through December 2017 with a sample of approximately 2,000 households. This phase served as a test pilot for telephone interviews. Phase 1 took a Random Digit Dialing (RDD) approach to generate a sample. Approximately 9,800 random numbers were generated in the 902-area code, of which the third-party CATI service provider estimates about 5,200 were actual telephone numbers. Since the 902-area code covers Nova Scotia and Prince Edward Island, and HRM comprises 38% of that area's population, we estimate that about 2,000 real HRM numbers were dialed.

Each selected phone number was first sent an SMS message which invited the individual to participate in the survey on behalf of their household. The text message included a link to the online survey with a household code which would take the respondent directly to the survey page. One week later, a follow-up message was sent with a reminder about the survey invitation. Starting two weeks after the first message, each selected number which has not completed the survey online was called for a telephone interview.

### *3.10. Phase 2: Landline sample*

The second phase of the NovaTRAC Halifax survey consisted of two waves of 5,000 household each, for a total of 10,000 households. The first wave started in June 2018 with telephone interviews until the end of August with the second phase starting in September with interviews until the end of November. The last day to complete the survey was November 30, 2018.

Respondent households were randomly selected from Canada Post's residential address list. Households required a name, address, and phone number to be included in the sample. The boundaries of the sample area were defined by Forward Sortation Area (FSA) and included all FSAs within HRM.

Each household on the list was sent a survey package by mail. The survey package included a: consent letter, letter from the mayor, information brochure, questionnaire brochure, travel log, and prepaid envelope. Households had the option to complete the survey online or to fill it out on paper and mail it back to DalTRAC in the prepaid return envelope. Mailed responses were entered into the web survey tool by DalTRAC staff. Two weeks after each mailing, households who had not completed the survey were contacted for telephone interviews.

### *3.11. Monitoring and quality assurance*

Continuous monitoring and analysis were required during the survey to ensure the target response rate and the overall success of the survey. Throughout the survey, the DalTRAC team monitored incoming data. For example, completion rates for each question were spot checked throughout the survey process and found satisfactory. We also worked closely with the third-party CATI service provided throughout the data collection process. The vendor collected feedback from the telephone interviews and passed along any issues, which were promptly discussed and resolved. To coordinate between the different types of data entry (direct web entry, telephone interview, and mail-in survey), DalTRAC provided the CATI service provider with a secure page which listed all household codes with complete surveys, to be taken off the call list. The telephone interviewer in turn sent us a weekly list of respondents who had requested to be sent a link to the survey. DalTRAC staff then sent a follow-up email to those participants, prompting completion of the survey.

### *3.12. Data quality standards*

Overall, the quality of responses was satisfactorily high. Most survey data did not require any post-survey quality control, however, we anticipated that data from the complex travel log would require some inspection. After the survey was complete, we submitted the travel log data to several checks. We manually inspected any travel logs with trips which had a duration over 2 hours, the same destination as origin, a trip origin or destination outside of Nova Scotia, or a trip which had a speed over three times the average speed for the mode of travel.

Manual inspection determined if a trip was reasonable given its origin, destination, timing, and the characteristics of the individual who made it. For instance, a trip over two hours would be reasonable if the traveller was driving from Halifax to Cape Breton, but not reasonable if they were driving within Bedford. Unreasonable trips were revised if possible and deleted as a last resort. For example, for back-to-back out-of-home activities with an unreasonably long trip between, the respondent was assumed to return home between activities. In a few cases, the respondent apparently searched for a place by name and chose a result in a different city (e.g., a business in Chester, NY instead of Chester, NS). These cases were identified and manually fixed to ensure the quality of the data.

#### 4. Result Analysis/Results

This section introduces the sample collected by the NovaTRAC Halifax survey, including completion rates, composition, and quality of the sample data, and how the sample is weighted for analysis.

##### 4.1. Completion rate

The NovaTRAC Halifax survey invited 12,000 randomly selected households in HRM to participate. Of these, 2,333 households completed the survey, for an overall completion rate of 19.4%.

As described above, the survey was conducted in three parts, with a cellphone (RDD) sample followed by two waves of landline (mailout) samples. Completion rates for the survey improved as the phases progressed, as shown in Table 1.

Table 1. Completion rates for project phases.

| Phase | Dates         | Sample    | Sampled households | Completed households | Completion rate |
|-------|---------------|-----------|--------------------|----------------------|-----------------|
| 1     | Oct-Dec 2017  | Cellphone | 2000               | 314                  | 15.7%           |
| 2a    | June-Aug 2018 | Landline  | 5000               | 986                  | 19.7%           |
| 2b    | Sept-Nov 2018 | Landline  | 5000               | 1033                 | 20.7%           |
|       |               | Total     | 12000              | 2333                 | 19.4%           |

In terms of completion rate by survey instrument, Table 2 shows that telephone survey responses comprised 64.9% of households in our final sample. 23.9% of respondents in the landline sample chose to mail back their completed surveys.

Table 2. Summary of responses by survey instrument.

| Phase | Method    | Web entry           |            | Telephone Survey    |            | Mail-in survey      |            | Total |
|-------|-----------|---------------------|------------|---------------------|------------|---------------------|------------|-------|
|       |           | Number of Responses | % of Phase | Number of Responses | % of Phase | Number of Responses | % of Phase |       |
| 1     | Cellphone | 95                  | 30.3%      | 219                 | 69.7%      | -                   |            | 314   |
| 2a    | Landline  | 116                 | 11.8%      | 601                 | 61.0%      | 269                 | 27.3%      | 986   |
| 2b    | Landline  | 127                 | 12.3%      | 693                 | 67.1%      | 213                 | 20.6%      | 1033  |
|       | Total     | 338                 | 14.5%      | 1513                | 64.9%      | 482                 | 20.7%      | 2333  |

##### 4.2. Sample Composition

The data collected by the NovaTRAC Halifax survey falls into three categories: household, person and trip data, which have datasets of different sizes. The survey was distributed to households and received 2,333 household responses. The survey asked for responses from each member of the household. In total, 4,159 people provided information for the survey, an average of 1.8 per household. This is less than the average number of people per

household reported below since household members could decline to participate. Each individual respondent provided information on their trips, and a total of 13,637 trips were recorded.

Certain survey questions, including those on health, attitudes, and occupation, were only asked to the survey's primary respondent. These questions have a sample size equal to the total number of households.

Table 3. Sample composition for each survey phase.

| Phase | Sample    | Households | Persons | Trips |
|-------|-----------|------------|---------|-------|
| 1     | Cellphone | 314        | 593     | 2118  |
| 2a    | Landline  | 986        | 1749    | 5563  |
| 2b    | Landline  | 1033       | 1817    | 5956  |
|       | Total     | 2333       | 4159    | 13637 |

#### 4.3. Weighting

A preliminary analysis of demographics in the sample showed a significantly higher rate of completion of the survey by older individuals than working age or youth cohorts. This is a unique case in comparison to similar surveys found in literature. The overrepresentation is due to the greater likelihood of older individuals having landlines and a higher rate of engagement of the survey from senior citizens. Other demographic characteristics such as household size and income as well as spatial distribution of respondents were found to be acceptable compared to the 2016 Census data.

To compensate for the overrepresentation of older individuals, the sample is weighted at the person level. Individuals are assigned a weight according to 5-year age cohorts. Figure 1 shows the sample rate for each cohort, i.e., the percent of the census population of that cohort included in the sample. In total, 4,159 individuals were sampled from a population of 403,390, so the mean sample rate is 1.0%. The weight for each age cohort scales the size of the cohort to 1.0% of its census population. Cohorts below age 55 have sample rates below 1.0% and so have weights above 1, and cohorts above age 55 have sample rates above 1.0% and so have weights below 1. Household, individual, and trip data are all weighed accordingly. Trips have the weight of the individual that took the trip, and households have the average weight of their members.

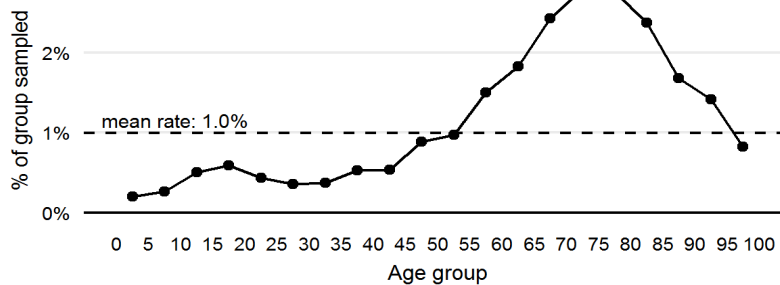


Fig. 1. Sample rate by 5-year age cohorts.

Weighing brings the NovaTRAC sample demographics in line with those of the 2016 Census. By construction, the weighting scheme matches the sample distribution of ages to the 2016 Census data. The weighted data also matches the levels of employment in HRM with census results. The values for both unweighted and weighted age and employment distributions are found in Table 4. Verification against the demographic and spatial characteristics mentioned above was conducted. The weighted data was a better match to the 2016 Census data than the unweighted data in all cases. All further analysis and results in this study/paper will use the weighted dataset.

Table 4. Comparison of weighted and unweighted data compared to 2016 Census.

|            | Ages  |       |       |       | Level of Employment |            |                     |
|------------|-------|-------|-------|-------|---------------------|------------|---------------------|
|            | 0-14  | 15-44 | 45-59 | 60+   | Employed            | Unemployed | Not in labour force |
| Census     | 15.0% | 40.3% | 22.6% | 22.1% | 62.1%               | 4.9%       | 33.0%               |
| Unweighted | 4.9%  | 18.8% | 25.6% | 50.8% | 46.9%               | 2.1%       | 51.1%               |
| Weighted   | 15%   | 40.3% | 22.6% | 22.1% | 63.4%               | 3.7%       | 32.8%               |

## 5. Discussion and Conclusion

### 5.1. Lessons Learned

Over the course of survey development and implementation there came subsequent challenges and learnings. With every iteration of the NovaTRAC survey, more efficient and effective strategies and methodologies were developed to better future versions.

Lessons learned from the NovaTRAC surveys focused on the development of tools, training of people involved, cost management, and adjustments in the overall methods used to conduct the survey. The 2016 survey utilized a web-based survey method. For this, DalTRAC developed an in-house CAWI survey software. Due to the relative newness of this survey, web-based survey response capture was the most cost-effective method for all parties involved. This CAWI survey software was again used in the 2018 NovaTRAC survey as it proved to be a success during the 2016 survey.

The 2018 NovaTRAC Halifax Survey was pivotal for the methodology used throughout the survey. As this was the first randomly sampled travel behaviour survey of significant sample size in HRM, to reach such a large sample size the survey used cell phone, landline, and web-based survey methods. This not only meant that the current CAWI system needed to be upgraded, but an external third-party telephone vendor needed to be hired to complete the cell phone and landline surveys. Our experience with this process has convinced us that conducting telephone interviews are expensive but effective. The use of telephone interviewing as a survey method was instrumental in collecting travel data from a large group of survey participants. As such, if a comprehensive survey is desired in a five- or ten-year interval, it should include telephone interviews to collect travel behaviour data until proven alternatives are available.

Training was also key in the deployment of the 2018 survey. Because this survey not only used inhouse DalTRAC researchers but also a third-party telephone survey vendor, a thorough training program had to be developed to ensure a cohesive understanding of the survey. This consisted of training sessions for DalTRAC students during the early stages of survey development, as well as training sessions for the third-party vendor to discuss how to use the CAWI survey tool, the survey script, expectations for data input, collection, and storage and how to handle circumstances that may arise during interviews.

Although the 2018 survey utilized more comprehensive survey methods than its previous counterparts, there were still some age cohorts that were underrepresented. RDD was used to text respondents a web-survey link with the intent of capturing a younger cohort. The survey results, however, showed an overrepresentation of senior citizens compared to working age and youth cohorts. Although there was a lesser representation from the younger cohorts, results from this survey were encouraging. To further increase participation of the younger population in the survey, the 2022 HaliTRAC survey has increased cell phone-based sampling and added a new social media-based sampling strategy.

Additionally, a multi-phase survey implementation was found effective in the 2018 NovaTRAC Survey. It allowed for re-evaluation of the sampling strategies, instrument utilization, and response rate at each phase. A pilot survey will be useful however, to identify opportunities for improvement and implement all changes prior to the successive phase. We also found that multiple waves of surveys help to monitor response rates and sociodemographic and geographic distribution.

## 5.2. Challenges and Accomplishments

As with any research, the development of the NovaTRAC surveys came with challenges. The NovaTRAC survey took time to build, develop, deploy, and refine. With each version of the survey that was produced, the team continued to learn and improve. They were able to clearly see whether each modification made to the survey worked or not. However, over the past eight years, DalTRAC and HRM teams have continued to grow and change as well. Consequently, although learnings from each version of the NovaTRAC survey were helping to develop future surveys, new researchers and staff were continuously having to be trained on these previous observations before moving forward with the next installment of the survey. For a fully developed survey like TTS, this is not much of a challenge, though, for a survey that is still in the early phases of development, having to continuously retrain staff has been a challenge.

Nevertheless, the NovaTRAC survey has seen some accomplishments. One goal of a multi-year travel survey is to build familiarity with the target population to eventually be able to reach a constant percentage of the population during each survey. The 2018 NovaTRAC survey observed a higher participation and response rate than that of 2016. Therefore, the updated methodology coupled with the growing familiarity is helping to build the reliability needed for a multi-year travel survey to succeed.

The use of DalTRAC's CAWI tool in 2018 was a great accomplishment as it efficiently collected and archived data from online and telephone surveys and facilitated recording of mail-back surveys. Integrating the Google Places API into the CAWI tool was also an achievement of the 2018 NovaTRAC survey. Trip destination selection used Google Maps which allowed respondents to pinpoint their locations simply by entering the location name and verifying that the correct address was selected. The map also allowed them to drag a pin onto the correct location. Data was then automatically geocoded and saved in latitudinal and longitudinal pairs. The automatic geocoding and verification of addresses by respondents saved time and improved the quality of data received as it reduced the need to guess addresses and postal codes. Due to this success, the 2022 HaliTRAC survey will continue to use the CAWI tool with the integration of Google Places API.

## 5.3. Conclusion

The goal of this research and subsequent surveys was to develop a multi-year travel survey program that can be utilized and implemented at the municipal, provincial, or regional level. Oftentimes, smaller communities such as Halifax do not have the funding nor the capacity to conduct large scale travel surveys. However, incremental experimentation and gradually developing university-government nexus could help to generate travel information necessary for research and planning purposes. The travel data can be utilized by transportation planners and engineers to develop multiple components of a transportation network modelling system and inform future policy decisions. It is also important to allow for comparisons over the course of continued surveys to monitor changes in travel behaviour. Therefore, DalTRAC will continue to work in tandem with the Province of Nova Scotia and Halifax Regional Municipality (HRM) to enrich this multi-year travel survey program for evaluating and monitoring transportation sustainability in the region.

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## References

- Bricka, S., 2007. Chicago Regional Household Travel Inventory. 2007. ICPSR34910-v1. Ann Arbor, MI: Inter-university Consortium for Political and Social Research. <http://doi.org/10.3886/ICPSR34910.v1>
- City of Edmonton & R.A. Malatest & Associates Ltd., 2008. *2015 Edmonton and Region Household Travel Survey*. City of Edmonton, AB. Retrieved from: [https://www.edmonton.ca/transportation/traffic\\_reports/travel-pattern-analysis](https://www.edmonton.ca/transportation/traffic_reports/travel-pattern-analysis)
- Habib, M.A., 2017. Tracking Progress 2016: Estimation of Transport Energy Use, Emission and Travel Choices in the Province of Nova Scotia. Nova Scotia Department of Energy, Halifax
- Inbakaran, C., and Kroen, A., 2011. Travel Surveys-Review of International Survey Methods. Australian Transport Research Forum 2011 Proceedings, 28-30 September 2011, Adelaide, Australia
- Krizek, K., 2003. Residential Relocation and Changes in Urban Travel: Does Neighborhood-Scale Urban Form Matter? *Journal of the American Planning Association*, 69(3), 265-281. Halifax Regional Municipality. (2014). Regional Municipal Planning Strategy. Halifax, NS
- Oregon Modelling Steering Committee., 2011. *Oregon Household Travel and Activity Survey, 2010*. Oregon Department of Transportation. Oregon Modelling Improvement Program (OMIP)
- Province of Nova Scotia., 2013. *Choose how you move Sustainable Transportation Strategy*. The Province of Nova Scotia, Canada. Retrieved from <http://novascotia.ca/sustainabletransportation>
- TTS Transportation Information Steering Committee., 2018. TTS: 2016, 2011, 2006, 1996 & 1986 Travel Summaries for the Greater Toronto and Hamilton Area, 2016. Data Management Group. Department of Civil Engineering, University of Toronto