Analysis of the Metropolitan Boston Transportation System During the Postblizzard Week–February 13-17, 1978

Benjamin Dansker and Charles Kalauskas, Central Transportation Planning Staff, Boston

On February 6 and 7, 1978, a major blizzard crippled transportation services in the Boston metropolitan area. The disruption was so great that all but emergency vehicles were banned from the streets and highways in most eastern Massachusetts communities during the week after the blizzard. Not until midnight on Monday, February 13, was the ban completely lifted in the densely populated activity centers of the region. In some of these communities an on-street parking ban remained in effect through Tuesday, February 14. In addition to these legal restrictions, large quantities of snow presented additional obstacles to vehicular travel. Because of these legal and physical impedances, state and regional transportation agencies encouraged the use of transit or ride sharing for work trips in the region. In addition, the state recommended staggered work hours for employees in downtown Boston. This paper analyzes the effects of the driving and parking bans on travel in the region. Data pertaining to the volumes and temporal distribution of the various modes of travel during the week after the blizzard were collected and analyzed. These data were compared with travel data from a more typical time period. The analysis indicates that a significant shift to public transportation took place for the commute-to-work trip and that, through a combination of staggered work hours and special suburban transit services, the public transportation system was able to accommodate the great increase in demand. This shift to public transportation was only temporary in nature, however; normal preblizzard travel patterns returned when restrictions on vehicular travel were removed.

On February 6 and 7, 1978, a major snowstorm struck the Boston metropolitan area and dropped from 66 to 81 cm (26 to 32 in) of snow in less than 24 h. This blizzard came only two weeks after another record-breaking storm. Most of the snow from that storm had not melted, although the streets and roads were cleared and public transportation service had returned to normal. The February 6 storm caused such disruption of transportation services, including both public and private transportation, that the governor banned all but emergency vehicles from state highways and local streets in most of the communities in eastern Massachusetts. This was done to enable snowplows to proceed unhampered in their efforts to clear the roads.

The driving ban was lifted in some communities as early as February 10. It was not until midnight on Monday, February 13, that the ban was lifted in the core communities of Boston, Cambridge, Somerville, Medford, Brookline, Chelsea, Revere, and Winthrop (shown in Figure 1). Nearly half of the employment in the Boston region is located in this area. While the driving ban was still in effect in these areas, an attempt was made to enable people to return to work on Monday, February 13, and to resume normal activities. Some means of transportation other than the automobile had to be used by the approximately 750 000 persons who work or reside in the areas where the driving ban was in effect. Normally approximately 60 percent of the peak-period trips to the Boston central business district (CBD) and approximately 50 percent of the trips to the remainder of the regional core area, which includes Cambridge, Somerville, Everett, and Chelsea, are made by public transportation. Although many of these persons normally use a public transportation mode, many others had to temporarily switch modes from automobile to transit.

The cities of Cambridge and Boston imposed an on-street parking ban for Tuesday, February 14. This discouraged automobile commuters from entering downtown Boston and Cambridge for an additional day after the driving ban had been lifted.

To enable the transit system to handle the higher-than-usual demand, a system of staggered work hours was implemented. Different categories of employment were allocated to different work shifts, ranging from a 7:00 a.m. to 3:00 p.m. early shift to an 11:00 a.m. to 7:00 p.m. late shift. Although compliance was voluntary, the lieutenant governor appeared on television to urge adherence to the staggered shifts. In addition, a large number of major employers were contacted by the Massachusetts Bay Transportation Authority (MBTA) to request their support in encouraging employees to comply with the schedule. The Executive Office of Transportation and Construction urged suburban cities and towns to establish emergency bus routes to rapid transit stations or to downtown Boston and organized temporary downtown terminal areas for these routes.

Travel restrictions during the poststorm week provided an incomparable opportunity to address the following questions:

1. Would people manage to utilize the transit system successfully as an alternative mode of travel?
2. Would the transit system be able to handle the vastly increased demand?
3. Would people voluntarily stagger their work hours to enable the transit system to expand its capacity successfully? and
4. Would the reduction in automobile travel have a major impact on air quality?

These questions are part of the larger issue of whether or not the transit system could successfully attract and absorb vastly increased patronage with little if any modification of existing facilities and thus provide an alternative to the automobile during an emergency situation. The questions are dealt with in this report by examining the following data:

1. Work attendance in impacted areas during the postblizzard week versus that for a typical week,
2. Systemwide transit ridership during the postblizzard week versus that for a typical week,
3. Distribution by time of transit alightments and boardings at the four transit stations in the high-density central area and two terminal stations,
4. Highway volumes at selected counting stations on the first two days of the poststorm week versus that for a typical weekday, and

Figure 1. Communities that lifted the driving ban at midnight, February 13.

5. Air quality data for the postblizzard week versus that for the rest of the month.

Because the contingency plan for enabling people to return to work while the driving ban was still in effect was hastily organized one day before it was to go into effect, the data collection efforts were also hampered by lack of sufficient planning. Even so, boardings and alightments were counted manually at selected stations, and further data were contributed by the MBTA, private carriers, and the municipalities that provided their own transit services, which resulted in enough data to form the basis for the analysis presented below.

PUBLIC TRANSPORTATION

Public transportation for 79 cities and towns in the Boston metropolitan region is provided primarily by the MBTA, which operates a system of rapid transit, trolleys, surface buses, and trackless trolleys. In addition, it subsidizes commuter-rail services operated by the Boston and Maine Railroad (B&M). Additional transportation service, mainly express bus service for commuters, is provided by numerous private carriers. The MBTA currently operates approximately 65 route-km (40 route miles) of rapid transit, 70 route-km (43 route miles) of streetcar lines, 5715 route-km (3550 route miles) of bus service, 13 route-km (8 route miles) of trackless trolley, and 385 route-km (240 route miles) of commuter rail. The MBTA operates approximately 1300 vehicles and the B&M operates approximately 200 vehicles.

Throughout this analysis of travel behavior during the postblizzard week, comparisons will be made to typical travel behavior. Typical MBTA 24-h ridership (based on 1978 revenue data) and typical peak-period ridership (based on factors derived from various MBTA ridership surveys) are given in the table below. Because transit travel shows seasonal variations, ridership on the postblizzard weekdays of February 1978 is compared with ridership on a typical February weekday.

Mode	24-h Regional Ridership (round-trip)	3-h Peak-Period Inbound Ridership to Boston CBD
MBTA rapid transit—including Green Line central subway	303 600	80 000
MBTA surface transit—bus, trolley, and trackless trolley	268 500	28 000
Private carrier	15 000	5 700
Commuter rail	31 000	12 000
Total	618 100	125 700

Work Attendance

To evaluate the ability of the transit system to transport persons to work when commuting by automobile is banned, it is helpful to compare work attendance during the postblizzard week (February 13-17) with that of a typical weekday. The table below presents this information and indicates that, except for the very first day of the week (February 13), attendance was nearly normal.

Date	Attendance (%)	Percentage Below Normal
Typical weekday	93-96	-
February 13	86-90	6-7
February 14	91-93	2-3
February 15	91-93	2-3

Date	Attendance (%)	Percentage Below Normal
February 16	93-96	-
February 17	93-96	-

The first question to be addressed is whether or not commuters were able to successfully utilize the transit system as an alternative mode of travel. If major ridership increases occurred during the postblizzard week, this would indicate an affirmative answer to the question.

Rapid Transit

Table 1 compares daily rapid transit ridership during the postblizzard week with daily ridership on a typical weekday in late February. As is obvious from the table, ridership was significantly greater on the first three days of the week, but the differences were smaller on Thursday and Friday.

Rapid transit boardings were counted for the four downtown stations that have the largest transit volumes (Washington, Park, State, and Government Center) and two terminal stations (Harvard and Forest Hills). These volumes were compared with those for a typical weekday in February, as given in Table 2. Boardings at these stations were only slightly higher than those of a typical weekday.

There are several possible explanations for this phenomenon. One is that the four downtown stations are located in an area that normally has a high mode split to transit. Another explanation may lie in the work attendance figures presented in the table above. Although these figures did not indicate a large drop in work attendance, it may be hypothesized that lower attendance rates may have been concentrated downtown, where companies and agencies that employ large numbers of people could afford to allow the employees whose access was particularly difficult to stay home. Another factor that could help account for the relatively low ridership figures at the downtown stations is a possible decrease in the number of discretionary trips, which may have been caused by expectations that the transit system would be overcrowded. The problem with all but the first of these reasons is that systemwide data indicate an increase in ridership; however, these reasons relate to reductions in ridership.

The usefulness of using systemwide data to predict ridership in the downtown stations is limited in that many persons who used the transit system during the post-blizzard week were former automobile drivers who (a) do not work downtown where transit access is good or (b) live at such distances from their work locations that they would have unreasonably long trips if they chose to use transit. In the first case, the new riders would not make radial trips and, thus, the increase would be reflected in the outlying stations rather than in the downtown stations. In the second case, the proportion that board at the outlying stations would be higher than usual, thereby increasing revenue and leading to an overestimate of boardings based on revenue data. The absence of school children and probable reduction in the number of elderly patrons could have the same result.

The two terminal stations for which data are presented (Harvard and Forest Hills), on the other hand, show significant increases in boardings. These terminal stations attract riders from the northwest and southwest areas of the Boston region, including passengers who are making through trips as well as downtown trips.

All legal restrictions, including the Boston and Cambridge parking ban, were lifted by Tuesday night. Station boardings began to decrease on Tuesday and the return to near-normal driving conditions on Wednesday apparently diverted many of the new transit riders back to their automobiles. Nevertheless, the analysis of travel behavior on Monday indicates that commuters were able to successfully use transit as an alternative mode of travel during emergency conditions.

Commuter Rail

Systemwide counts for all B&M and special Amtrak commuter services that operated during the week of February 13 are presented in Table 3, along with an average count for a more typical operating day.

The increase in ridership on the commuter rail lines was proportionately the largest increase of any part of the public transportation system and persisted the most strongly through the second week after the storm. This may be in part because commuter rail serves outlying suburban towns where the road conditions may have discouraged travel by automobile longer than they did elsewhere. As with rapid transit, the data indicate a successful mode shift to public transportation.

MBTA Surface Lines

Ridership information for surface lines of the MBTA, including buses, trackless trolleys, and the surface stations of the Green Line, is presented for the system as a whole, both for a typical day (February 28) and for the postblizzard week, in Table 4.

As with the other transit modes, ridership was much higher on Monday and Tuesday than on a typical day and

Table 1. Comparison of round-trip rapid transit ridership.

Date	Ridership[a]	Difference from Typical Weekday (%)
Tuesday, February 28[b]	303 600	-
Monday, February 13	421 150	+39
Tuesday, February 14	391 250	+29
Wednesday, February 15	361 300	+19
Thursday, February 16	352 300	+16
Friday, February 17	380 500	+25

[a]These figures show estimated total round-trip ridership (excluding passholders) on the Red, Blue, and Orange Lines and on the Green Line central subway for the dates indicated.
[b]Typical weekday example.

Table 2. Comparison of rapid transit boardings.

Date	Four CBD Stations	Difference from Typical Weekday (%)	Two Terminal Stations	Difference from Typical Weekday (%)
Tuesday, February 28[a]	66 000	-	30 150	-
Monday, February 13	80 000	+21.0	45 280	+50.0
Tuesday, February 14	76 000	+15.0	32 943	+9.0
Wednesday, February 15	70 000	+6.0	35 919	+19.0
Thursday, February 16	71 000	+7.5	31 267	+4.0
Friday, February 17	76 000	+15.0	35 676	+18.0

[a]Typical weekday example.

declined as the week proceeded. It is interesting to note that the midweek decline was steeper for surface transit than for rapid rail. This is probably due in part to road conditions, which gave rail service a greater advantage over private vehicles than that of surface transit.

Private Carriers

A number of private carriers provide regular commuter service by express bus into Boston from outlying suburban communities. During the postblizzard week, many of these companies provided additional service in combination with the special services put together by some of the communities in the Boston region; others simply added to their regular service. Ridership data from three of the larger private carriers for the week of February 13 along with data for a typical day are presented in Table 5. As shown, the private carriers carried substantially more passengers during the postblizzard week. As with other transit services, the difference decreased as the week proceeded.

Emergency City and Town Bus Service

Twenty of the region's 101 cities and towns responded to the transportation problems of the snow emergency by organizing special bus services (with either school buses or contracted private carriers) to transport commuters either to major distribution points in downtown Boston or to nearby commuter-rail and rapid-transit stations. Fares on these services ranged from no charge to $2.00, depending on whether or not the municipality subsidized the service. The majority of these services operated only on Monday and Tuesday of the postblizzard week, although six towns continued service through Friday, February 17.

These services ranged in size from a pair of operations that carried more than 2000 bus passengers on Monday to a small suburb's operation of a single bus that carried 43 passengers. More than 13 000 passengers commuted to Boston via these emergency services on Monday, February 13. Detailed ridership information for the remainder of the week was difficult to obtain, but it is known that the six services that continued still carried more than 1000 commuters to and from Boston on Friday, February 17. The reason for the sudden decline in ridership is obvious. As restrictions on driving private automobiles were removed, the incentive to use special bus services weakened. Nevertheless, the level of patronage of these operations points to the existence of a potential market for such services—particularly for express bus service to downtown Boston.

Other Public Transportation Services

Two other public transportation or related services showed increases during the postblizzard week. These were the commuter boat, which operates from Hingham to Boston, and fringe parking lots (after they were plowed). The rise in patronage of the commuter boat was quite dramatic, from a typical ridership of 60 riders to 1000 riders on Monday, February 13. Even at the end of the week ridership was still 50 percent greater than on a typical weekday. Fringe parking lots showed only minimal increases.

Summary of Public Transit Ridership

As is evident from the preceding sections, a significantly larger than usual number of people used public transit during the postblizzard week. The total number of persons who used public transportation on Monday, February 13 was nearly 900 000, an increase of almost 50 percent above that for a typical day in February, and on February 14 ridership was over 775 000, an increase of 28 percent. As stated previously, commuters in the Boston region successfully utilized the transit system as an alternative form of travel.

HIGHWAY TRAFFIC VOLUMES

As a corollary to the data on public transit ridership, vehicle counts for selected highway locations are presented in Table 6. The traffic volumes for Monday, February 13, on the highway links shown are from 20 to 68 percent lower than the typical average daily traffic (ADT) volumes for those links and show an average drop of more than 50 percent. Traffic had stabilized somewhat by Tuesday but was still lower in most cases. The drops were more pronounced, generally, for CBD-oriented highways, such as the Northeast and Southeast Expressways, than for highways that have a more suburban orientation, such as MA-128; this holds true more for February 14 than for February 13. On February 14, the driving ban was lifted, but the city of Boston's parking ban was still in effect.

Unfortunately, the data on which the analysis is based are a bit spotty. A number of counting stations (automatic traffic recorders) were disrupted by the storm or the snowplows and had not been repaired by the following week. Manual counts were not possible and, thus, valuable automobile-occupancy data were not collected. However, we can assume that automobile occupancies did

Table 3. Comparison of daily commuter rail ridership.

Date	Number of Passengers	Difference from Typical Weekday (%)
Tuesday, February 28[a]	31 000	-
Monday, February 13	59 925	+93.0
Tuesday, February 14	45 600	+47.0
Wednesday, February 15	42 275	+36.0
Thursday, February 16	39 570	+27.0
Friday, February 17	37 445	+21.0

[a]Typical weekday example.

Table 4. Comparison of daily ridership on MBTA surface lines.

Date	Number of Passengers	Difference from Typical Weekday (%)
Tuesday, February 28[a]	268 500	-
Monday, February 13	391 000	+45
Tuesday, February 14	322 500	+20
Wednesday, February 15	318 000	+19
Thursday, February 16	311 000	+16
Friday, February 17	265 000	-1

[a]Typical weekday example.

Table 5. Comparison of daily ridership on private-carrier express bus service.

Date	Riders[a]	Difference from Typical Weekday (%)
Typical weekday	7 300	-
Monday, February 13	12 500	+71
Tuesday, February 14	10 200	+40
Wednesday, February 15	9 500	+30
Thursday, February 16	9 250	+27
Friday, February 17	9 300	+27

[a]These figures include only service provided by three of the largest private carriers in the region.

Table 6. Comparison of selected highway volumes.

Date	CBD Oriented (Sumner-Callahan Tunnel) ADT	CBD Oriented Difference from Typical Weekday (%)	Non-CBD Oriented (MA-128) ADT	Non-CBD Oriented Difference from Typical Weekday (%)
Typical weekday	70 000	-	57 900	-
Monday, February 13	27 100	-61	46 300	-20
Tuesday, February 14	47 700	-32	53 700	-8
Wednesday, February 15	58 400	-17	NA	-
Thursday, February 16	66 900	-4	57 500	-1
Friday, February 17	76 100	+9	61 800	+7

Table 7. System supply and demand characteristics.

Mode	Tuesday, February 28	Monday, February 13	Tuesday, February 14	Wednesday, February 15
Bus and trackless trolley				
Vehicle trips	7 660	7 924	7 806	8 113
Passengers	294 400	202 500	215 100	180 850
Passengers per bus	38	26	28	22
Rapid transit				
Vehicle trips	2 987	2 452	2 450	2 955
Passengers	303 600	421 150	391 255	361 313
Passengers per vehicle trip	102	172	160	122
Commuter railroad				
Vehicle trips	773	564	564	564
Train passengers	33 105	59 926	47 995	42 281
Passengers per vehicle trip	43	106	85	75

increase on Monday and Tuesday of the postblizzard week because of the driving and parking bans.

CAPACITY OF THE TRANSIT SYSTEM

The information on transit ridership that has been presented reveals only one aspect of the change in transit usage that took place during the week of February 13. The aspect discussed so far is the change in demand. The change in supply (the degree to which the capacity was changed) must be determined in order to analyze how the vastly increased demand was handled. If capacity was not in fact increased, then changes in riders' behavior, such as the staggering of work hours, must have facilitated the accommodation of the demand.

Table 7 presents the number of passengers and vehicle trips and the vehicle loads for February 13, 14, and 15 and for a typical day—February 28. February 28 appears to be a typical day with regard to supply as well as ridership, according to data available from the MBTA.

As can be seen in the table, capacity (measured in daily vehicle trips) was in fact reduced during the postblizzard week. This was caused primarily by equipment shortages caused by storm-related damage. Therefore, as the table indicates, vehicle loads were significantly greater than on a typical weekday. The obvious conclusion is that the postblizzard surge in transit travel was not handled by an increase in capacity.

Ordinarily, peak-hour transit vehicles operate at greater than 75 percent capacity on a typical weekday and on some lines at greater than 100 percent capacity. Therefore, given the postblizzard reduction in capacity, the system's ability to absorb the greatly increased demand must be attributed to a combination of the extremely high number of passengers per vehicle and the effectiveness of the staggered work hours program, which is discussed in the next section.

It should be pointed out that most schools in the region were closed for the entire week of February 13-17. One exception to this was private schools, which had already begun to open. In the MBTA region, approximately 65 000 students rely on the MBTA for transportation to and from school. In addition, many colleges and universities in the core area (which have a total enrollment of approximately 150 000) did not hold classes on February 13 and 14, which also must have had an effect on the regional transportation system. The effect of these school closings was to create some additional capacity in the transit system, although much of it was off-peak capacity and therefore did not directly affect most commuter trips.

STAGGERED WORK HOURS POLICY

One of the problems faced in financing and operating transportation systems, both highways and mass transit, is peaking characteristics. A transportation system is usually built and operated to accommodate approximately the maximum demand expected on a typical weekday. To increase the capacity of the system, physical expansion is usually required. Particular attention has been drawn in the past few years to the short duration of the peak, which is more characteristic of transit systems than other modes. Two effects of this short peak are (a) the necessity of a much larger vehicle fleet and labor force than would be needed if this travel occurred over a longer time period and (b) uncomfortably crowded conditions that may discourage some travelers from using transit.

During the week of February 13, in which both legal restrictions and physical impedances reduced the number of work trips made by automobile, we expected that the shift to transit would place an enormous strain on transit service during the already overburdened peak period. Therefore, the governor's office recommended that a policy of staggered work hours be in effect during the week. Different categories of workers were assigned to different arrival and departure times in an effort to spread out the peak period and thereby increase the capacity of the transit system for that week.

Figure 2 shows the percentage of morning-peak-period transit alightments that occurred in each 0.5-h interval at four of the central stations (Government Center, State, Park, and Washington) on February 13, 14, and 28. Figure 3 shows these distributions for two terminal transit stations (Harvard and Forest Hills). We would expect that both graphical depiction and statistical analysis would show more pronounced peaking on February 28 than on February 13 and 14, the peaking distributions of which would be similar. We might expect

Figure 2. Rapid transit alightments at four stations in the Boston CBD during the morning peak period.

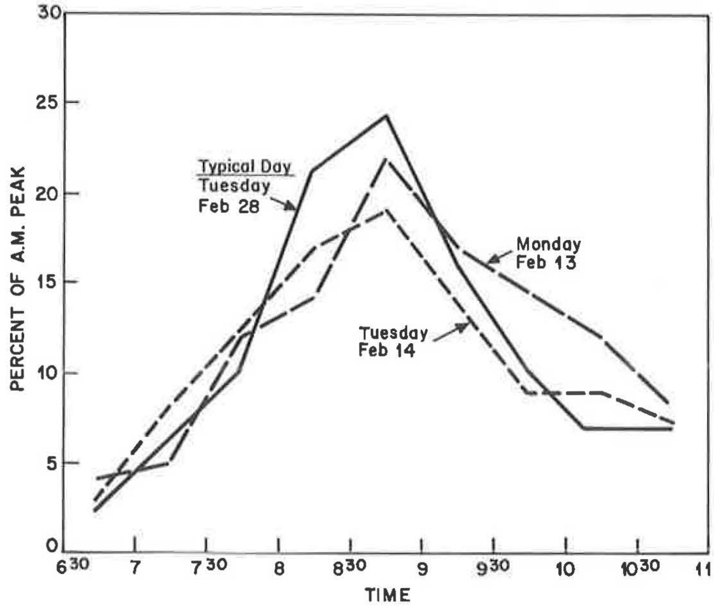


Figure 3. Rapid transit boardings at two terminal stations during the morning peak period.

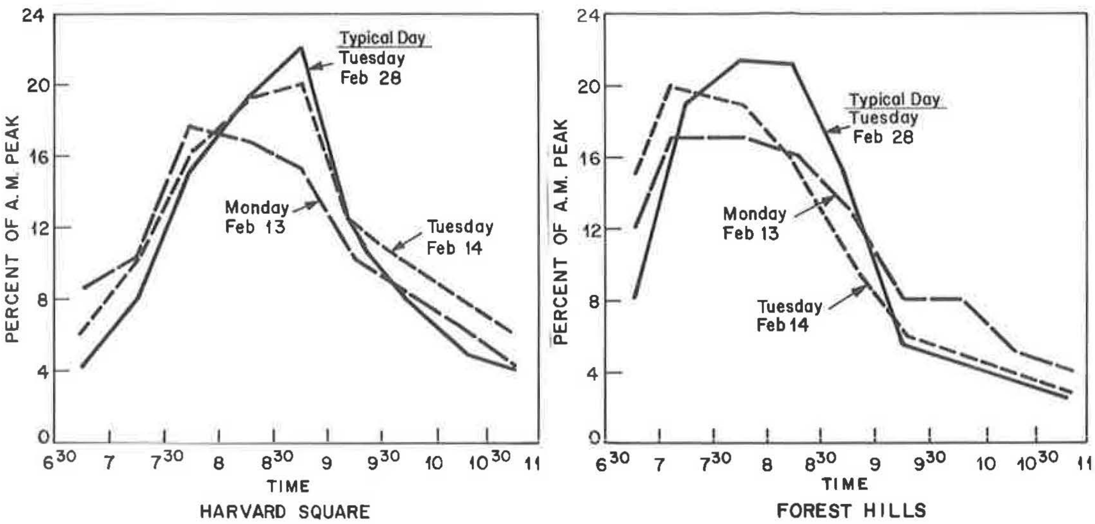
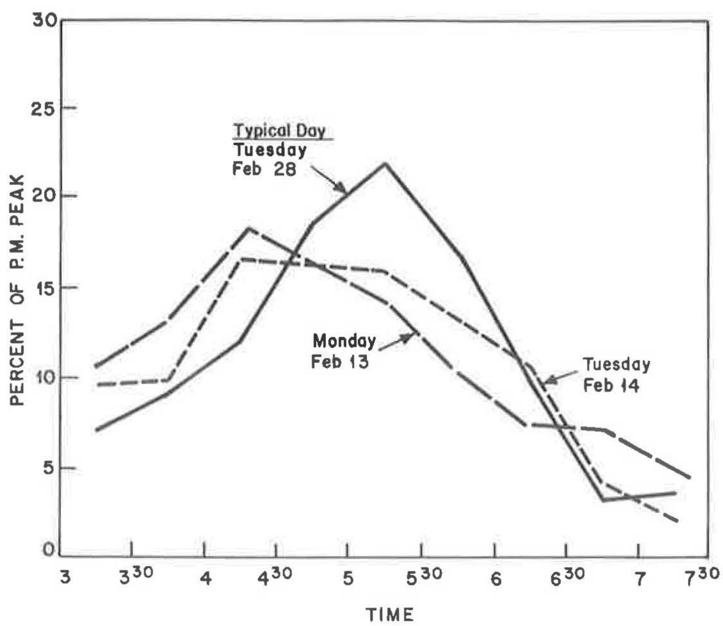


Figure 4. Rapid transit boardings at four stations in the Boston CBD during the evening peak period.



that the peak would be more spread out on Monday than on Tuesday because commuters might have had higher expectations of crowding on that day and, therefore, shifted their boarding times. On the other hand, even more shifting of boarding times might have been expected on Tuesday as a response to the experience of overcrowding on Monday. This is what, in fact, occurred. A further explanation of why peak-period travel was more spread out on Tuesday is that more travelers may have understood how to comply with the staggered work hours program. Another possible factor is that persons who had attempted to arrive at work at their usual time on Monday, by using transit, may have switched to automobile on Tuesday, when there was, in fact, a shift from transit to automobile for peak-period travel.

Figure 4 depicts the evening peak-period boardings at the four central stations. Commuters departed earlier than usual on February 13 and 14 to try to avoid congestion and to compensate for longer travel times. The evening peak period was more spread out on Tuesday than on Monday, perhaps for the reasons given above regarding the morning peak period.

Two different statistical tests were performed to corroborate the conclusions reached through graphical depiction. The first was the chi-square test, which evaluates whether or not observed frequencies differ significantly from normally expected frequencies. The second was the Wilcoxon matched-pairs test, which ranks differences between two distributions to determine if they are statistically different from one another. In all cases the chi-square test corroborated our graphical depiction: The distributions of boardings on February 13 and 14 were significantly different from those of the typical weekday and were also significantly different from each other. This was true for both morning and evening periods and for both the central and the terminal stations. The Wilcoxon test was slightly less conclusive but generally supported the results of the chi-square analysis.

In order to see if the recommended staggering of work hours had any effect on the peaking characteristics of the roadways, hourly traffic volumes at a number of locations on February 2, 13, and 14 were graphed and analyzed. A graph that typifies the pattern found is presented in Figure 5. A chi-square test shows that these distributions of highway volumes are significantly different from one another.

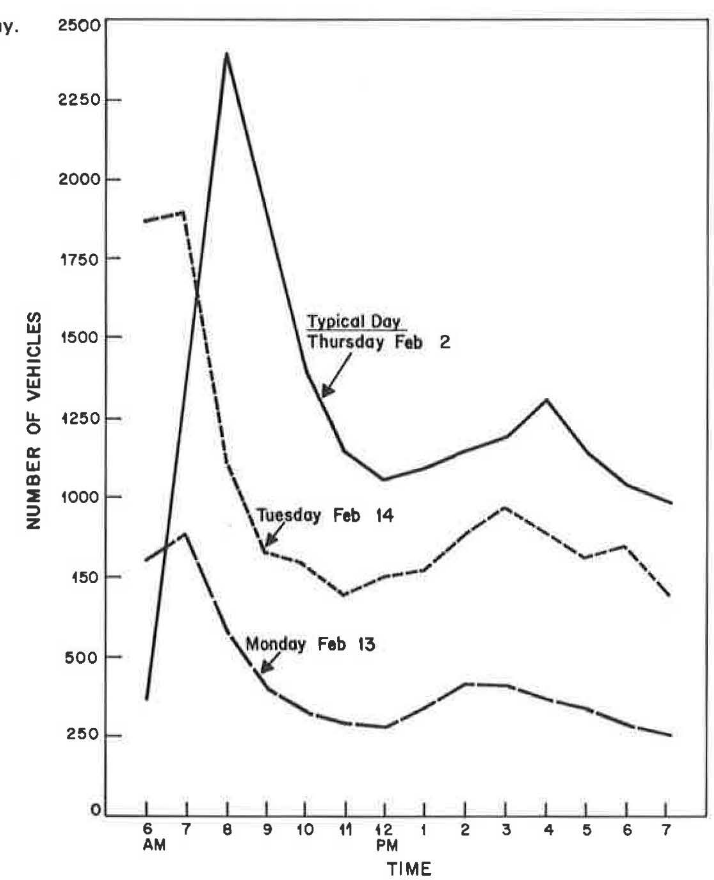
The major differences between the three days is in magnitude (as also shown in Table 6), although, as Figure 5 indicates, some differences in peaking are apparent. On February 13, the morning peak retains a large portion of the travel but is less pronounced than usual; on February 14, the pattern is similar but the peak is slightly more pronounced. On both February 13 and 14, the morning peak hour occurred somewhat earlier than usual as commuters attempted to compensate for longer travel times.

The analysis of highway travel, as well as that of transit travel, shows that a staggering of work hours did occur, although significant peaking still existed on both February 13 and 14.

AIR QUALITY IMPACTS

One of the important objectives of transportation planning in recent years has been to improve air quality by reducing mobile-source emissions. This can be achieved by restricting travel by automobile, controlling the availability of parking spaces, and staggering work hours. Figure 6 depicts the levels of carbon monoxide

Figure 5. Hourly traffic counts on a Boston expressway.



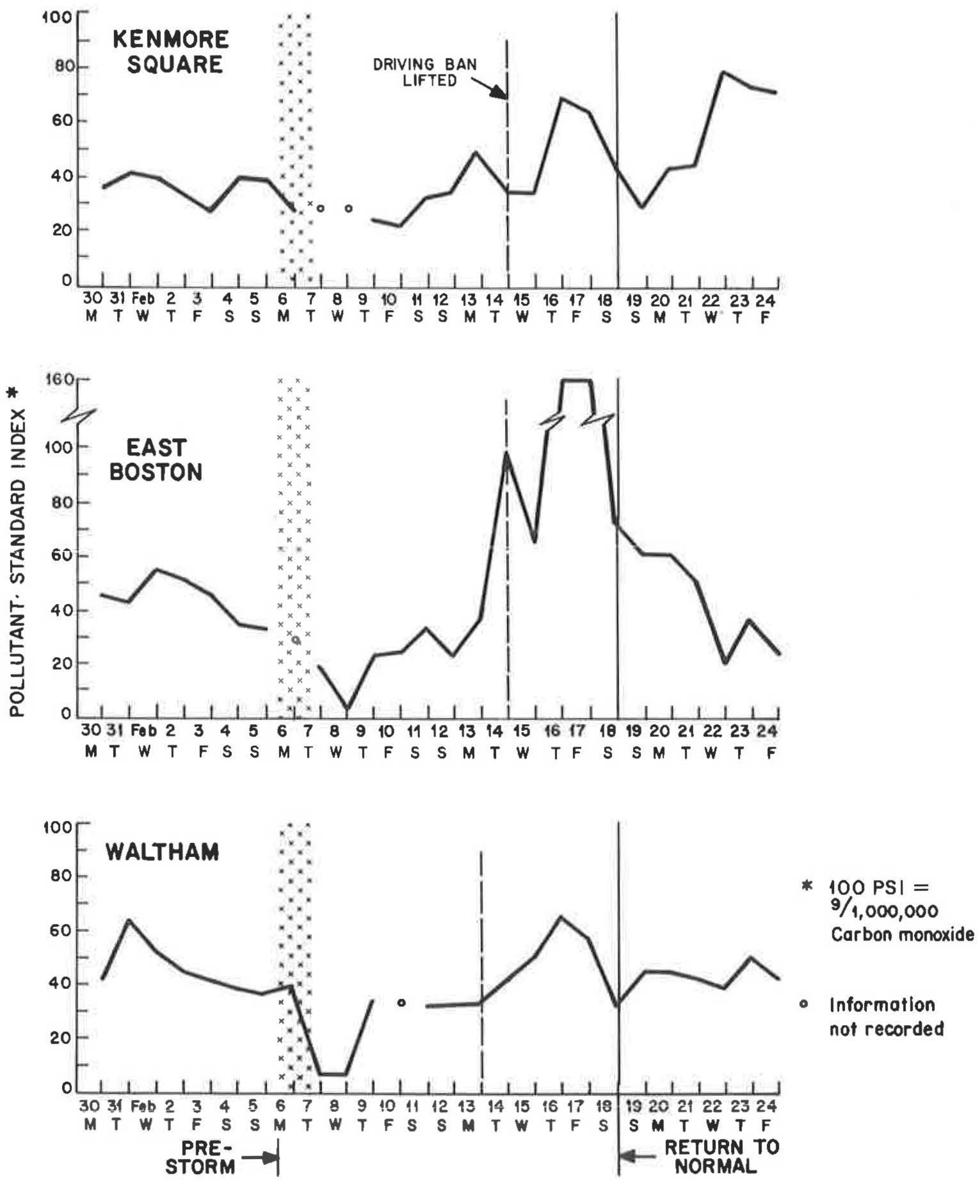


Figure 6. CO measurements at three locations.

(CO) in the atmosphere at three locations in the region during the week of February 6, when the blizzard occurred and an areawide driving ban was in effect. For comparison, data for the following week, during which a partial driving ban was in effect, are presented, as are data for two more typical weeks.

A comparison based only on the postblizzard week would be misleading because pollution levels were higher than normal that week. Many automobiles were used for the first time after being unused for up to a week. Therefore, many drivers tended to idle longer than usual after starting their automobiles, which resulted in higher than average emissions. Impedances created by the blizzard and the postblizzard cleanup forced some automobiles to take more circuitous routes than usual and to travel more slowly, which also caused higher emissions. In fact, emissions for this week were about 70 percent higher than those for the two typical weeks presented in Figure 6. A comparison between the week of the driving ban and these two weeks shows that during the ban, CO levels were 50 percent lower than average. This conclusion is not surprising since approximately 90 percent of CO emissions in the region are produced by automobiles.

CONCLUSIONS

The four major questions posed earlier in the paper can be answered as follows:

1. Commuters forced to travel by means other than private automobile were able to successfully utilize the region's public transit system;
2. The transit system was able to handle the vastly increased demand, though not without some uncomfortable crowding of passengers;
3. People voluntarily staggered their work hours, which helped the transit system to cope with the increased demand; and
4. The reduction in automobile travel resulted in vastly improved air quality.

In addition, the postblizzard week introduced the transit system to people who previously may have considered the automobile to be the only reasonable mode for their work trips. Another important ramification of the postblizzard week was the organization of successful emergency transportation services by cities and towns in the Boston region. Some of these communities operated a subsidized service; others apparently covered their costs from farebox revenues. It has long been thought that one of the largest untapped markets for transit in the Boston region is in express services for commuters who reside in suburban communities and work in downtown Boston. In line with this theory and as a result of the satisfaction of many of the commuters with the temporary express bus services of February 13 and 14, officials and citizens in a number of these communities have begun to examine their feasibility or to plan and develop permanent express bus services for commuters.

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Use of Before-and-After Data To Improve Travel Forecasting Methods

Frederick C. Dunbar, Charles River Associates, Inc., Boston

Most practitioners think that disaggregate probability choice models are a theoretical advance over traditional methods. The accuracy of these models remains in doubt, however, given the conflicting, often aggregate, findings from time-series research and before-and-after studies, which may have more validity than disaggregate demand studies. This paper evaluates various travel-demand research methods to uncover a consistent explanation for variations in their findings. The results of before-and-after studies can be used to infer first-order approximations to travel-demand relations. It is shown how these results, by using demand elasticities, can be integrated into a system for predicting travel behavior responses to system changes. We argue that the observed differences between quasi-experimental and disaggregate model results can be attributed to differences in the types of data being used. Without a priori information or a formal specification of long-run household decisions, the cross-sectional data used in estimation of disaggregate models will not typically reveal short-run traveler preferences. Future research should concentrate on isolating short- and long-run behavior. This may require merging data from cross-sectional surveys and before-and-after quasi experiments. If only cross-sectional data are used, attention should be given to the effects of long-run residential decisions in interpretation of the data.

Volumes along a transportation link that connects an origin and destination (arbitrarily defined) are the result of the interaction between two separate relationships. The first of these, labeled supply, assumes a fixed capacity for this transportation service; consequently, as the volume on this link increases past a certain point, its level of service will decline. Prior to any change in the system, it is a knowable relationship within tolerable error limits. Short-run demand for travel is premised to be a separate relationship that increases as the level of service for the link improves.

The major problem for an analyst in the evaluation of a change in the transportation system is that the effects of level of service on demand are not known within acceptable limits of certainty. Prior to a system change, the analyst knows equilibrium volumes, level of service, and the system performance relationships. A system improvement is depicted by a translation of the supply curve. If we assume short-run stability and equilibrium in the network, a new level of service and volume along the link will result. To evaluate whether this improvement should be made, the analyst needs to forecast the new volumes and level of service. This requires an approximation of a segment of the demand curve.

Consideration of long-run demand increases the complexity of forecasting the effects of system changes. Sometimes we can assume that the locational impacts of system change are negligible. However, often long-run demand cannot be ignored, even if the analyst is only interested in predicting short-run effects.

How can an analyst predict equilibrium volumes and level of service? Traditionally, there are two procedures: (a) previous experience with similar system changes can be used to infer the potential impacts or (b) two or more existing situations where there are variations in the level of service can be compared to infer how these variations affect trip making. We will call the former quasi-experimental design and the latter cross-sectional data analysis.