

tion. This difference is about 1.0 ft. on the narrower roads and 0.5 ft. on the 24-ft. pavement.

#### CONCLUSIONS

It is important to remember that the values presented are averages for the highways selected and the conditions that were studied. Some of the conclusions might have to be qualified by the results of additional analysis on roads of similar width but with other design features.

Under the conditions presented the following conclusions have been derived:

1 Trucks stay closer to the edge of the pavement than passenger cars both when meeting other vehicles and when moving freely. The greater truck body and tread width are undoubtedly factors in the lower edge clearances for trucks. It may also be attributed to the fact that truck drivers are better trained to handle their vehicles than drivers of passenger cars.

2 The path of a vehicle on a concrete road goes from one extreme when meeting opposing traffic to the other extreme when passing other vehicles in the same direction of travel. The normal position is considered to be that occupied when the vehicle is moving freely unaffected by proximity of other vehicles. The transverse shift from the free-moving to the meeting position is about 1.0 ft. for passenger cars and 0.5 ft. for trucks.

3 Under the highway conditions included in this analysis (concrete pavement and good grass shoulders), the average passenger car would not travel closer than 1.9 ft. to the edge of the pavement and trucks 1.4 ft. even at the expense of greatly restricted clearance between meeting vehicles. An edge clearance of approximately 3 ft. is required before added pavement width will be utilized to increase materially the clearances between meeting vehicles. With these conditions a pavement width of 20 ft. is inadequate for comfortable meeting, even of passenger cars.

## CURRENT TRENDS IN THE VOLUME AND CHARACTERISTICS OF HIGHWAY TRAFFIC

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### SYNOPSIS

The Public Roads Administration and the State highway departments are continuously collecting, analyzing, and making available to the various war agencies, through periodic bulletins, data showing fluctuations in traffic volumes and vehicle speeds. In the summers of 1942 and 1943 short surveys, which gave information concerning changes in vehicle weights and loading practices since the more extensive pre-war survey, were made in nearly all States.

The general trend in traffic volume has been downward throughout 1942 and 1943 in all sections, but to a greater degree in the East than elsewhere. In the Midwest and West traffic dropped sharply following gasoline rationing in December 1942, and then made a partial recovery. A large part of the traffic reduction has been due to a virtual elimination of summer vacation travel, and to drastic declines in Sunday and holiday travel in regions where pleasure-driving bans have been in effect.

The indicated decrease in total vehicle-mileage on main rural roads from 1940 to 1943 is about 45 percent in the East, 34 percent in the Midwest, and 31 percent in the West. The indicated decrease in truck mileage from 1940 to 1943 is about 24 percent in the East, 20 percent in the Midwest, and 9 percent in the West. Traffic by truck combinations, however, has increased in all regions since 1940. Average weight increases have nearly offset decreases in vehicle-mileages so that

the ton-mileage of load carried by truck in the United States as a whole, in 1943, is expected to be only about 5 percent less than in 1940

The average number of heavy axle loads passing each survey station in the eight hours of operation was much greater in 1942 than in the 1936-1940 period, but was only slightly greater in 1943 than in 1942. The same is true of heavy gross weights.

The President's appeal for slower speeds to conserve tires, actions taken by the States in response to this appeal, and finally the Office of Defense Transportation order limiting speeds to 35 miles per hour, caused successive reductions in speeds in 1942, but speeds have tended to increase slightly in 1943. In October and November, 1942, when speeds were lowest, regional differences, and differences in speeds of busses, passenger cars, and trucks, were much less than they had been previously. Average speeds have never been below the maximum permissible in the ODT order, and the percentage of drivers violating the order has never been less than 53 percent.

During the past year, the highway departments of the various States, in cooperation with the Public Roads Administration, have continued to collect data indicative of trends in the volume and characteristics of highway traffic. The collection and prompt analysis of such data has been of especial importance because of the wartime regulation of the sale of automobiles, tires and gasoline, and of the loading and operation of motor vehicles.

The various war agencies exercising controls have been kept informed of the net effects of the natural and artificial factors bearing on highway transport through bulletins issued periodically by the Public Roads Administration, showing mainly the fluctuation in traffic volumes and in vehicle speeds. Information concerning trends in vehicle weights and loading practices, and digests of the traffic volume and speed data, were presented to the Highway Research Board last year, and some of the information has been published in the official magazine of the Public Roads Administration.<sup>1</sup>

The traffic volume trends are derived principally from the records of automatic traffic recorders operated continuously at about 500 fixed locations on rural roads in 46 States. The speed-data result from studies made on rural roads periodically in 1941, 1942, and 1943, in which the speeds of about 800,000 vehicles were determined at about 2,000 locations in 43 States.

Special surveys were made in the summers of 1942 and 1943 to give information con-

cerning changes in the composition of traffic and in vehicle weights and loading practices. Traffic was counted and classified by vehicle type, and trucks were weighed during an eight-hour period on a weekday at each of a number of locations on main rural roads. The operations were so scheduled as to time and place that the 1943 data would be strictly comparable with the 1942 data, as well as with data obtained in the original highway planning survey, made in a pre-war year. The survey was made in all three years by 42 States and in two of the three years by the remaining 6 States. However, the analysis has not been completed in all cases and this discussion is based on 1943 data from 40 States and 1942 and pre-war data from 46 States. The number of stations operated all three years was 423; the number of vehicles counted and classified exceeded 360,000 and the number of trucks weighed exceeded 45,000, in each of the years.

Though the operations were confined to a single season, and the stations were rather thinly spaced, it is believed that the comparisons which were made under conditions of strict comparability, show trends in truck traffic volume and in weights and loading practices, which are reasonably representative of the general trends for the years covered. This is supported by the fact that the 1940-1942 trends in truck traffic volume, calculated from the data taken in the summer, were later checked almost exactly by data which became available from 122 classification-count stations operated in all seasons of the two years, in 16 States well distributed geographically.

Figure 1, which is based entirely on auto-

<sup>1</sup> *Proceedings*, Highway Research Board, Vol 22, p 375, *ibid*, p 362; *Public Roads*, Vol 23, No. 9, (issue of July-August-September, 1943) p 231.

matic traffic recorder data, covers the period from February, 1942 to September, 1943 and shows the relation of traffic each month of that period with traffic in the corresponding month of 1941, thus obliterating the effects of seasonal variation and giving an indication of the changes caused by wartime restrictions. In calculating totals, the percentage relations shown by the automatic recorder data for each United States census region were weighted in accordance with the vehicle-miles of travel on rural roads in the region, to eliminate any effects of disproportionate coverage.

The bottom curve labeled "East" applies to the three eastern census regions, which include all of the States bordering on the Atlantic Ocean and also West Virginia; and the top

traffic, in relation to that of the preceding year, from March through August. In contrast, rationing in the Midwest and Far West on December 1, 1942, caused an abrupt decline to a level very close to that in the East, though there was a partial recovery in January and February, 1943. This violent reaction suggests that rationing was less in keeping with the availability of gasoline, and with the psychological factors, than in the East. The moderate decline from February, 1942 to August, 1942, in the Midwest and Far West was probably caused largely by tire shortages. The decline in the East at the end of 1942 was caused in part by the cut in coupon values and in part by the freezing of gasoline supplies for several days in December.

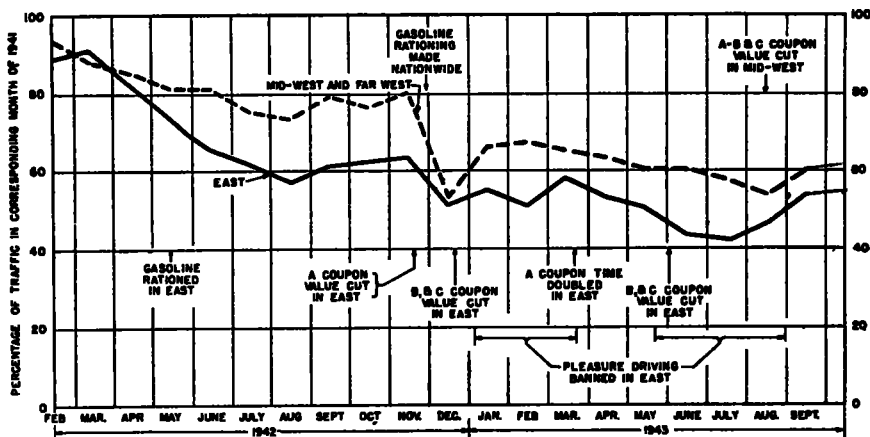


Figure 1. Percentage Relations of Rural Traffic in Months of 1942 and 1943 with That in Corresponding Months of 1941

curve, labeled "Midwest and Far West," applies to the rest of the United States. The notes below the curves show the most important official acts affecting travel in the East, and the notes above the curves show those affecting travel in the Midwest and Far West. While the eastern area, as defined in official orders and regulations, does not conform to State lines and is therefore not exactly coincident with the area to which the lower curve applies, the differences between the two areas are not great.

The absence of a sharp drop in travel in the East when gasoline was first rationed on May 15, 1942, suggests that increasing shortages and psychological factors, rather than the act of rationing, caused the steady decline in

Both curves show midsummer dips for both years. This is undoubtedly due to the fact that the recreational driving which normally occurs in the summer months is more readily curtailed than the more essential driving which occurs throughout the year. This is clearly shown in Figure 2, which applies to the New England region where recreational travel in the summer is especially great. The curves, in this case, represent the sum of the average daily number of vehicles at the 31 automatic recorders for months of 1941, 1942, and 1943. In 1941, summer travel in this area was nearly twice as great as winter travel, whereas in 1942 it was only slightly greater, indicating an almost complete elimination of vacation travel. In 1943, traffic increased progres-

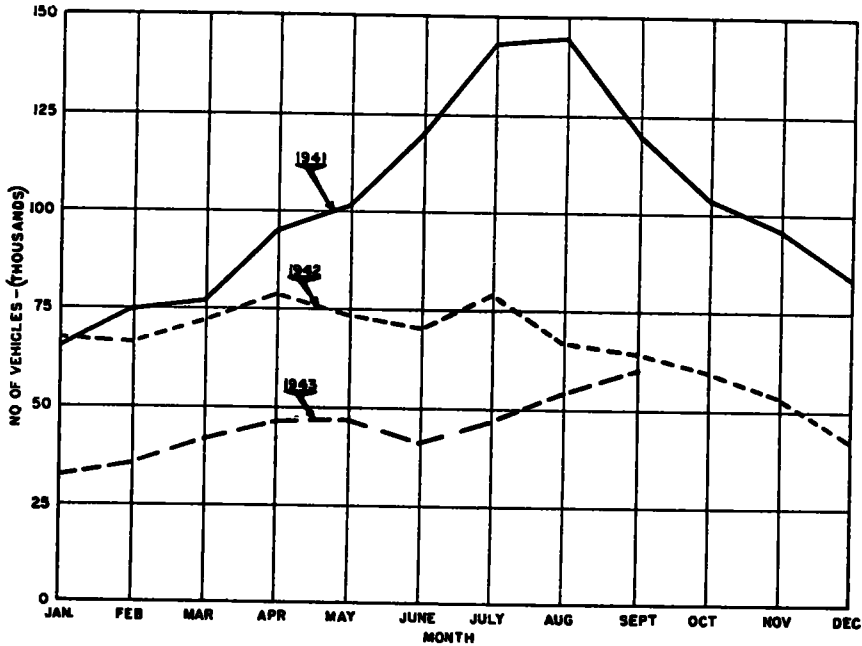


Figure 2. Average Daily Traffic in 1941, 1942 and 1943 at 31 Automatic Traffic Recorder Stations in the New England Region

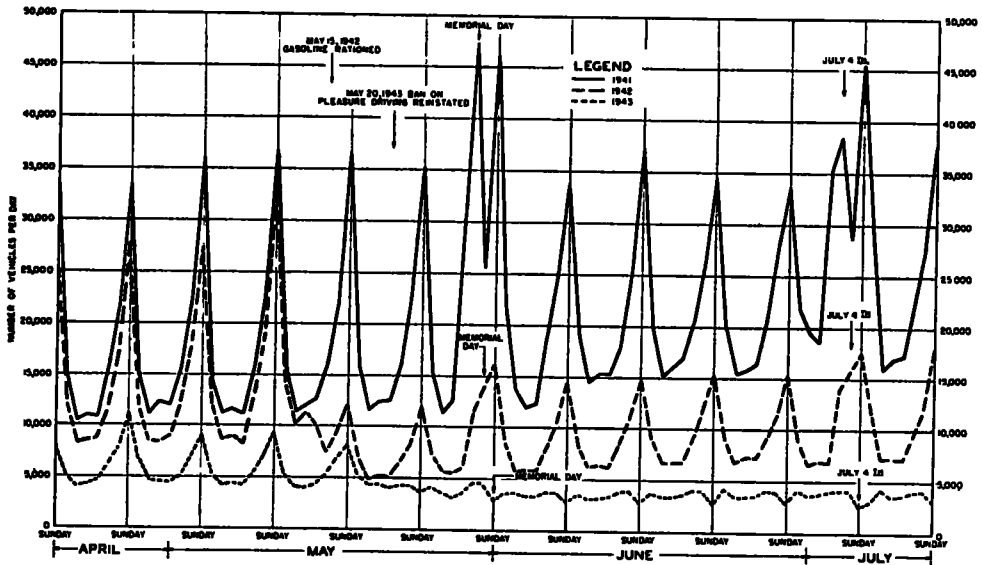


Figure 3. Daily Traffic Volumes on the Merritt Parkway in Connecticut during Corresponding Periods of 1941, 1942 and 1943 Showing Effects of Gasoline Rationing and Restriction on Pleasure Driving.

sively through July, August, and September, although it still remained below the already greatly depressed 1942 traffic. This rise may be due to increased optimism with respect to

the gasoline situation in the East, reflected finally in the lifting of the pleasure-driving ban on September 1.

Figure 3 gives a striking illustration of the

effects of rationing and pleasure-driving bans on Sunday and holiday passenger-car traffic. It shows daily traffic during corresponding periods of 1941, 1942, and 1943 at a point on the Merritt Parkway in Connecticut near the New York State line. This parkway is restricted to passenger cars and a very small toll is charged.

In 1941, the Sunday peaks went up to about 35,000 vehicles and on Memorial Day, the Sunday following, and the sixth of July, the daily traffic exceeded 45,000 vehicles. In 1942, before gasoline was rationed, traffic was only slightly below that of 1941, and the pattern was similar. As soon as gasoline was rationed on May 15, traffic dropped to about half of that of corresponding days of 1941,

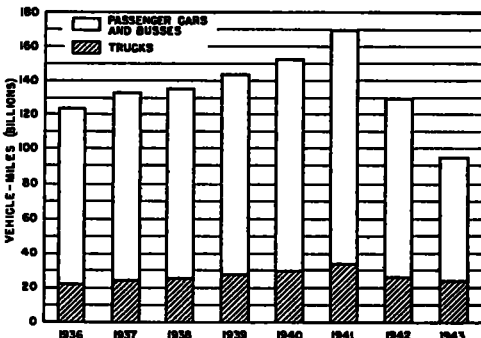


Figure 4. Estimated Vehicle-Miles of All Traffic and of Truck Traffic on All Rural Roads in Each Year from 1936 to 1943, Inclusive.

but this change was nearly proportional as regards weekdays and Sundays, the general shape of the curve remaining about as before. When the pleasure-driving ban was applied on May 20, 1943, however, the shape of the curve was entirely altered, and the Sunday and holiday peaks became valleys.

The behavior of traffic on the Merritt Parkway is not the same as on roads in the East generally, as can be seen by comparing the sudden drop in traffic on this road after gasoline rationing with the more gradual drop shown for the area as a whole in Figure 1. However, the conversion of Sunday and holiday traffic peaks into valleys is typical of the effects of the pleasure-driving ban, as revealed by data from automatic traffic recorders at numerous other locations.

Figure 4 shows trends in rural vehicle-miles by all vehicles and by trucks from 1936 to

1943, inclusive. The 1943 vehicle-mileage shown for all vehicles is based on trend data from automatic traffic recorders for the first nine months combined with estimates for the last three months, and that shown for trucks is based on the trends shown by the midsummer survey. The estimates are preliminary, of course, and will be revised as appears proper after data from the automatic recorders and from the classification counts become available for the full year 1943.

It is estimated that 1943 traffic on all rural roads will amount to about 96 billion vehicle-miles, 56 percent of the 1941 peak and lower than at any time in the last ten years or more. Rural truck traffic in 1943 will probably amount to about 24 billion vehicle-miles,

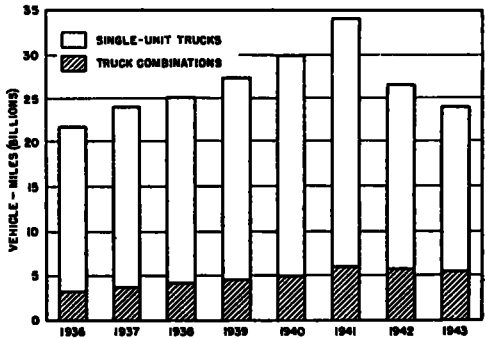


Figure 5. Estimated Vehicle-Miles of All Trucks and Truck Combinations on All Rural Roads in Each Year from 1936 to 1943, Inclusive.

which is 71 percent of the 1941 peak and about the level of 1937 truck traffic.

In Figure 5, the elevation of the tops of the bars indicates traffic by all trucks, while the elevation of the shaded portion indicates traffic by truck combinations. It is estimated that, in 1943, rural travel by combinations will amount to about 5.2 billion vehicle-miles, only slightly below that of 1942 and 1941, and above the level of 1940.

Since the weight surveys in 1942 and 1943 were confined to main rural roads, the subsequent discussion will be confined to roads of that class. These roads constitute about 12 percent of the total rural road mileage, but carry about 72 percent of the rural vehicle-mileage, as the average density of travel on them is about 20 times as great as on the local roads.

In Figure 6, the estimated 1943 vehicle-mileages of all vehicles and of trucks, classified to this time. The relations are shown separately for the East, which comprises the three

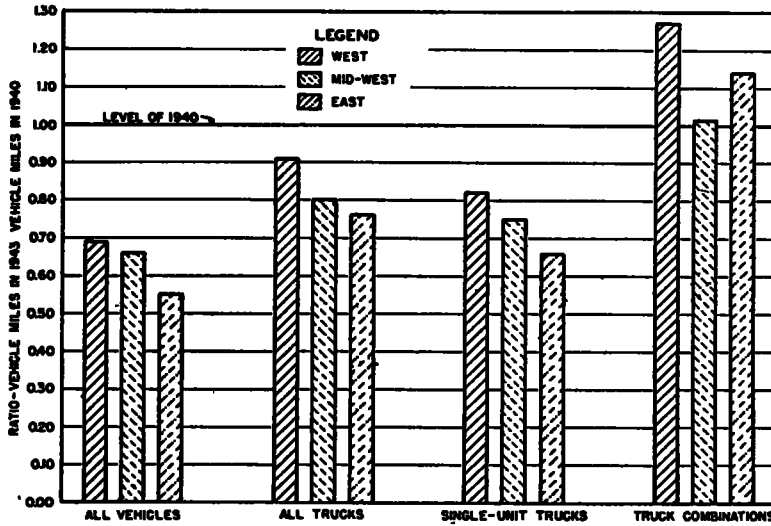


Figure 6. Ratio of Estimated Vehicle-Mileage on Main Rural Roads in 1943 to That in 1940, by Vehicle Type in the West, Mid-West, and East

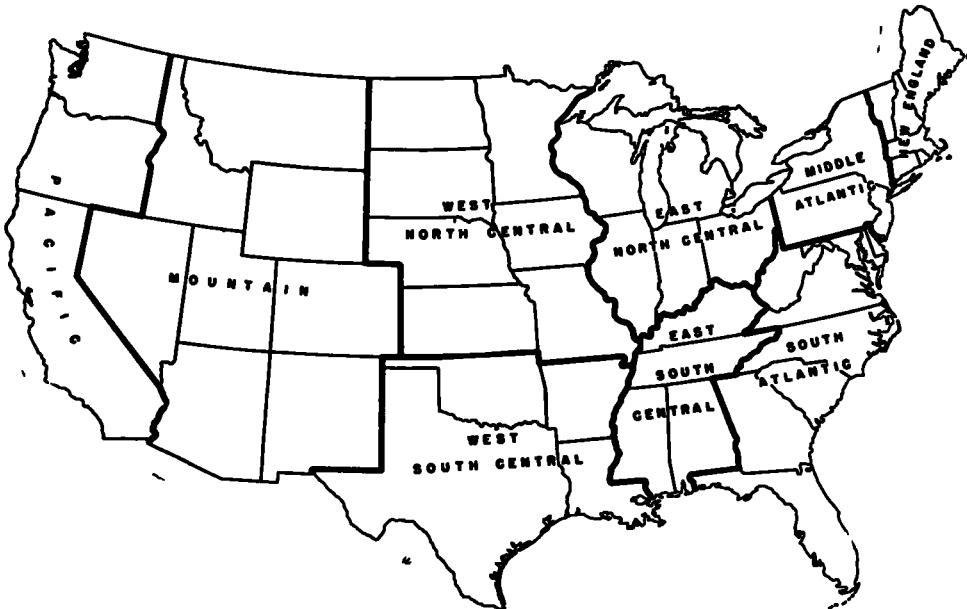


Figure 7. Census Regions of the United States

separately as single-unit trucks and truck combinations, are compared with those of 1940 to show the net effects on traffic of the war up

eastern census regions (shown in Fig. 7) and includes the States bordering on the Atlantic Ocean, and West Virginia, for the Midwest

which includes the four central census regions, and for the West which includes the Mountain and Pacific regions

For both passenger cars and trucks, declines have been the most severe in the East and smallest in the West. In the East, 1943 traffic by all vehicles will amount to only about 55 percent of that in 1940, while in the West it will be about 69 percent of the 1940 traffic. Truck traffic in 1943 is expected to be about 91 per cent of that in 1940 in the West, but only about 76 percent of the 1940 traffic in the East. In contrast to traffic by single-unit trucks, which declined sharply, traffic by truck combinations has increased substantially in

similarly, and it is assumed that the increases in average carried load were about proportional to increases in gross weights. Figure 9 shows estimated average carried load for 1940, 1942, and 1943 in each section. The progressive increases from 1940 to 1942 and from 1942 to 1943 took place to about the same degree in all sections. Loads are heaviest in the West, next heaviest in the East, and lightest in the Midwest.

Figure 10 shows the load increases by vehicle type. The percentage increases for all trucks have been greater than those for either type, because of the increased proportions of combinations which weigh, on the

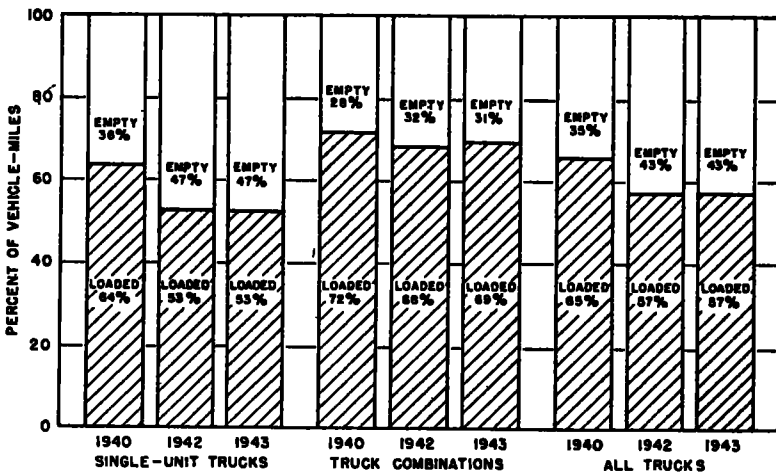


Figure 8. Estimated Per Cent of Vehicle-Miles Loaded in 1943, in 1942, and in 1940, for Single-Unit Trucks and Combinations on Main Rural Roads

the West and East, and slightly in the Midwest, since 1940. The vehicle-mileage by combinations in 1943 will be about 27 percent above that of 1940 in the West, and about 14 percent above in the East.

There was an increase in the percentage of empty vehicles in 1942 compared with 1940, both as regards single-unit trucks and combinations. This trend did not continue into 1943, however, and the percentage relationships between loaded and empty vehicles are about the same as last year. This is shown in Figure 8.

In all sections of the country, average gross weights continued to increase for both single-unit trucks and combinations. Average weights of empty vehicles increased

average, almost four times as much as the single-unit trucks.

In Figure 11, the vehicle-mileage of loaded vehicles is plotted as abscissa and the average carried load is plotted as ordinate so that ton-miles, which is the product of the two is represented by area. The vehicle-mileage of loaded vehicles was substantially less in 1942 than in 1941, and is less in 1943 than in 1942, but the decreases have been nearly offset by increases in carried load, so that the ton-mileage of load carried has declined only very slightly, the total decline from 1940 to 1943 amounting to only 5 percent. The estimated ton-mileages for main rural roads are 46.7 billion in 1940, 46.0 billion in 1942, and 44.5 billion in 1943.

In Figure 12 the ton-mileage hauled in each of the three years is shown separately for single-unit trucks and combinations. The increasing importance of the combinations is clear, as the ton-mileage for this type of

The number of heavy axle loads, and the number of heavy gross weights, per thousand trucks, were much greater in 1942 than in the pre-war year, and substantially greater in 1943 than in 1942. However, because of the

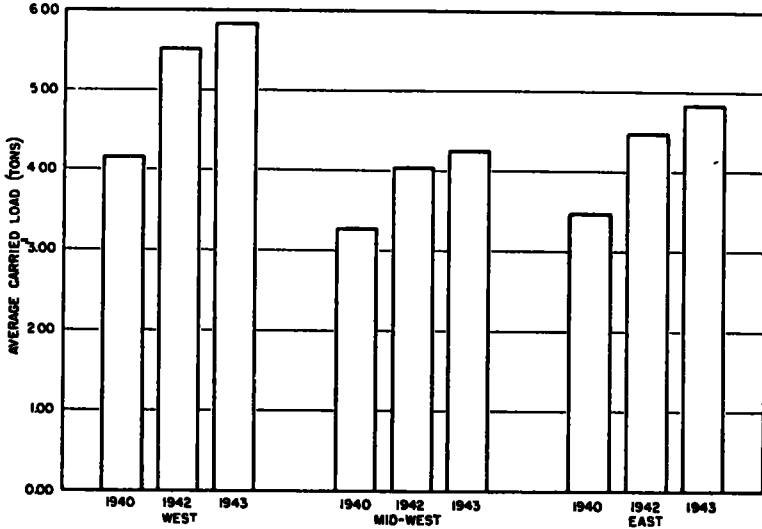


Figure 9. Estimated Average Carried Load of Loaded Trucks in 1943, 1942 and 1940 on Main Rural Roads in the West, Mid-West and East

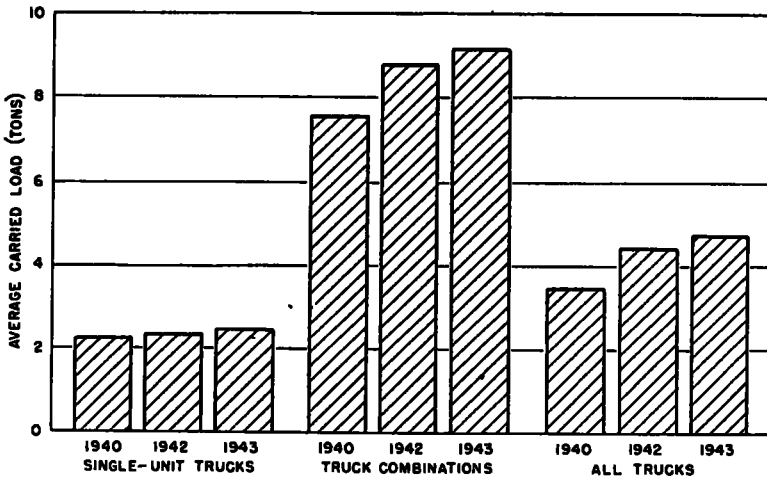


Figure 10. Estimated Average Carried Load of Loaded Single-Unit Trucks and Combinations in 1943, in 1942, and in 1940, on Main Rural Roads

vehicle increased from 1940 to 1942 and again from 1942 to 1943, while the ton-mileage for single-unit trucks decreased in both periods. In 1940, truck combinations hauled only about half of the total ton-mileage, while in 1943 they hauled about two-thirds of the total.

decrease in traffic, the absolute numbers of these heavy loads per survey station were almost the same in 1943 as in 1942, though they were considerably greater in 1942 than in the pre-war year.

Figure 13 shows the average number of



heavy axle loads per station for each of the three surveys. Percentages obtained from the sample weighed at each station have been applied to the total number of trucks counted at the station during the operation so that the numbers shown are for all trucks passing the stations during the 8-hr. periods, whether

lar trend; but the average number exceeding 22,000 lb, which was not great in any period, was smaller in 1943 than in either of the two earlier periods.

Figure 14 shows similar trends with respect to gross weights. The number exceeding 15 tons, 20 tons, and 25 tons more than doubled from the pre-war year to 1942, but increased only slightly from 1942 to 1943.

The number of heavy load concentrations, as measured by the gross weight formula was not determined in a pre-war year, but was about the same in 1943 as in 1942. The formula is

$$C = \frac{W}{L + 40}$$

in which *W* is the total weight in pounds, *L* is the distance in feet between the first and the last axle of the vehicle or of any interior group of axles, and *C* is a measure of the load concentration. Values of *C* exceeding 750, which are generally considered excessive, averaged 4.6 per station in 1942 and 4.8 per station in 1943, for the eight hours of operation.

The speed data collected in 1941, 1942, and 1943 have been compiled by time periods two

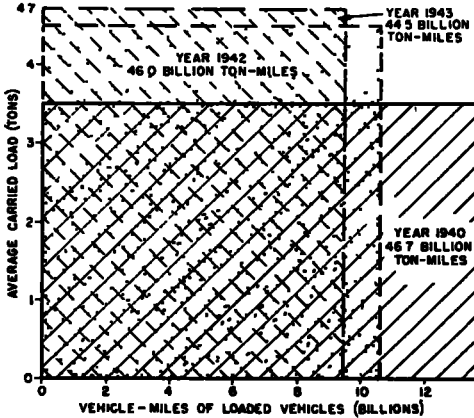


Figure 11. Estimated Ton-Miles in 1943, in 1942, and in 1940 on Main Rural Roads

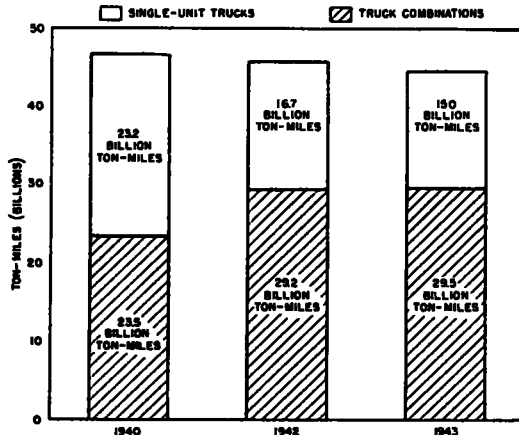


Figure 12. Estimated Ton-Miles Carried by Single-Unit Trucks and by Combinations in 1943, in 1942, and in 1940, on Main Rural Roads

weighed or not. The pre-war year was not the same in all States, but was generally in the 1936-1938 period.

The average number per station of axle loads exceeding 18,000 lb. was nearly twice as great in 1942 as in 1941, but was only slightly greater in 1943 than in 1942. The average number exceeding 20,000 lb. followed a simi-

lar trend; but the average number exceeding 22,000 lb, which was not great in any period, was smaller in 1943 than in either of the two earlier periods.

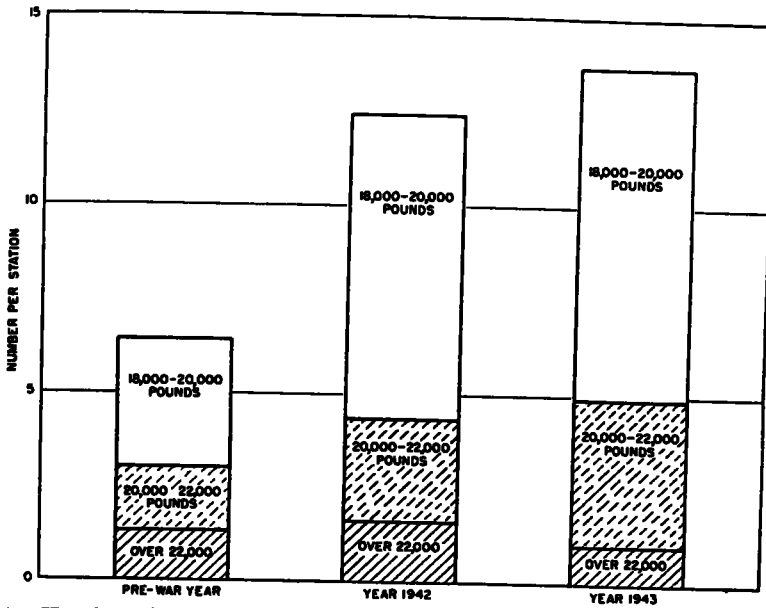


Figure 13. Number of Heavy Axle Loads in an 8-hour Period per Survey Station in 1943, 1942, and a Pre-war Year

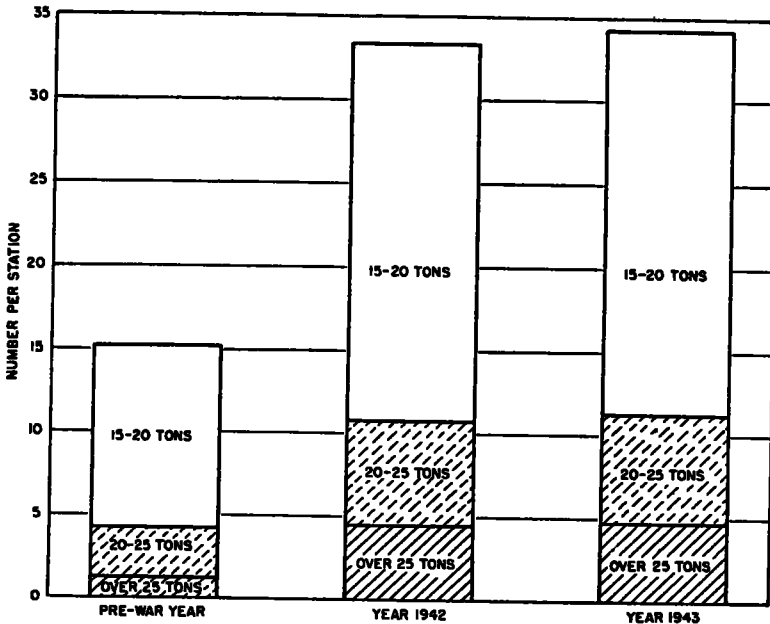


Figure 14. Number of Heavy Gross Loads in an 8-Hour Period per Survey Station in 1943, 1942, and a Pre-war Year

as this method should result in the closest possible approximations to true average speeds, and tests showed that it gave prac-

tically the same trends as those obtained by limiting the comparisons to figures taken at identical locations in two consecutive periods.

Figure 15 shows average speeds separately for the East and for the Midwest and Far West. Of course the speeds did not remain constant throughout periods of several months and then change suddenly, as shown by the successive horizontal sections of line at different levels. The shape of the curves, in this respect, is due to the combining of all of the data for each period in the calculations. However, as will be shown later by specific examples, the true shapes of the curves probably did not vary as much from the shapes shown as might be expected.

In normal times, average speeds in the East are lower than those in the Midwest and West. The difference during the period prior to

hour, there was a moderate drop in speeds in the East, and a sharp drop in those in the Midwest and Far West, bringing average speeds for the two sections of the country almost to the same level, at about 36 miles per hour. It will be noted, however, that the average speed for each section was still above the maximum prescribed.

In each of the three subsequent periods studied, average speeds increased slightly in each section, rising to about 38 miles per hour in the East, and 39 miles per hour in the Midwest and Far West, in the June-July-August period. This rise was probably due at first to a typical rebound from the first reaction to the ODT order, and later to greater opti-

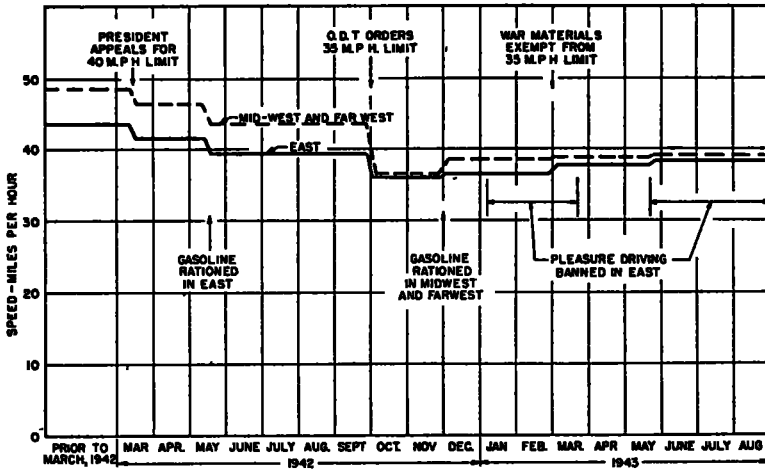


Figure 15. Average Wartime Speeds of All Vehicles on Main Rural Roads in East and in Mid-West and Far West

March, 1942, included in the study, was 5 2 miles per hour

The President's appeal for a 40-mile-per-hour maximum speed resulted in immediate reductions in average speeds of 2 1 miles per hour in the East and 2.3 miles per hour in the Midwest and Far West; and subsequent actions by the States in response to the President's request further reduced average speeds 2.1 miles per hour in the East and 2 9 miles per hour in the Midwest and Far West. The average speed differential between the two sections of the country was still 4 2 miles per hour, compared to 5 2 miles per hour prior to the President's appeal

Following the order of the Office of Defense Transportation limiting speeds to 35 miles per

mism on the part of the general public with respect to the tire situation.

Figure 16 shows average speeds separately for passenger cars, trucks, and busses. The samples for trucks and busses were not sufficiently large to justify the calculation of averages for two separate periods between March and September, 1942, and the data for these vehicle types taken in the two periods were therefore combined. Average bus speeds have been consistently higher than those of passenger cars or trucks, and average passenger-car speeds have remained consistently higher than those of trucks. Following the ODT order limiting speeds to 35 miles per hour, however, average speeds for busses and passenger cars dropped below the level of the

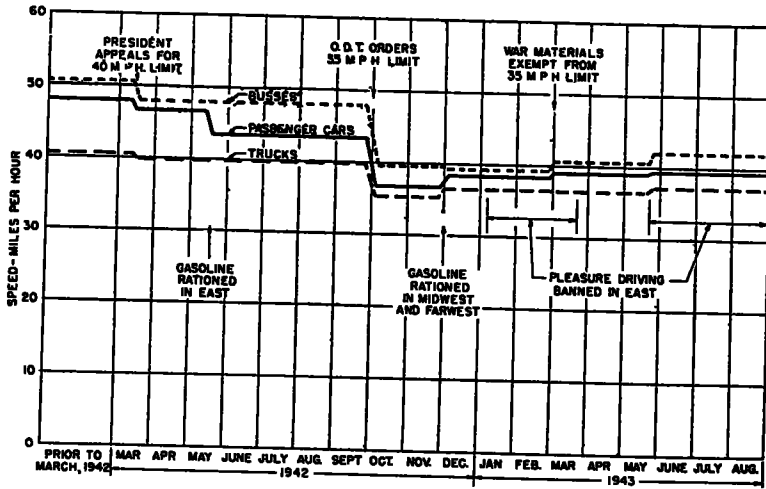


Figure 16. Average Wartime Speeds of Passenger Cars, Trucks, and Buses on Main Rural Roads

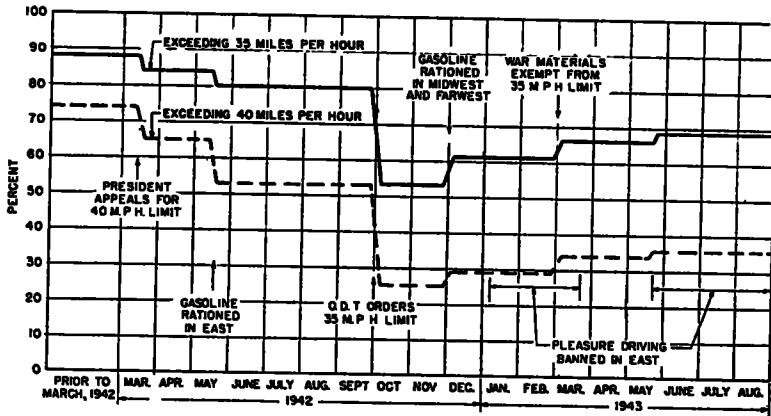


Figure 17. Percentage of Vehicles on Main Rural Roads Exceeding 35 and 40 Miles per Hour, Respectively

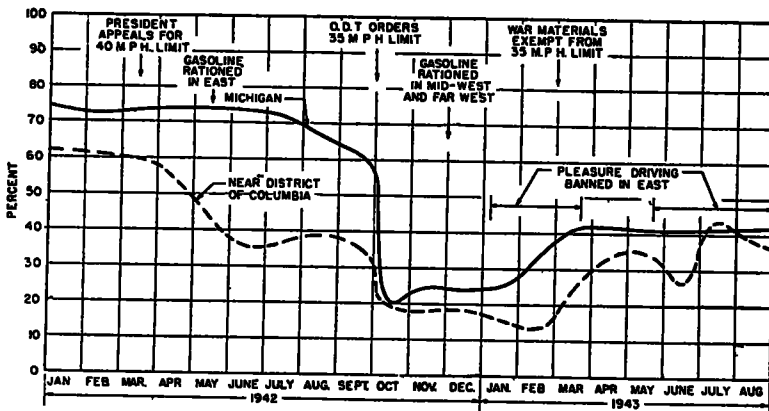


Figure 18. Percentage of Vehicles on Main Rural Roads in Michigan and Near District of Columbia Exceeding 40 Miles per Hour

average truck speeds which prevailed prior to the order. The ODT order issued on March 1, 1943, which exempted trucks hauling war materials from the speed limit of 35 miles per hour, had no apparent effect on average truck speeds.

A curve, showing the frequency of speeds in excess of certain values, is a more sensitive index of the response of motorists to the appeals and orders relative to speed reduction than one showing averages. Figure 17 shows the percentage frequencies of speeds exceeding 35 miles per hour and of those exceeding 40 miles per hour. Prior to March, 1942, 88 percent of all drivers exceeded 35 miles per hour as they passed the speed stations. This portion dropped to 84 per cent immediately following the President's appeal, to 80 percent in the next period studied, and to 53 percent immediately following the establishment of the 35-mile-per-hour limit by the Office of Defense Transportation. The percentage driving in violation of the ODT order increased from 53 percent to 61 percent, to 66 percent, and to 69 percent in the next three successive periods. However, the percentage of very fast drivers decreased to a greater extent and later increased to a lesser extent than the percentage exceeding 35 miles per hour. The portion exceeding 40 miles per hour was 74 percent prior to the President's appeal, was down to 25 percent immediately following the ODT order, and increased only to 34 percent subsequently.

Figure 18 is included mainly for the purpose of indicating the extent to which the true curves showing speed changes conform to those previously shown, in which data for several months were averaged. For a group of Michigan stations, and for another group near the District of Columbia, the studies were made for frequent periods with less than a month between successive studies, and the plotted points from which the curves were drawn are therefore relatively closely spaced. These curves show that the speed changes took place rather suddenly, and that there were periods in which little or no change occurred. Though the percentage driving in excess of 40 miles per hour was considerably higher in Michigan than near the District of Columbia throughout most of the period studied, it was almost exactly the same for the two areas (about 20 percent) immediately following the ODT order.

From all of the charts showing speed trends it is obvious that changes in 1943 have been much less than those which occurred in 1942. The same is true with respect to vehicle weights and loading practices. In 1942, it was necessary to make drastic adjustments to wartime conditions; and now that these adjustments have been made, comparative stability has been achieved. However, increasing shortages of gasoline, and successive restrictive acts, have caused traffic volumes to continue to decline, though at a somewhat slower rate, on the average, than in 1942.