Census Data in Transportation Planning, Rutland County, Vermont

Dean L. Pierce, *Rutland Regional Planning Commission*

Recent experiences are described of a predominantly rural regional planning organization that is using data from the U.S. census for transportation planning purposes. These experiences include analyzing the statewide Census Transportation Planning Package to reveal journey-to-work trip patterns and to improve the calibration of the region's newly developed traffic forecasting model. In light of the planning organization's limited budget and staff, census transportation data proved essential to the timely completion of these tasks. The data also significantly increased policy makers' understanding of transportation issues and, when used in a "fratar" technique, vastly improved the usefulness of the traffic model. In general, any limitations of the census transportation data were easily overcome or were small relative to their advantages. Experience suggests that the Census Bureau should consider release of Urban Element data for very small metropolitan areas in the future.

Since late 1992, the Rutland Regional Planning Commission (RRPC) has provided a range of transportation planning services to 27 predominantly rural municipalities in west central and southwestern Vermont. The RRPC has participated in a statewide Transportation Planning Initiative (TPI), working in close cooperation with the Vermont Agency of Transportation (VAOT) and Vermont's 11 other regional planning organizations.

As a partner in the TPI, the RRPC has been responsible for the completion of numerous tasks, including the development of a comprehensive regional transportation plan, a regional traffic forecasting model, and lists of transportation problems and improvement priorities. In carrying out these tasks, the RRPC has made extensive use of data from the U.S. census, particularly the Census Transportation Planning Package (CTPP) (*1*).

The purpose of this case study is to document some of the applications related to transportation planning that were performed using census data in the Rutland region. Indicated in connection with each application will be how crucial the data were to the completion of the application, including whether or not the data were essential and, if not, what information might have been substituted. Also touched on are issues such as the context and objectives of the applications, relevance to transportation planning at other administrative levels and in other geographic locations, and problem solving. However, in light of space and time limitations, extensive details are not provided.

Background

The RRPC was created in 1968 and provides leadership and technical expertise to encourage cooperative planning among the Rutland region's communities and areawide interests. The RRPC's policies are advisory, although some do have legal standing in certain regulatory

proceedings (2). The Rutland Region Transportation Council (RRTC) serves as the Transportation Advisory Committee (TAC) to the RRPC and provides members for several working groups and subcommittees.

The Rutland region, which comprises 27 predominantly rural municipalities in west central and southwestern Vermont, has a total population of 61,753 (1990). The heart of the Rutland region, which includes the state's second largest city (Rutland), is located approximately 100 mi northeast of Albany, New York, and 165 mi northwest of Boston, Massachusetts (Figure 1).

Approximately 945 mi^2 in size, the region boasts a wide range of natural resources, which serve as the foundation for several sectors of the economy, ranging from agriculture and mining to recreation and tourism. The Rutland region is the home of the nationally recognized Killington and Pico ski areas.

The transportation system in the Rutland region, as in most other rural areas, is primarily highway-oriented. The region is located at the intersection of two National Highway System (NHS) routes—US-7 and US-4; however, it does not have a direct connection to the federal Interstate highway system, and only limited sections of the NHS routes are access controlled. The transportation system also includes a small commercial aviation airport and significant mileage in railroad track. Public transit is available in and around the urban core and between the urban core and the Killington ski area (Figure 2).

The primary transportation issues facing the region include the need to address traffic congestion and safety problems in the urban core and in village areas along the major highway corridors. Also included is the need or desire to improve the transportation connections between the region and surrounding regions and states through highway, air, and rail improvements (3).

Through the Vermont TPI, the staff of the RRPC/RRTC and similar organizations have attempted to use planning as a tool to depoliticize the identification and programming of projects needed to solve important transportation problems in the state. Census data have been used extensively in analyses and evaluations intended to serve as the foundation for informed and rational decision making. In the next section of this paper some of the applications related to transportation planning that have been performed in the Rutland region using census data will be briefly documented.

Applications and Experience

Census data have been used in comprehensive transportation planning activities in the Rutland region since 1992. Some possibly noteworthy applications of census data for transportation purposes include the following:

1. Using CTPP data to reveal journey-to-work (JTW) trip patterns by major (and minor) mode regionwide,
2. Using CTPP data to reveal JTW town-to-town trip patterns (across all modes) regionwide, and
3. Using the CTPP-based JTW town-to-town trip table to improve the calibration of the region's newly developed traffic forecasting model (by "frataring" the initial distribution of trips using the CTPP JTW trip table).

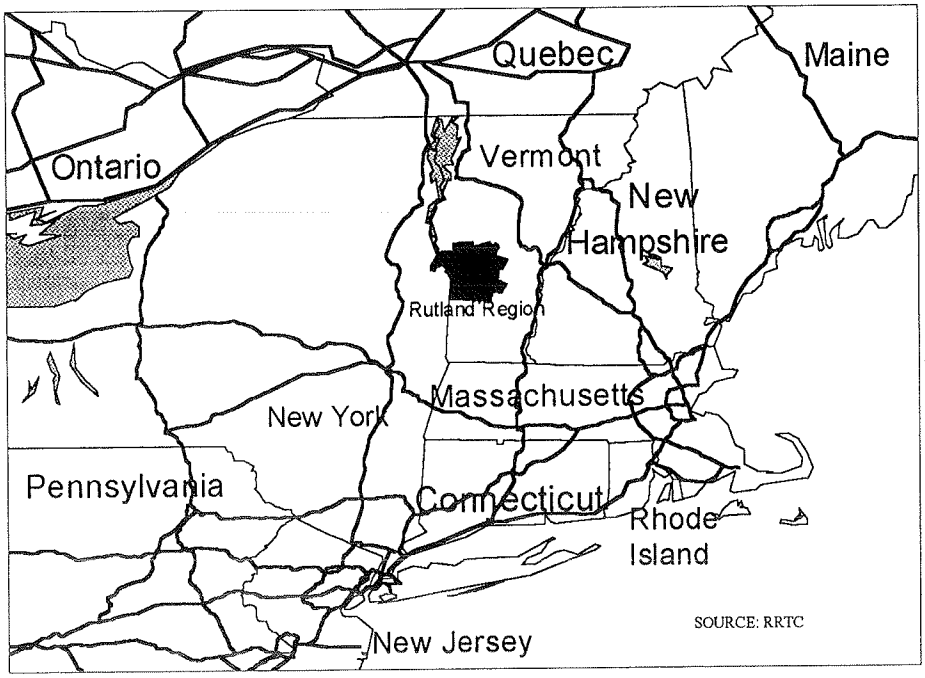


FIGURE 1 Location of Rutland region within northeast United States.

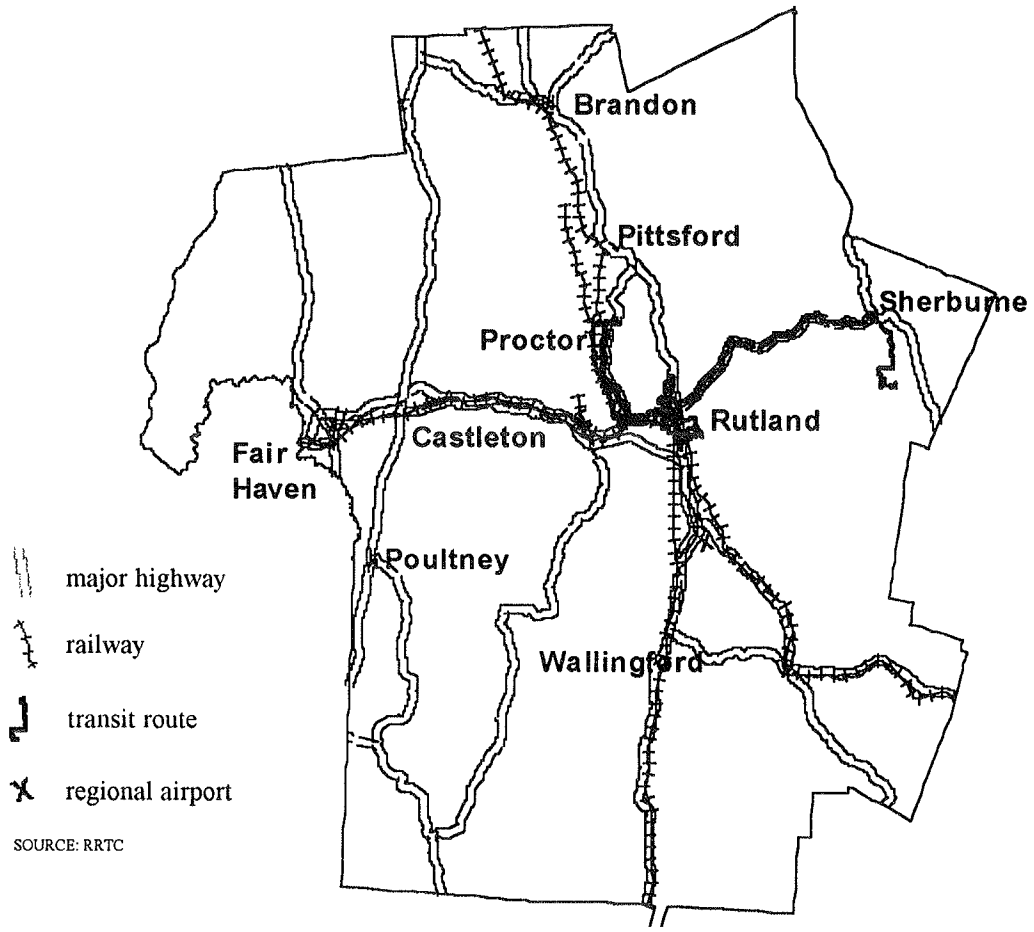


FIGURE 2 Rutland region transportation system.

Applications 1 and 2 were carried out in the course of developing the "Existing and Future Conditions" section of the Rutland Region Transportation Plan. As noted earlier, Application 3 was carried out during the development of the Rutland region's regional traffic forecasting model based on Quick Response System II for Windows (*4*); the model was used in a limited capacity in the transportation plan.

Application 1: Using CTPP Data To Reveal JTW Trip Patterns by Major (and Minor) Mode Regionwide

The approach used to carry out Application 1 was straightforward and involved little more than the extraction of the data from the CTPP dataset, entry into commercial presentation software (Harvard Graphics for Windows, Version 2.0, and Microsoft Publisher for Windows, Version 2.0), and preparation of suitable tables and pie charts. For comparative purposes, similar data for 1980 were obtained by referencing Census Bureau publications and handled in the same manner (Table 1 and Figure 3). To disseminate this information, the tables and charts were published in regional transportation newsletters and the regional transportation plan.

Presentation of this information confirmed for policy makers the overwhelming reliance of residents on the personal automobile for work trip travel. Perhaps more important, it also hinted at the potentially significant impact that relatively small changes in JTW mode choice could have on vehicle miles traveled by alternative transportation modes.

Application 2: Using CTPP Data To Reveal JTW Town-to-Town Trip Patterns (Across All Modes) Regionwide

Application 2 was also carried out by extracting data from the CTPP dataset, entry into commercial presentation software, and preparation of suitable tables and graphics. It also involved the preparation of data-base files (.dbf) compatible with Arc/Info geographic information system (GIS) software and the use of Arc/Info to prepare maps portraying regional place-of-work patterns (Figure 4).

TABLE 1 Means of Transportation to Work, Rutland County, 1980 and 1990

Mode	1980	1990
Single Occupancy Vehicle	14,551	21,612
Car Pool	6,487	4,384
Public Transportation	185	87
Other	2,897	2,228
Worked at Home	1,117	1,732
Total	25,237	30,043

Source: U.S. Census

The first step in the process was the preparation of a master matrix showing where workers live and where they work on a town-by-town basis across the entire region. The next step in the process was the preparation of "simplified" tables based on the master matrix. Examples of these include tables showing where workers live on a town-by-town basis and where they work on the basis of various categories, for example, at home, in their home municipality, in another municipality within the county, in the Rutland urban core, and outside the county (Table 2).

Numbers included in the simplified tables were then exported in data-base format (.dbf) for use with Arc/Info software. Finally, the GIS software was used to prepare shaded thematic maps based on the tables, and the matrix, tables, and maps were published in community data profiles, newsletters, and the regional transportation plan (Figure 5).

Presentation of the information produced in the second application confirmed policy makers' intuitive understanding of the macro (regional) pattern of JTW trips within the region. The information also shed light on micro (town-level) patterns that had heretofore been undocumented and therefore were not very well understood.

Application 3: Using CTPP-Based JTW Town-to-Town Trip Table To Improve Calibration of Region's Newly Developed Traffic Forecasting Model

The third application of census data took place within the considerably more complex process used to develop the region's new traffic forecasting model. In the most basic terms, however, Application 3 was simply an extension of one of the products created in Application 2, the master matrix depicting where workers live on a town-by-town basis and where they work on a town-by-town basis across the entire region.

With the assistance of consultants, the Rutland region initiated the development of a microcomputer-based regional traffic forecasting model using QRS II software. Model development was initiated with an eye toward

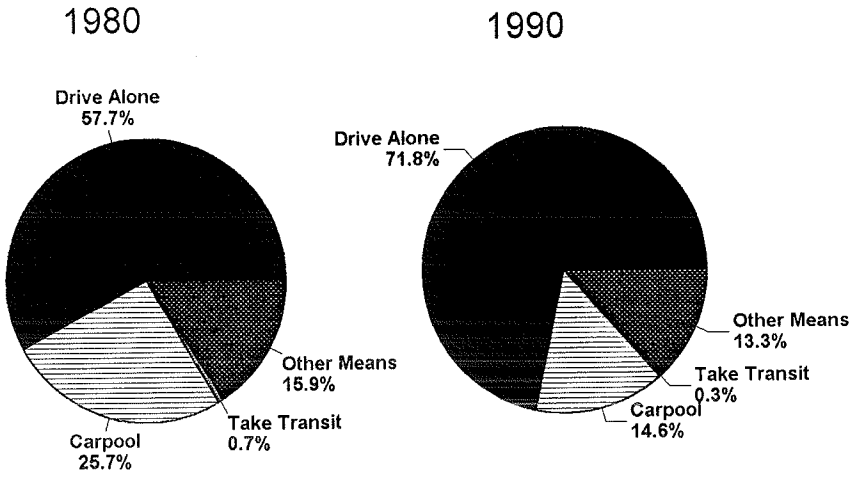


FIGURE 3 Generalized means of transportation to work, Rutland region, 1980 and 1990.

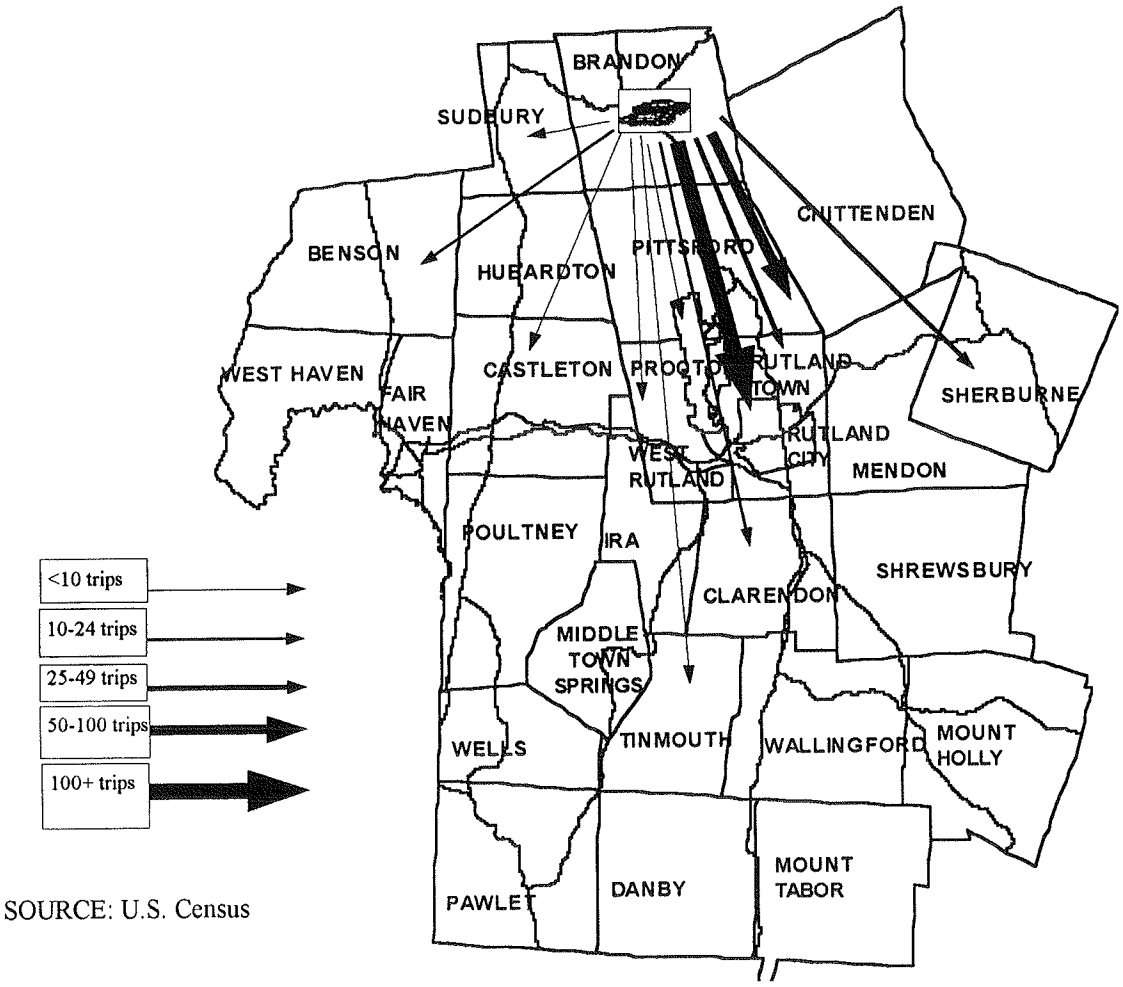


FIGURE 4 Town of Brandon journey-to-work distribution, 1990.

following the traditional four-step modeling process, which may be summarized as follows:

1. Trip generation,
2. Trip distribution,
3. Mode choice, and
4. Trip assignment.

Trip generation (Step 1) was accomplished using a combination of census block-group-level sociodemographic data (i.e., number of households, median household income, automobiles per household) obtained from STF3C, disaggregated employment data obtained from the Vermont Department of Employment and Training (DET), and QRS II defaults [based on National Cooperative Highway Research Program (NCHRP) Report 187 (*5*)].

Initially, internal-internal (i-i) and internal-external (i-e) trips estimated in Step 1 were distributed in Step 2 using the gravity model included within QRS II; external-external (through) trips, estimated by the consultants, were incorporated using QRS II's "add user defined trip table" option. Later, however, the origin-destination (O-D) table containing i-i and i-e trips was "fratared" using the CTPP-based JTW town-to-town trip table to more closely calibrate the model to existing traffic conditions.

In brief, the fratar technique is an iterative procedure for solving a system of equations. It involves the application of a set of uniform adjustment factors to the cells of a matrix (such as an O-D table) to alternatively match row and column totals for the matrix. This iterative procedure converges to a set of matrix values that maintain constant row and column totals but reflect a user-specified initial set of seed values for the matrix cells.

In the case of modifying the O-D table, the constant row and column totals were the estimated trip origin and destination volumes for each census block. The initial seed values were the O-D pair values contained in the CTPP-based JTW town-to-town trip table. The final fratar cell values are the modified estimates of O-D pairs.

Given the very small percentage of JTW trips made using transit and nonmotorized modes of transportation

TABLE 2 General Location of Work by Place of Residence, Rutland Region, 1990

	Work Location:			
Place of Residence	At Home	In Place (town), Outside Home	In Region, Outside Place	Outside Region
Benson	407	107	300	47
Brandon	1880	926	954	278
Castleton	2097	768	1329	192
Chittenden	541*	115*	426*	34*
Clarendon	1541	291	1250	88
Danby	567	164	403	258
Fair Haven	1183	444	739	157
Hubbardton	262	41	221	26
Ira	221	30	191	14
Mendon	584	137	447	37
MiddletownSprings	350	85	265	43
Mount Holly	458	128	330	162
Mount Tabor	114	7	107	54
Pawlet	679	258	421	387
Pittsford	1527	413	1114	61
Poultney	1622	777	845	208
Proctor	933	225	708	38
Rutland City	8587	6088	2499	342
Rutland Town	1974	250	1724	151
Sherburne	441	315	126	67
Shrewsbury	545	133	412	50
Sudbury	256	59	197	67
Tinmouth	191	61	130	19
Wallingford	1107	311	796	85
Wells	415	65	350	215
West Haven	166	37	129	13
West Rutland	1222	212	1010	42
Total				

Source: U.S. Census, Census Transportation Planning Package

*NOTE: Town of Chittenden data as reported prior to correction

in the region (as documented by the CTPP and described in Application 1), the decision was made to assign all trips generated in Step 2 to the highway-nontransit mode and assume the NCHRP Report 187 defaults for automobile occupancy (Step 3 of the modeling process).

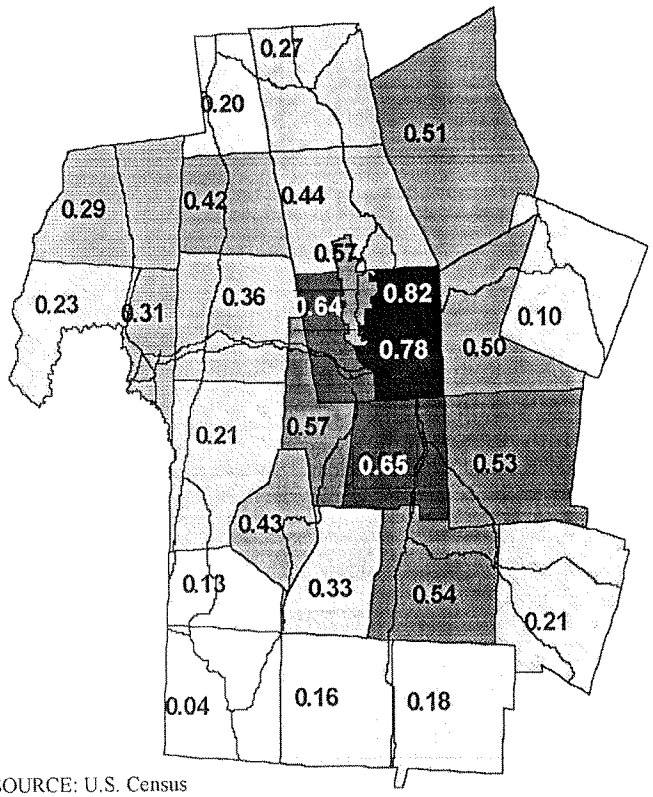
Finally, Step 4 (trip assignment) was accomplished using QRS II system defaults and a highway speed table based on functional classification.

Some key assumptions were made in the course of carrying out the third application. One of these was that the pattern of JTW trips embodied in the CTPP data fairly reflects the pattern of all trips on the regional highway system as a whole on a daily basis. A second was that use of CTPP JTW data would not mask important changes in trip patterns caused by population or employment growth projected to take place in the region by the model's forecast year.

Utility of Census Data

The utility of census data for transportation could be measured in a number of different ways. For the purpose of this paper, effectiveness has been measured in terms of

1. How crucial the data were to the completion of a project, including whether or not the data were essential;
2. If the data were essential, what made them so; and
3. If the data were not essential, what information might have been substituted to complete the application.



SOURCE: U.S. Census

FIGURE 5 Percentage of workers with journey-to-work destination in Rutland urban core, Rutland region, 1990.

Application 1

Census data were central to the completion of Application 1. Without the data, the Rutland region would have (*a*) incurred significant expense and time delay in an attempt to collect this information independently, (*b*) "borrowed" data from a similar region and chosen to assume that mode choices in both areas were essentially the same (potentially erroneous), or (*c*) decided to ignore the issue of mode choice and proceeded to plan for the region's transportation needs on the basis of "guesstimates."

Recently, consultants working for the VAOT completed a statewide household travel pattern survey that could begin to substitute for the data used in Application 1. However, this information has advantages as well as disadvantages relative to use of census data. Its major advantage is that it incorporates data about all trip purposes, not only JTW trips, and is thus more robust. Its major disadvantage is that it was collected on a statewide basis and represents a very small sample of the Rutland region's households (~200). Although it is tempting to assume that statewide trip-making characteristics will mirror those found in the region, it is not clear that this assumption is any more valid than the assumption to borrow from a similarly situated geographic region.

Application 2

Census data were also central to the completion of Application 2, for the same reasons indicated for Application 1. The data allowed policy makers to see and understand the regional pattern of JTW trip making at the same time they were developing a regional transportation plan. Again, without the data the region would have (*a*) incurred significant expense and time delay in an attempt to collect this information independently, (*b*) "borrowed" data from a similar region and chosen to assume that mode choices in both areas were essentially the same (potentially erroneous), or (*c*) decided to ignore the issue of mode choice and proceeded to plan for the region's transportation needs on the basis of guesstimates until the completion of state-level surveying. And again, a major disadvantage of the statewide survey is that it represents a very small sample of the Rutland region's households and is not necessarily better than the remaining alternatives.

Application 3

Census data were not essential to the completion of the trip distribution step of the regional modeling process. However, the information did assist dramatically in improvement of the model (Table 3). Following employment

TABLE 3 Impact of Census Journey-to-Work Data on Traffic Model Screen Lines

	Deviation from Actual Counts (in Percent) at Conclusion of:		
Screen Line	Initial Calibration	Fratar with Census data	Final Calibration
A	58.90	19.75	15.45
B	11.52	-17.60	-19.49
C	32.12	0.84	-10.27
D	88.75	33.20	22.45
E	26.51	2.92	-0.61
F	68.83	28.42	20.84
G	23.07	5.68	5.37

Source: U.S. Census, Census Transportation Planning Package

of the fratar technique and the census data, differences between actual and modeled volumes at screenlines dropped from unacceptable to acceptable levels. (Census data were also highly valuable in the trip generation step of regional modeling, although this was not considered to be part of Application 3 as it is summarized here).

In the absence of census JTW data, the Rutland region might have either spent a considerable amount of time continuing to calibrate the traffic model (with no guarantee of success) or simply accepted the model in its earlier iteration, which in hindsight would not have been desirable.

As indicated above, the recently completed VAOT statewide household travel pattern survey might begin to substitute for the JTW data used in the region (*6*). But both its advantages and disadvantages relative to census data remain. The RRPC might also have waited for the completion of the statewide traffic model and avoided developing a regional model; however, confidence in planning decisions based on the statewide model would likely never have approached that of decisions based on a regional model.

Additional Comments

The following additional comments are intended to address questions raised by the conference steering committee.

Relevance of Applications to Regional or Statewide Transportation Planning Programs

In Vermont, regional transportation planning is taking place as a component of the statewide transportation planning effort. Regions across Vermont are already using census data in applications similar to those described here and in other ways.

Limitations of Census Data

The major limitation of census data for transportation planning in the applications described here is the relatively large or high level of geography for JTW trip origins and destinations (including aggregation of some towns with areas in excess of 20 mi^2). The region chose to base its traffic analysis zones (TAZs) on the census block groups owing to the availability of this type of data; availability of data for smaller geographies would have benefitted the modeling process. The release of Urban Element data for very small metropolitan and nonmetropolitan areas such as the Rutland region should be given serious consideration by the Census Bureau if this data program continues.

Problems Encountered

Problems encountered in the data included coding errors most likely resulting from confusion surrounding trips to or from Chittenden *County* in northwest Vermont and Chittenden *town* in west central Vermont. The county is Vermont's most populous (>125,000 residents); the town, on the other hand, is very rural (<1,200 residents). A number of trips presumed to end in Chittenden County were mistakenly assigned to end in Chittenden town.

Fixes Made

JTW trip data for Chittenden data were adjusted using data from the Vermont DET. Future censuses should in-

clude more rigorous data-checking routines that screen for place-of-work coding errors in states with similarly named county and subcounty geographies.

Recommendations for Other Areas

Very simply, small or rural regions should take advantage of census data while the information is still available and free.

Transferability to Other Areas

The applications of census data made in the Rutland region were relatively straightforward. Virtually any region or metropolitan planning organization (MPO) could employ Applications 1 or 2. Virtually any region or MPO developing a regional model could consider employing Application 3.

ACKNOWLEDGMENTS

The author wishes to acknowledge the personal and professional contributions of the following individuals: Dan Hardy and Whit Blanton, JHK & Associates; Mark Blucher, Steve Schild, and Judy Holcomb, Rutland Regional Planning Commission; Steve Bower, formerly of the Vermont Center for Geographic Information; and Perry Norton.

REFERENCES

1. Journey-to-Work and Migration Statistics Branch, Population Division. *1990 Census Transportation Planning Package, Statewide Element—Parts A, B, and C: Technical Documentation for Summary Tape*. Bureau of the Census, U.S. Department of Commerce, 1993.
2. Rutland Regional Planning Commission. *Rutland Regional Plan*. Rutland, Vermont, Nov. 1994.
3. Rutland Region Transportation Council. *Rutland Region Transportation Plan*. Rutland, Vermont, June 1995.
4. Horowitz, A.J. *Reference Manual: Quick Response System II for Windows, Version 3.6*. Center for Transportation Studies, University of Wisconsin-Milwaukee/AJH Associates, Milwaukee, June 1993.
5. Sosslau, A.B., et al. *NCHRP Report 187: Quick Response Urban Travel Estimation Techniques and Transferable Parameters: User's Guide*. TRB, National Research Council, Washington, D.C., 1978.
6. Vanasse, Hangen, Brustlin, Inc. *Statewide Travel Development: Final Report*. Vermont Agency of Transportation, Montpelier, April 1996.