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As truck traffic continues to gain in volume and in tonnage of freight hauled, the frequency of heavy axle loads is increasing at an accelerated rate

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BUREAU OF PUBLIC ROADS

U. S. DEPARTMENT OF COMMERCE

E. A. STROMBERG, Editor

Axle-Load and Gross-Load Trends

BY THE HIGHWAY TRANSPORT RESEARCH BRANCH
BUREAU OF PUBLIC ROADS

Reported [1] by JOHN T. LYNCH, Chief, Planning Surveys Section and T. B. DIMMICK, Head, Current Data Analysis Unit

East of the Rockies, about one-third of the commercial vehicles (exclusive of light trucks) are three- and four-axle tractor-truck semitrailer combinations. They carry two-thirds of the tonnage hauled, and are responsible for almost all of the heavy axle loads.

Some 30 years ago there was great concern about the damage being done to improved highways by what were then considered as heavily laden trucks. With the replacement of solid rubber by pneumatic tires, the introduction of legal limitation of sizes and weights of vehicles, resulting in wider use of vehicle combinations with multiple axles, and the construction of thicker pavements in the great road-building era beginning in the 1920's, the earlier concern was forgotten. By 1931 the loads carried on the highways were rarely heavy enough to overtax their structural capacity.

The State-wide highway planning surveys provided the first Nation-wide data on frequency of heavy loads for the 1936–37 period, and have annually collected such data beginning in 1942. The information, presented in this article, shows how rapidly the frequencies of heavy loads have increased in recent years. In the 1936–37 period, gross loads of 40,000 pounds or more amounted to only about 1 percent of the total number of commercial vehicles on the highways. By 1942 this frequency had tripled, and by 1948 had again doubled. Frequency of heavy axle loads shows a similar rise. But, since the number of trucks has also increased greatly, the total number of heavy axle loads found on the highways in 1948 was eighteen times the number in the 1936–37 period, and the rate of increase appears to be accelerating rapidly.

A study of heavy load frequencies by regions indicates that the most favorable situation exists in the Western regions, where legal limitation of 50 feet or more in length permits advantageous distribution of heavy loads on vehicle combinations with five or more axles. In the remainder of the country, where the length is limited to 45 feet in most States, vehicles with more than four axles are little used, and three- and four-axle combinations carry the bulk of the highway tonnage. It is these two types that have the highest frequency of heavy axle loads.

Legal limitation of axle loads, with effective enforcement, seems to be the only way our pavements can be protected. Somewhat less-stringent length limits would encourage wider use of vehicle combinations that spread the load over a sufficient number of axles, thus permitting reasonable increases in pay loads.

IN the period beginning toward the close of World War I, much was said about the damage being done to improved highways by the heavily laden trucks that were then coming into general use. For example, in the First Biennial Report of the California Highway Commission, issued in 1918, we find this statement:

> "The present State highways are being subjected to constant abuse by too heavily loaded trucks and other agencies. The statute books of California already contain sufficient legislation to regulate and penalize these violations, but the delinquency lies in the enforcement of these laws."

However, a survey made in California [2] in 1920 did not reveal any loads that we would regard as heavy today. Of a total of 219 motortrucks weighed at five locations, there were only 33 with a capacity of 3 tons or more, and the average gross weight of these was 14,640 pounds. The average rear axle weight was only 9,889 pounds, but the load was generally on solid tires, which were more damaging to the highway than are the pneumatic tires of today.

In surveys made in Vermont,[3] New Hampshire,[4] and Ohio,[5] in 1926 and 1927, no gross weights were found as great as 25,000 pounds, and no axle loads as great as 18,000 pounds.

In a 1926 survey in Connecticut,[6] however, almost 1 percent of the 82,738 trucks observed weighed over 25,000 pounds gross, and they were so loaded that the average rear axle weight was 18,500 pounds. There was one gross load of 30,400 pounds with a rear axle weight of 25,500 pounds.

A survey in Cook County, Ill.,[7] (adjacent to the city of Chicago) in 1925, revealed some surprisingly heavy axle loads. At 5 of the 17 stations operated, rear axles weighing 17,500 pounds or more were found on from 2 to 14 percent of the loaded vehicles. There were several axle loads over 30,000 pounds and one as high as 36,000 pounds and these loads were principally on solid tires. In the majority of these cases the load was brick or cement. Figure 1 shows a heavy truck used at that time.

[1] This paper was presented at the twenty-ninth annual meeting of the Highway Research Board in Washington, D. C., December 16, 1949.

[2] *Report of a Study of the California Highway System*, by the U. S. Bureau of Public Roads, to the California Highway Commission and Highway Engineer; 1920.

[3] *Report of a Survey of Transportation on the State Highways of Vermont*, by the Bureau of Public Roads, U. S. Department of Agriculture, and the Vermont State Highway Department, 1927.

[4] *Report of a Survey of Transportation on the State Highways of New Hampshire*, by the Bureau of Public Roads, U. S. Department of Agriculture, and the New Hampshire State Highway Department, 1927.

[5] *Report of a Survey of Transportation on the State Highway System of Ohio*, by the Bureau of Public Roads, U. S. Department of Agriculture, and the Ohio Department of Highways and Public Works, 1927.

[6] *Report of a Survey of Transportation on the State Highway System of Connecticut*, by the Bureau of Public Roads, U. S. Department of Agriculture, and the Connecticut State Highway Department, 1926.

[7] *Report of a Study of Highway Traffic and the Highway System of Cook County, Illincis*, by the U. S. Bureau of Public Roads and the Cook County Highway Department, 1925.

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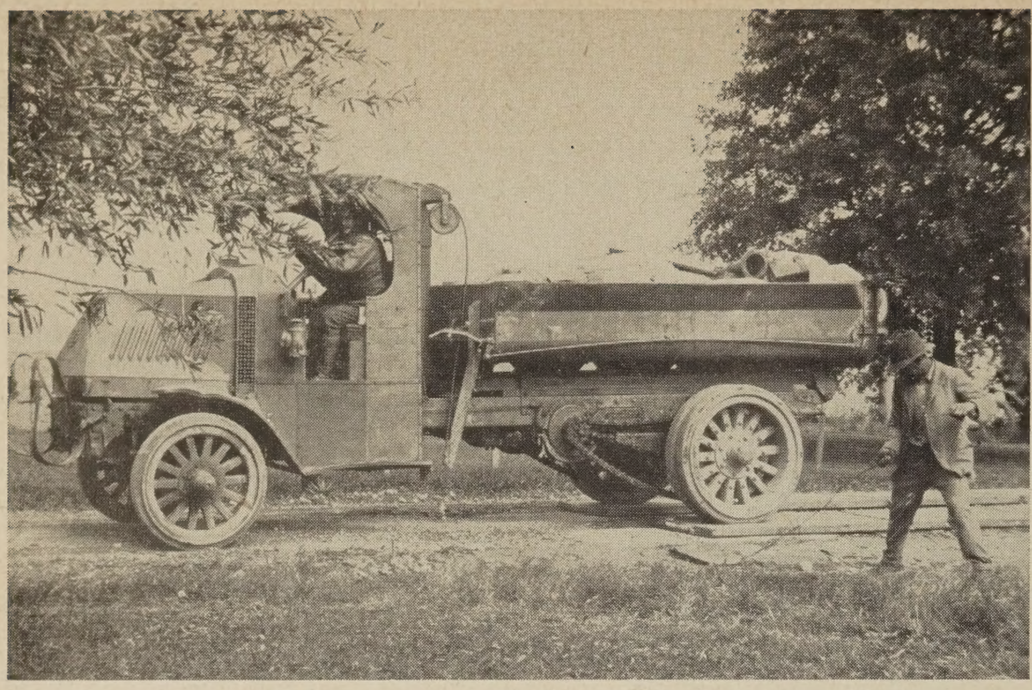


Figure 1.—A typical heavy truck circa 1920.

It seems probable that the stations in the Cook County survey were so located as to intercept exceptionally heavy hauling, for Mr. Frank T. Sheets, Chief Highway Engineer for Illinois, said in February 1926 that the percentage of trucks around Chicago which exceeded the legal axle-load limit of 16,000 pounds was small.[8] Certainly there is no evidence that heavy loads comparable to those weighed in Cook County were to be found in appreciable numbers outside the Chicago area.

Regulation of Sizes and Weights

Laws governing the sizes and weights of motor vehicles were in effect in most States at that time. Fifteen States passed such laws prior to 1919, and by 1927 all of the States except Kansas and Montana had legal limitations on sizes and weights.[9] Kansas passed its first limitation act in 1929 and Montana in 1931. In most States the laws have been changed many times since they were first enacted, but the weight limits have remained largely within the ranges of 8,000–9,500 pounds per wheel for States limiting wheel loads and 16,000–22,400 pounds per axle for States limiting axle loads. The cumulative effect of these laws over the years has been to promote increasingly wider use of vehicle combinations with the load spread over a number of axles.

In addition to limiting weights, fees were increased for vehicles with solid tires, thus hastening the change-over to pneumatics and lessening road damage—for it was the impact of solid tires on the macadam roads and on the narrow concrete pavements with relatively thin edges prevailing at that time that was principally responsible for the damage during the first World War and in the years immediately following.[10] Many of the early concrete roads had uniform slab thicknesses of only 6 inches or even 4 inches. Following the Bates Road Test in 1921, thickened edges of 7 inches, 8 inches, and 9 inches became prevalent. More recently, slabs of uniform thickness of 8 inches and 9 inches have been constructed by many States; [11] and several States, including New Jersey, where heavy axle loads are particularly frequent, have used a 10-inch uniform thickness.

Thus, the problem of heavy loads was attacked from three angles: legal limitation, vehicle design, and pavement design. By 1931 the loads carried on the highways were rarely heavy enough to overtax their structural capacity, and Commissioner MacDonald made the following statement (which has been quoted recently by those interested in obtaining higher axle-load limits): "The roads are more destroyed really by climatic and soil conditions than they are by any use that is made of them." How greatly heavy axle-load frequencies of today exceed those prevailing at the time that statement was made will be shown in the data presented in this paper.

First Comprehensive Data Obtained in 1936–37

Our present large investment in roadway pavements makes it impracticable for us to provide for greater loads by increasing pavement thicknesses on any but a small fraction of our improved road mileage. There remain then only vehicle regulation and vehicle design as effective means of protecting our roadway plant from excessive loads.

The State-wide highway planning surveys, which were started in 1935, gave for the first time Nation-wide comprehensive data from which accurate determination could be made of the frequency of occurrence of heavy gross loads and heavy axle loads on our highways.[12] Nearly all of the States conducted truck-weighing operations in 1936 or 1937, although a few did not do so until a year or two later.

Figure 2 shows the situation at that time with regard to heavy gross loads. The heights of the bars indicate the number of gross loads of 40,000 pounds or more per 1,000 commercial vehicles on the highways, including both loaded and empties, in each of the census regions. In the Pacific region, 47 out of each 1,000 vehicles passing the weighing stations had a gross load of 40,000 pounds or more. In the remainder of the United States, loads as heavy as 40,000 pounds were comparatively infrequent and amounted to more than 10 per 1,000 vehicles, or 1 percent, in only three regions—the Middle Atlantic, the New England, and the East North Central.

[8] *Traffic control and the regulation of overloading of motor-trucks*, by Frank T. Sheets; Proceedings of the Twelfth Annual Conference of Highway Engineering, University of Michigan, 1926, p. 85.

[9] *Federal Regulation of the Sizes and Weight of Motor Vehicles*, report of the Interstate Commerce Commission, Aug. 14, 1941. House Doc. No. 354, 77th Cong., 1st Sess., pp. 63–66.

[10] *The highways of the country and the burden they must carry*, a symposium of eight articles; PUBLIC ROADS, vol. 1, No. 2, June 1918.

[11] *Design details of structural features of concrete pavements as practiced by the various State highway departments in 1946*, by T. J. Kauer; Report of Committee on Concrete Pavement Design, American Road Builders' Association Technical Bulletin No. 121, 1947; pp. 48–49. Also, *Comments on concrete road design*, Engineering-News Record, Nov. 15, 1934; pp. 618–619.

[12] *Amount and characteristics of trucking on rural roads*, by J. T. Lynch and T. B. Dimmick; PUBLIC ROADS, vol. 23, No. 9, July-Aug.-Sept. 1943.

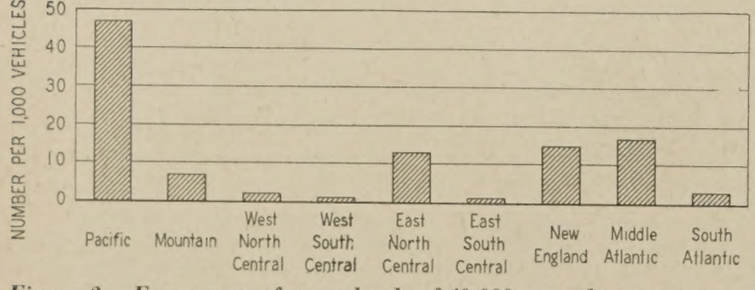


Figure 2.—Frequency of gross loads of 40,000 pounds or more, per 1,000 vehicles, by regions, in 1936–37.

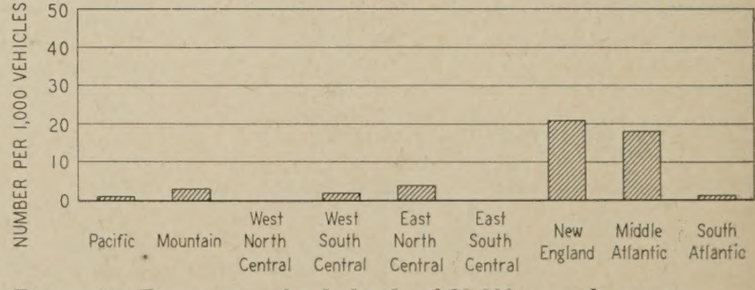


Figure 3.—Frequency of axle loads of 20,000 pounds or more, per 1,000 vehicles, by regions, in 1936–37.

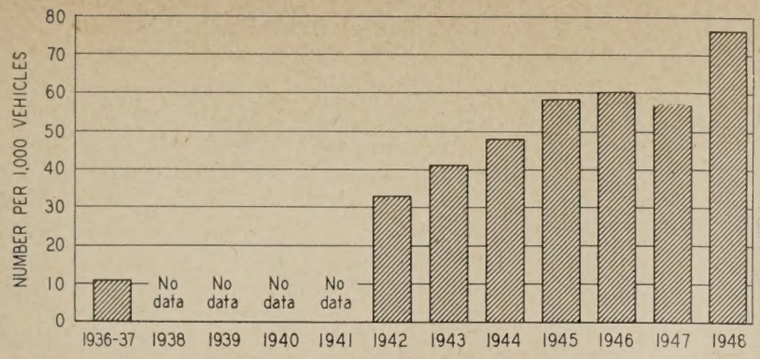


Figure 4.—Frequency of gross loads of 40,000 pounds or more, per 1,000 vehicles, by years.

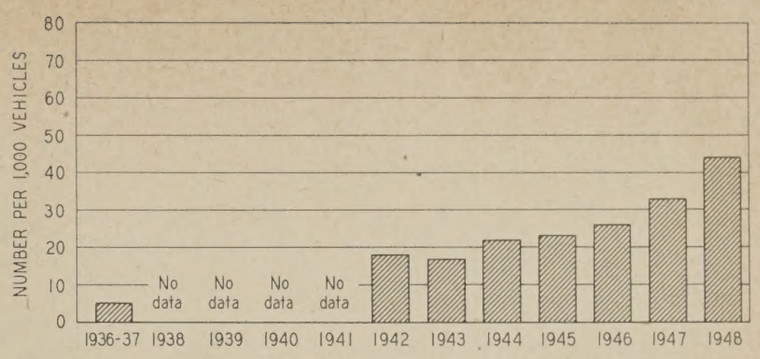


Figure 5.—Frequency of axle loads of 20,000 pounds or more, per 1,000 vehicles, by years.

Figure 3 shows the frequency of occurrence of heavy axle loads of 20,000 pounds or more in the different regions at the time of the 1936–37 surveys. Only in the New England and Middle Atlantic regions were axle loads as great as 20,000 pounds found in appreciable numbers—the frequency of axle loads of this magnitude in these two regions being approximately 20 for each 1,000 commercial vehicles, loaded and empty.

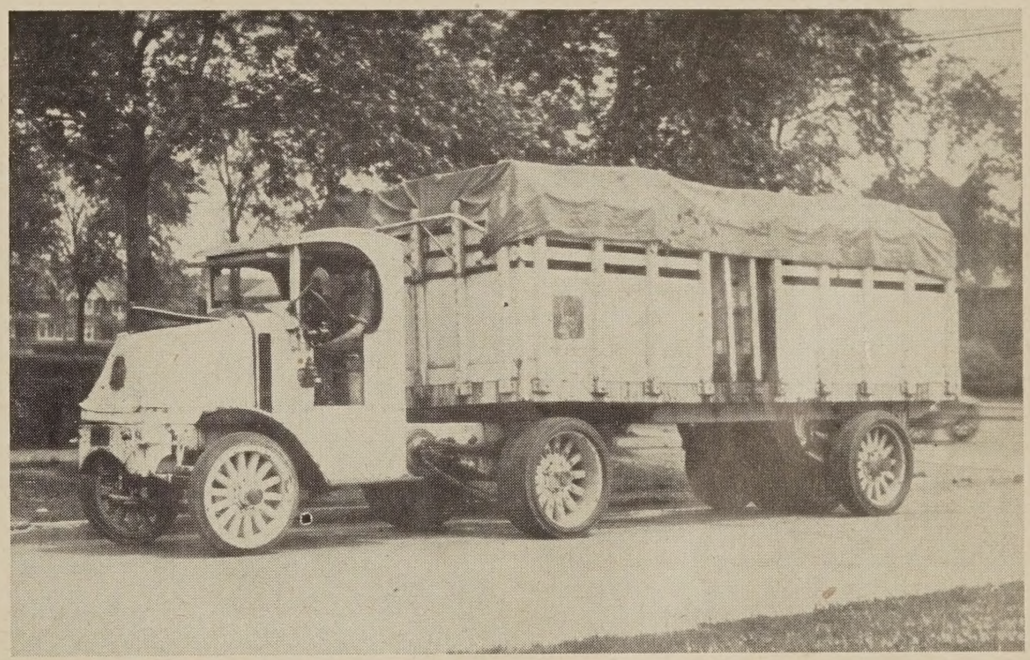
Following the original collection of weight data by the highway planning surveys in the 1936–37 period, only fragmentary data concerning truck weights were obtained until 1942, when the increased loading because of World War II activities began to cause some concern. In that year and in each year since then data which give a clear indication of trends have been obtained at a number of representative stations, operated for 8 hours in the summer in practically all of the States. The number of trucks weighed each year in these repeat surveys has ranged from about 50,000 to over 100,000.

Increase in Frequency of Heavy Gross Loads and Heavy Axle Loads

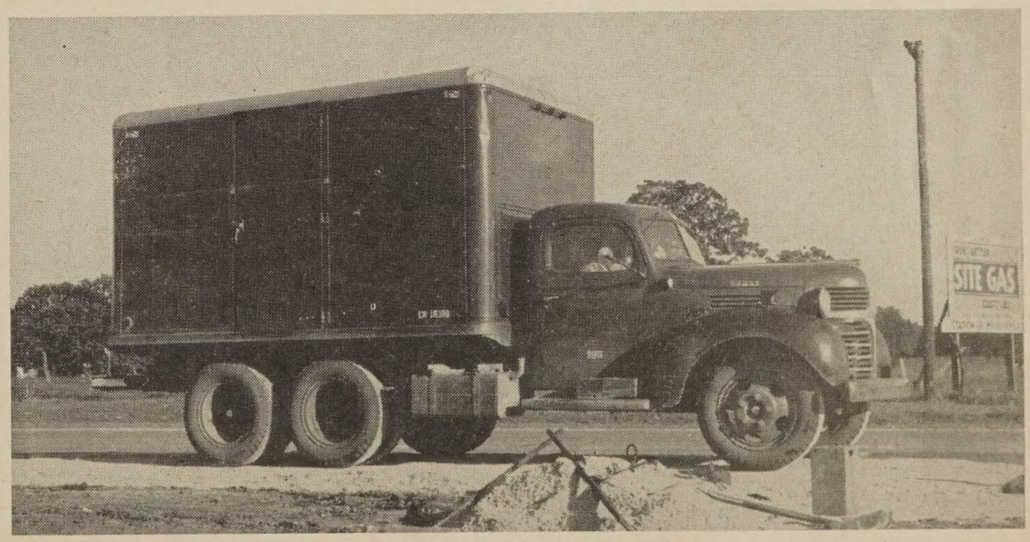
Figure 4 shows the steady increase in frequency of heavy gross loads since the 1936–37 surveys. In 1942, the first year of the war, gross loads of 40,000 pounds or more were about three times as frequent as in the prewar period. At the close of the war the frequency of gross loads did not decline (except slightly in 1947) but continued to increase, so that in 1948 gross loads of 40,000 pounds or more were more than twice as frequent as in 1942, and seven times as frequent as in the 1936–37 period.

The long-range tendency over the years has been to spread the load over more axles, thus permitting large increases in gross loads without corresponding increases in axle loads. At the time of the early surveys (1926–27), mentioned in the first part of this paper, only two-axle vehicles were in general use. Gross load was only from one-fourth to one-half greater than the maximum axle load. In the recent surveys, on the other hand, it has been found that the gross load averaged about twice the maximum axle load for vehicles of all types, and nearly three times the maximum axle load for combinations, which are the vehicles carrying the heaviest loads.

It naturally follows that the frequency of heavy gross loads has increased faster than the frequency of heavy axle loads, over the years. Since 1945, however, this tendency has been reversed, and heavy axle loads are increasing in frequency faster than heavy gross loads. For each 1,000 vehicles passing over the highways there were, in 1945, 5.3 times the number of gross loads of 40,000 pounds or more than there were in the 1936–37 period (fig. 4), compared to 4.6 times the number of axle loads of 20,000 pounds or more found in the earlier period (fig. 5). In the 3 years from 1945 to 1948, however, the heavy axle-load frequency increased 91 percent, compared to an increase of only 32 percent for the heavy gross load frequency. The reason for this reversal can most likely be



A 1924-vintage tractor-semitrailer, probably one of the earliest of this type. Note the center wheels on the rear axle.



A dual-tire, three-axle truck.

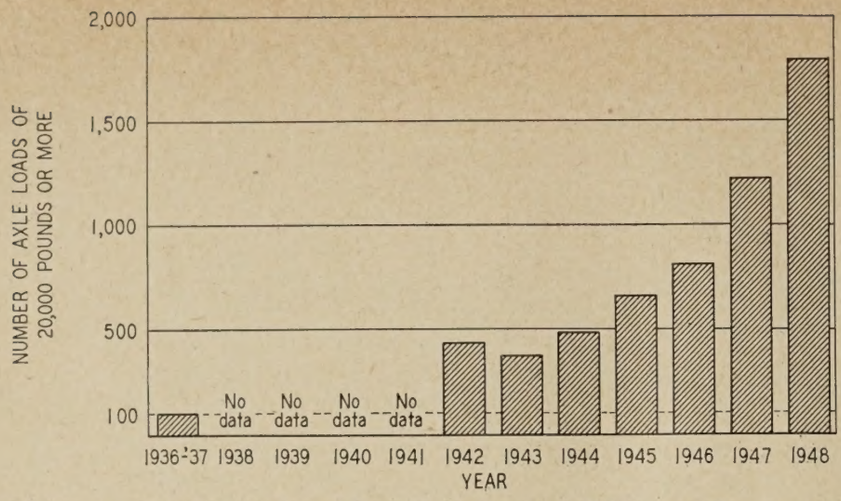


Figure 6.—Relative total number of axle loads of 20,000 pounds or more, 1942–48, using the number in 1936–37 as an index of 100.

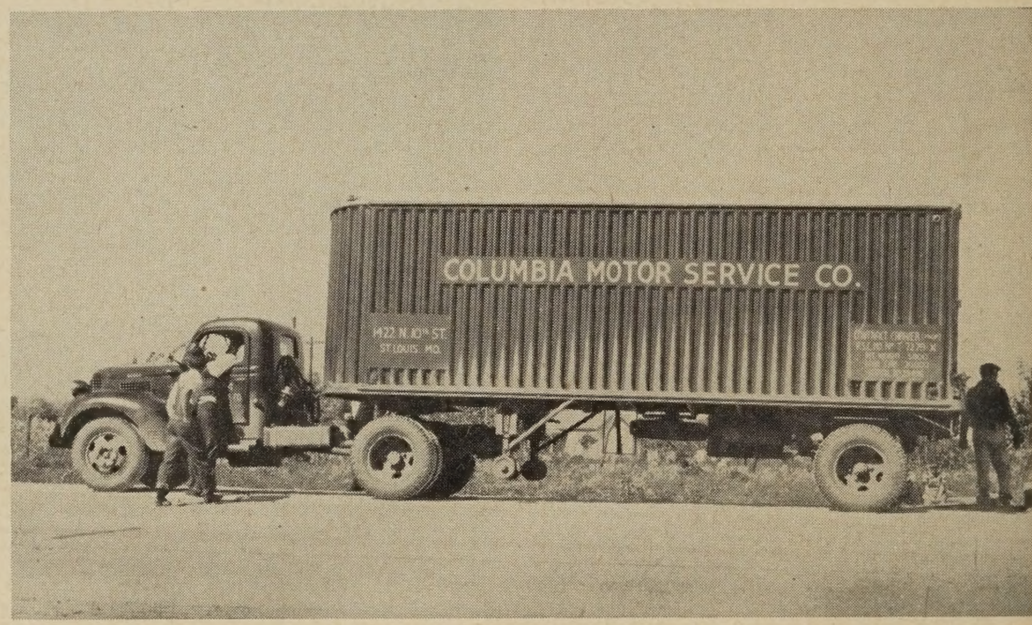
found in legal length limitations, in effect over much of the country, which effectively discourage the use of vehicles with five or more axles. While, in earlier years, the increased gross loads were spread over an increasing number of axles, this tendency has been stopped at four axles in many States and increases in gross loads can now only be accomplished by increases in axle loads.

In 1948, the number of axle loads of 20,000 pounds or more in each 1,000 vehicles passing over the highways was approximately 9 times the number in the 1936–37 period. This tells only part of the story, however, because the number of trucks on the highways almost doubled during this time. Figure 6 compares the relative number of axle loads of 20,000 pounds or more found on the highways each year from 1942 to 1948 with the number found in the 1936–37 period used as an index of 100. In 1948, our highways were being subjected to approximately 18 times as many axle loads of 20,000 pounds or more as they were in 1936–37. It is plain, therefore, that Mr. MacDonald's statement made in 1931 does not apply to the conditions we find today. The alarming thing about the picture presented in figure 6 is that the rate of increase of the absolute number of heavy axle loads appears to be accelerating rapidly. In the 2-year period from 1946 to 1948, the number of axle loads in excess of 20,000 pounds more than doubled, which is a greater rate of increase than was found in any previous 2-year period.

Regional Variation in Frequency of Heavy Loads

Figure 7 shows the frequency of gross loads of 40,000 pounds or more in 1948, by regions. The Pacific region still had the highest frequency of loads of this magnitude, but the use of heavy vehicles in the East North Central and Middle Atlantic regions had increased to such an extent that the frequency of occurrence of gross loads of 40,000 pounds or more was greater than 100 in each 1,000 vehicles—not much below the frequency of 127 per 1,000 vehicles in the Pacific region.

Figure 8 shows the frequency of heavy axle loads in 1948, by regions. Data from all of the States except Pennsylvania, Florida, Wyoming, and Oregon are included. The Middle Atlantic region had by far the greatest frequency, there being in this region 153 axle loads weighing 20,000 pounds or more for each 1,000 trucks or truck combinations of all types (including panels and pick-ups), both loaded and empty. Since Pennsylvania data are missing for 1948, the height of the bar for the Middle Atlantic region actually reflects conditions in New York and New Jersey.



A three-axle tractor-semitrailer combination.

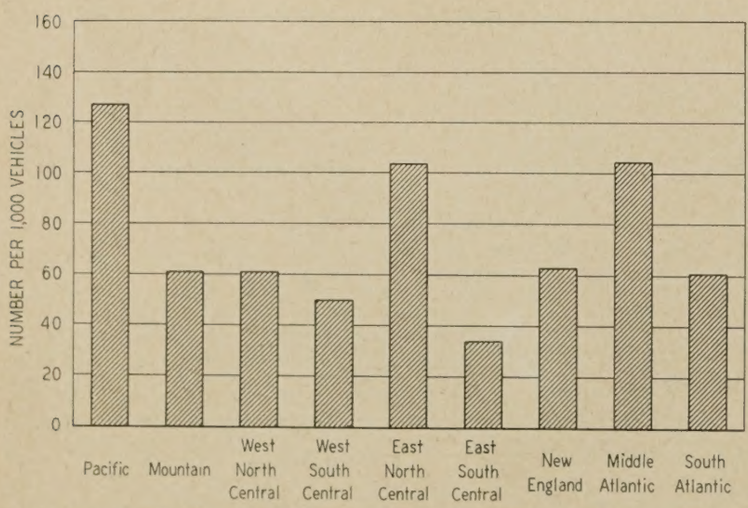


Figure 7.—Frequency of gross loads of 40,000 pounds or more, per 1,000 vehicles, by regions, in 1948.

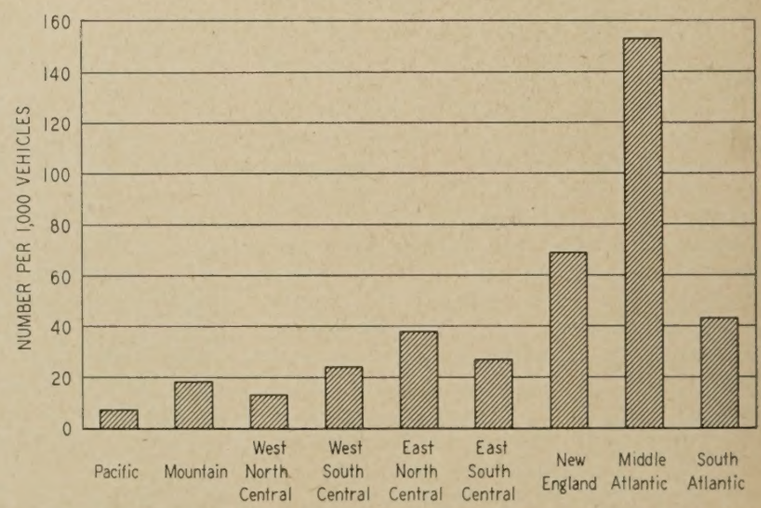
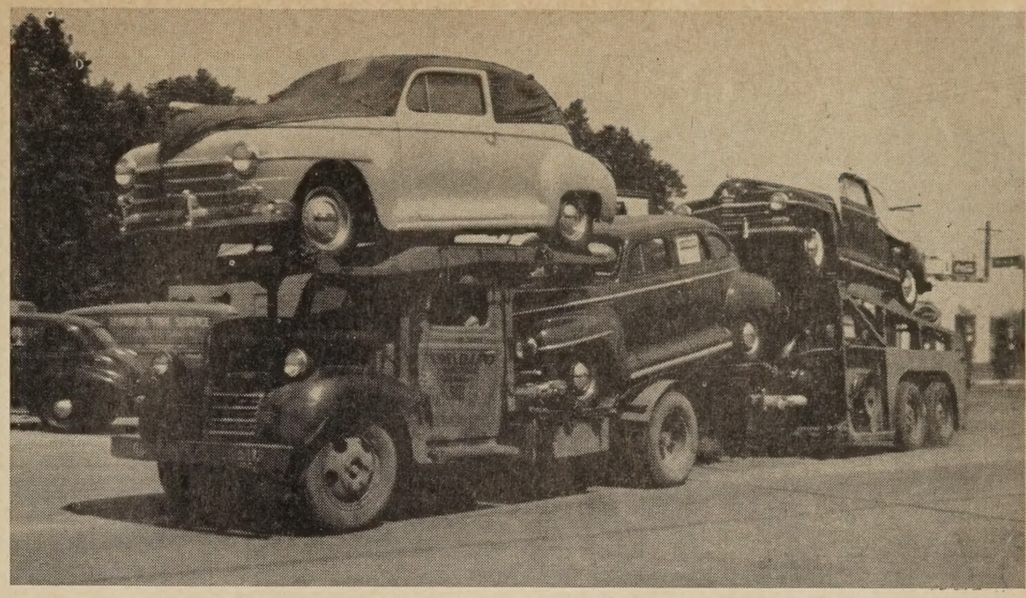


Figure 8.—Frequency of axle loads of 20,000 pounds or more, per 1,000 vehicles, by regions, in 1948.

The laws in these States, as well as in several other Eastern States, have the effect of encouraging heavy axle loads.

New England, with about 69 axle loads of 20,000 pounds or more for each 1,000 vehicles, had the second highest frequency. It will be noted that the Pacific region, which had the greatest frequency of heavy gross loads (fig. 7), had the lowest frequency of heavy axle loads, there being only 7 axle loads as great as 20,000 pounds for each 1,000 vehicles observed in this region.

Figure 9 shows the frequency of heavy axle loads in the 10 States in which axle loads of 20,000 pounds or more occurred more frequently than 50 per 1,000 vehicles, arranged in order of frequency of occurrence. New Jersey, with 239 axle loads of 20,000 pounds or more, of which 165 weighed 22,000 pounds or more, in each 1,000 commercial vehicles, had the greatest frequency. There is no specific axle-load limit in New Jersey, the weight permitted on an axle being determined by the size and number of tires. Evidently the tire criterion does not serve to limit axle loads greatly, since a number of axle loads exceeding 30,000 pounds were recorded in the survey, and there was one axle load of 40,100 pounds.



A four-axle auto transporter.

The nine States having the greatest frequency of heavy axle loads are all along the Atlantic seaboard. The tenth State, Ohio, with an 18,000-pound axle load limit, had 58 axle loads in excess of 20,000 pounds for each 1,000 vehicles observed.

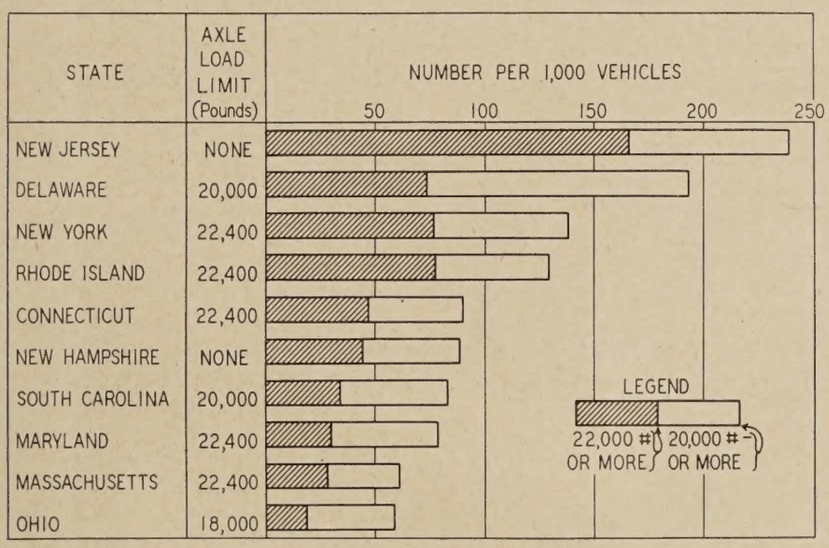
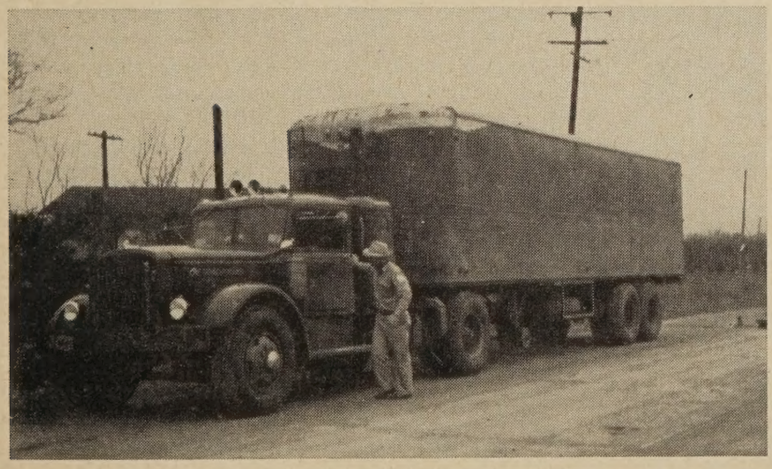


Figure 9.—Frequency of axle loads of 20,000 pounds or more and of 22,000 pounds or more, per 1,000 vehicles, in the 10 States with highest frequencies, in 1948.

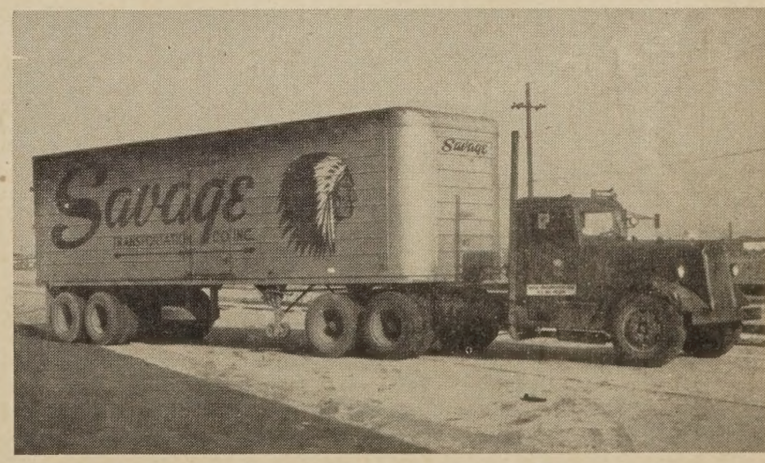
Frequency of Heavy Axle Loads Dependent on Types of Vehicles Used

The frequency of occurrence of heavy axle loads in the different States is dependent upon the types of vehicles used, as well as upon the legal axle load limitation. The usage of the different vehicle types, in turn, is dependent to a considerable extent upon the legal length and other limitations. The legal limitations affecting axle loads and vehicle lengths vary throughout the country but are fairly uniform in the Mountain and Pacific regions. In these regions there is an axle load limit of 18,000 pounds throughout and no State has a legal length limit for tractor-truck and semitrailer combinations of less than 50 feet. The 50-foot limit applies in Oregon, and all of the other States in the two regions permit lengths of 60 feet or more. Throughout the remainder of the country most of the States have length limits of 45 feet for tractor-truck and semitrailer combinations, and this limit has a definite bearing on the type of vehicle used.

Figure 10 shows the frequency distribution of vehicles of different types for the Mountain and Pacific regions combined, and for the remainder of the United States. Panels and pick-ups and other light, two-axle, single-tire trucks of similar character are excluded from



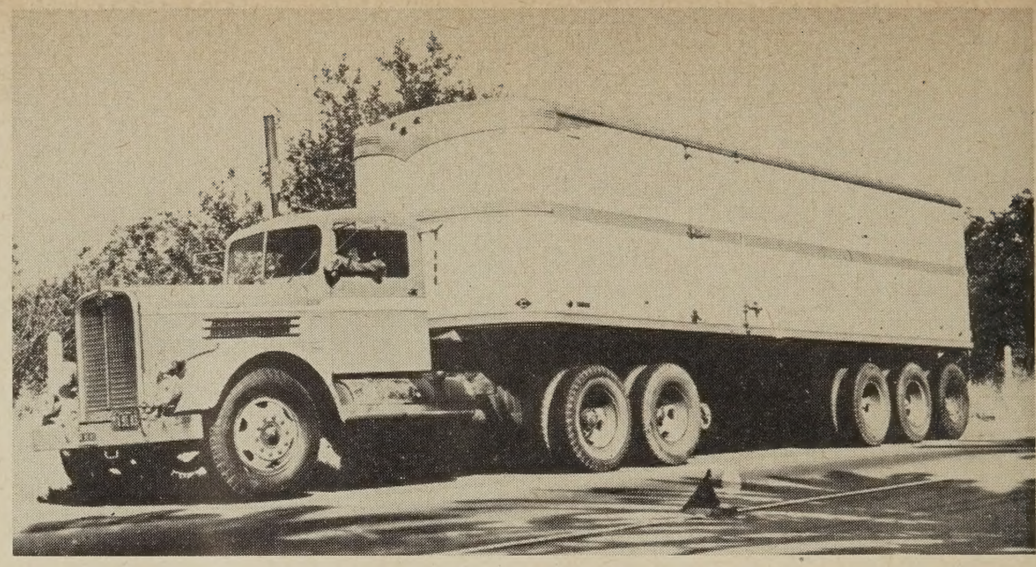
A four-axle combination vehicle, widely used throughout the United States.



A five-axle combination vehicle, popular in the western part of the country.

this distribution. In both sections of the country the two-axle, dual-tire trucks constitute approximately one-half of the total, and in the Mountain and Pacific regions the remaining vehicles are rather evenly distributed among a number of different types, with the five-axle tractor-truck and semitrailer combination predominating. In the Central and Eastern regions the number of vehicles with more than four axles is minute and the three-axle tractor-truck semitrailer combination type constitutes almost one-third of the total.

Although the dual-tire, two-axle, single-unit truck is most frequent n occurrence, it does not carry the greatest pay-load tonnage. This is shown in figure 11, which gives the percentage of the total pay-load tonnage hauled by vehicles of different types. In the Mountain and Pacific regions the five-axle tractor-truck and semitrailer combination carries a higher percentage of the pay-load tonnage than any other type of vehicle, whereas in the remainder of the United States it is the three-axle tractor-truck and semitrailer combination which carries the bulk of the tonnage.



A six-axle tractor-semitrailer combination.

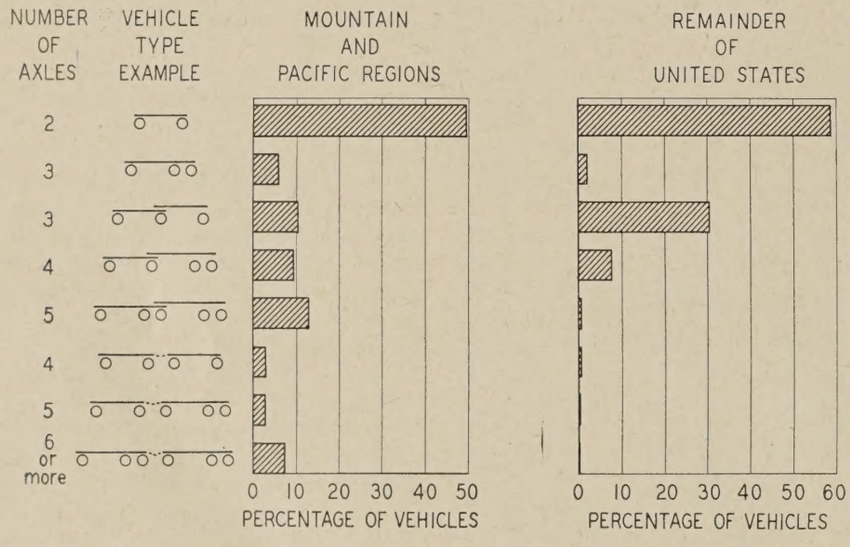


Figure 10.—Percentage distribution of vehicles of various types (exclusive of two-axle, single-tire vehicles) in the West and in the remainder of the United States, in 1948.

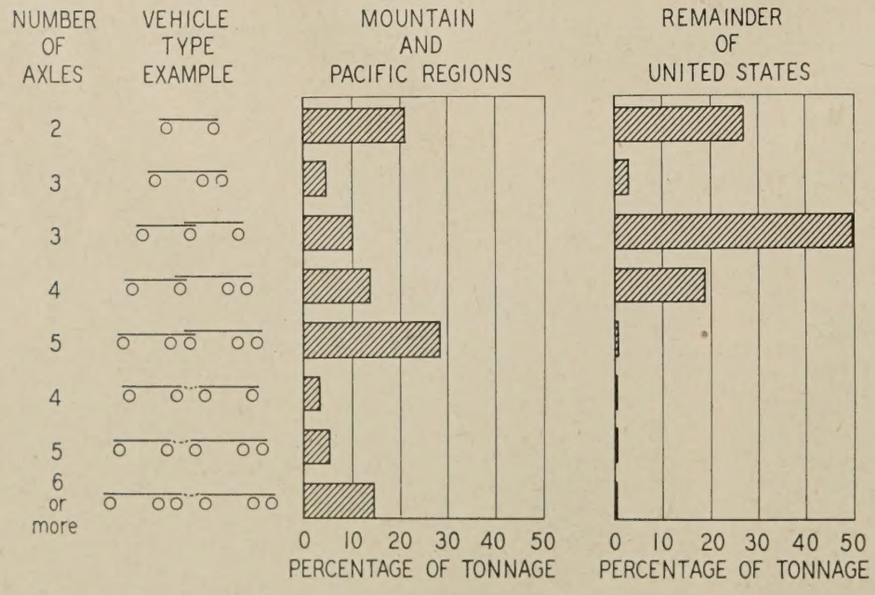


Figure 11.—Proportion of tonnage hauled by vehicles of various types (exclusive of two-axle, single-tire vehicles) in the West and in the remainder of the United States, in 1948.

Figure 12 shows the average gross load and the average pay load for vehicles of different types, for the United States as a whole. The five-axle tractor-truck and semitrailer combination has a slightly higher average pay load than any other type of vehicle, although the group of tractor-truck and full trailer combinations with six or more axles has the highest gross load.

Figure 13 shows the frequency of heavy axle loads for the vehicles of different types. Since there are significant differences between the Eastern and Central regions as regards frequency of heavy axle loads, largely because of differences in State laws, these groups of regions, as well as the Western group, are shown separately in this chart.

In all the regions it is the four-axle tractor-truck and semitrailer combination that has the greatest frequency of heavy axle loads. In the Eastern regions almost half of these vehicles, including both loaded and empties, have an axle load weighing 20,000 pounds or more, whereas in the Western regions less than 10 percent of them have axle loads of this magnitude. Almost invariably it is the rear axle of the tractor that has the heaviest load. It is easy to see why this should be so, because any uniform loading would tend to overload this axle unless the dual axles at the rear of the semitrailer were placed well forward, and such an arrangement would frequently cause violation of the axle-group loading regulations in effect in many States.

In figure 14 the amount of pay load carried is taken into consideration. Here the frequency of axle loads of 20,000 pounds or more per 1,000 tons of pay load is shown. On this basis it is the three-axle tractor-truck and semitrailer combination that has the highest frequency of heavy axle loads in the Eastern and Western regions, while the four-axle tractor-truck and semitrailer combination continues to hold first place in the Central regions.

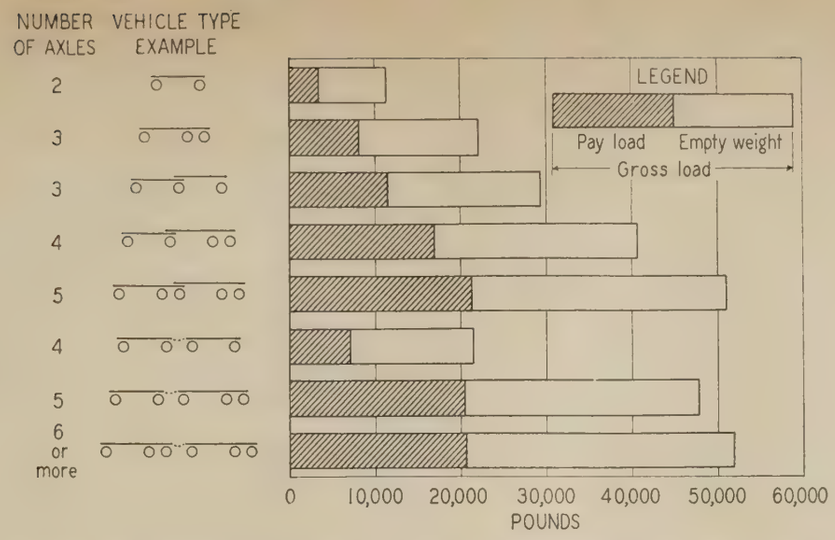


Figure 12.—Average pay load and average gross load of vehicles of various types (exclusive of two-axle, single-tire vehicles) in 1948.

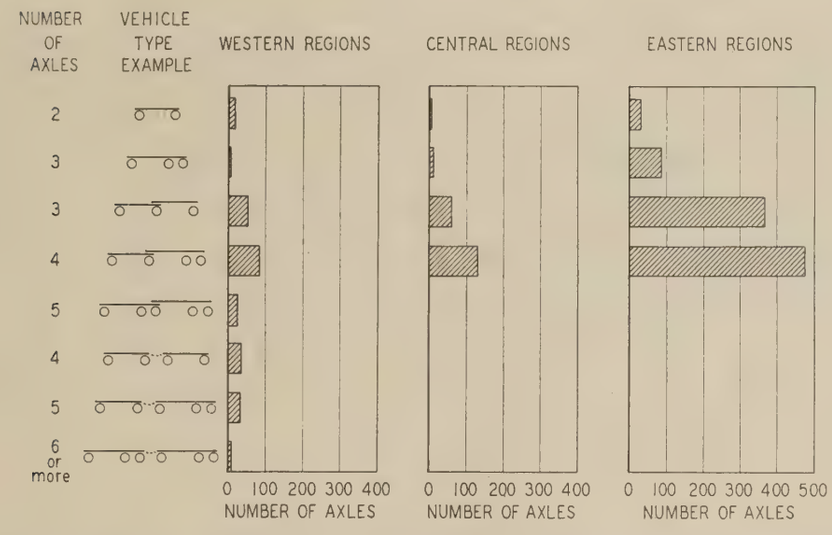


Figure 13.—Frequency of axle loads of 20,000 pounds or more, per 1,000 vehicles, by vehicle types (exclusive of two-axle, single-tire vehicles), in three geographic regions, in 1948.

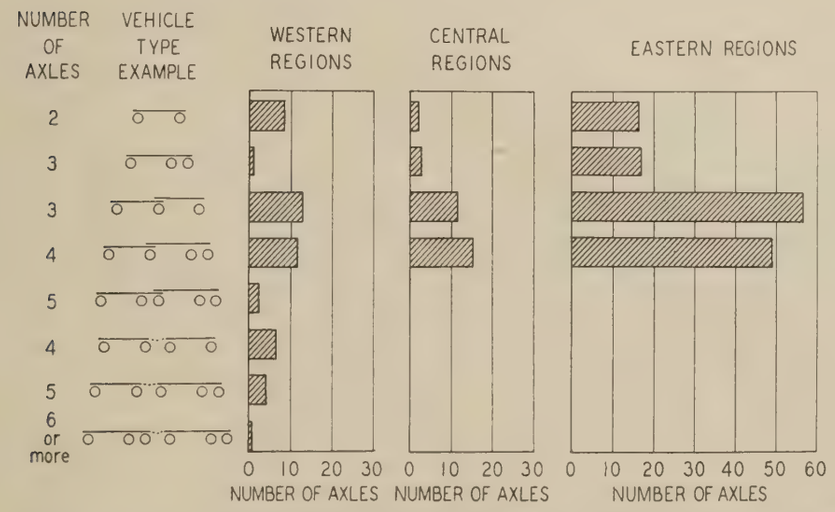


Figure 14.—Frequency of axle loads of 20,000 pounds or more, per 1,000 tons of pay load, by vehicle types (exclusive of two-axle, single-tire vehicles), in three geographic regions, in 1948.

The five-axle tractor-truck and semitrailer combination, which is used in appreciable numbers only in the Mountain and Pacific regions, has the lowest frequency of heavy axle loads per 1,000 tons of pay load of any of the more commonly used vehicle types.

Length Limits Restrict Use of Five-Axle Combination

The failure to make use of this five-axle combination type in the Central and Eastern regions has been attributed by some to shortcomings in operating characteristics of the vehicle design, but any such difficulties do not appear to be sufficiently great to restrict the usage in the West. A more evident reason for the scarcity of this type of vehicle throughout the Central and Eastern States is the 45-foot length limitation for tractor-truck and semitrailer combination that prevails throughout most of this area. The average wheel-base length for a five-axle, tractor-truck and semitrailer combination, over the whole United States, was 43.4 feet from center of front wheel to center of rear wheel. Obviously the over-all length of the vehicle, including the overhang, front and rear, would have to be greater than 45 feet with this length of wheel base. The two-axle tractor-truck with two-axle semitrailer, on the other hand, which is one of the principal offenders as regards heavy axle loads, had an average wheel-base length of 34.1 feet, which permits a vehicle length well within the 45-foot limitation.

The photograph at the bottom of page 283 (*left*) shows a four-axle combination of a type widely used throughout the country. The gross load on this vehicle was 68,900 pounds and the weight on the second axle was 27,690 pounds. This compares with less than 17,000 pounds each for the third and fourth axles. Such unequal loading is not uncommon for vehicles of this type.

The five-axle combination shown in the photograph at the bottom of page 283 (*right*), which was weighed in California, is the most popular type of heavy vehicle in the West. It is 49 feet long and would therefore violate the length limit in effect in 23 of the 37 Central and Eastern States. The gross weight was 66,700 pounds, almost the same as that of the four-axle combination (p. 283, *left*), but the maximum axle load was only 17,500 pounds.

The weights for single axles and axle pairs were as follows:

Axle number	*Single axle (pounds)*	*Axle pair (pounds)*
1	7,600	
2	17,500	29,100
3	11,600	
4	15,000	30,000
5	15,000	

This type of load distribution is typical of that found on many of the five-axle combinations. Apparently the vehicle was so designed and loaded as to take maximum advantage of legal limits in effect in the area throughout which it was operated. The second axle was loaded for maximum traction almost to the 18,000-pound limit. The third axle, probably not a drive axle, carried a lighter load so that the 32,000-pound limit for an axle pair was not exceeded. The load at the rear was equally distributed between the fourth and fifth axles. The axle-group loading, also, was probably just within the legal limit, for the California law permits 59,500 pounds within

a 30-foot length, which is about the probable distance from the center of the second axle to the center of the fifth axle, though there is no record of the actual measurement in this case. The axle group load limit recommended by the American Association of State Highway Officials, however, was doubtless exceeded somewhat, as that limit is 52,650 pounds for a 30-foot length.

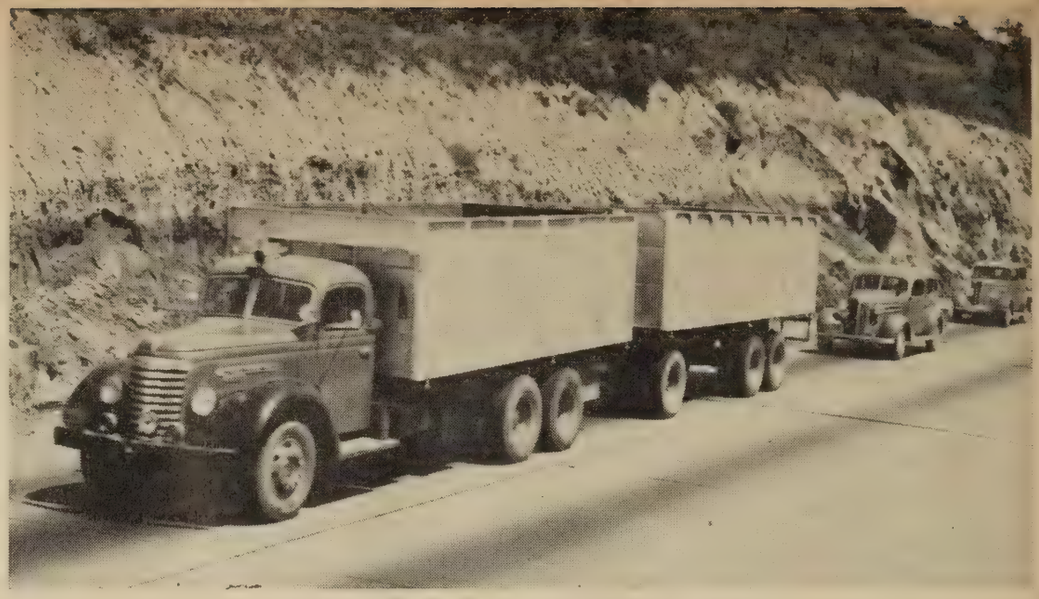
The five-axle semitrailer combinations have a better record of compliance with State weight laws than combinations of other types. In the Pacific region, for example, the percentage exceeding one or more of the weight limits was 9 percent for the five-axle combinations, compared to 12 percent for combinations of other types.

The laws regarding axle-group weights are somewhat more lenient in California and Washington than recommended by the American Association of State Highway Officials, and 22 percent of the five-axle combinations had axle groups loaded beyond the Association's recommended limits. In most cases, however, the excess weight was small, amounting to more than 10 percent excess in the case of only 10 percent of the vehicles.

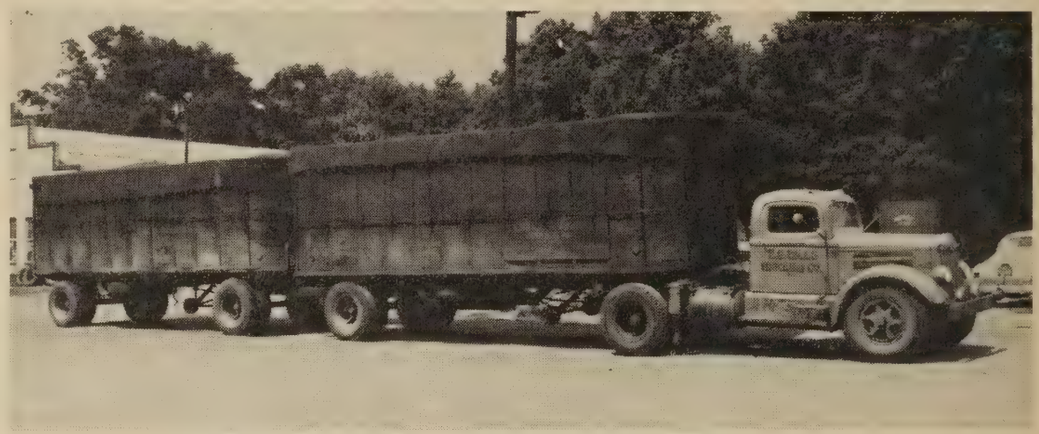
The number of axles with loads exceeding the 18,000-pound limit per 1,000 vehicles was only 64 for the five-axle combinations compared to 95 for combinations of other types in the Pacific region. As regards compliance with axle-load limits, therefore, the five-axle tractor-truck semitrailer combination has a materially better record than other types of large vehicles.

Enforced Axle-Load Limits Needed to Protect Highways

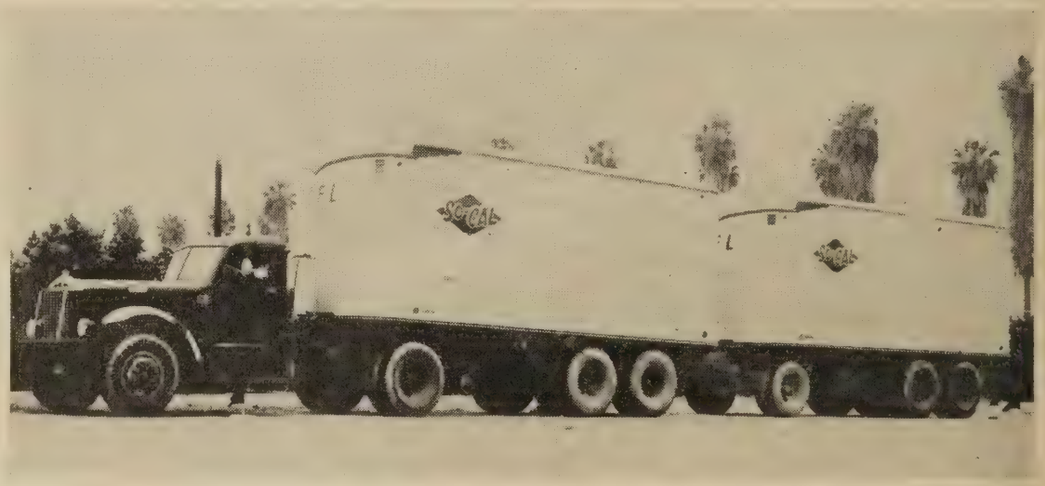
The major part of the Nation's principal highways was constructed in the period from 1920 to 1940. These existing highways must be maintained, and gradually reconstructed or replaced, with the funds currently available for the purpose. It is obviously impossible to meet the rapidly increasing frequency of heavy axle loads by thickening the pavements, as was done to some extent in the earlier years of road building. Legal limitation of axle loads, with effective enforcement, seems to be the only way our pavements can be protected. This does not necessarily mean, however, that gross loads and pay loads may not be allowed to increase, provided the vehicle is so designed as to spread the load over a sufficient number of axles. Somewhat less-stringent length limits, within the A. A. S. H. O. recommendation, would encourage such design and would probably reduce pressure for higher axle-load limits. As a specific example, if those States which have a 45-foot length limit for tractor-truck and semitrailer combination would raise it to 50 feet, as recommended by the American Association of State Highway Officials, this would encourage the widespread use of the type of vehicle which carries more tonnage than any other single type in the West and does so with a very low frequency of excessively heavy axle loads.



A three-axle truck with three-axle full trailer.



A three-axle tractor-semitrailer with two-axle full trailer.



A four-axle tractor-semitrailer with three-axle full trailer.

Traffic Trends on Rural Roads in 1948

BY THE HIGHWAY TRANSPORT RESEARCH BRANCH
BUREAU OF PUBLIC ROADS

Reported by THOMAS B. DIMMICK, Head, Current Data Analysis Unit

Total travel on rural roads in 1948 broke all records, exceeding the previous year's high by 6 percent and the prewar peak by 17 percent. On the 345,000 miles of main rural roads in the United States travel in 1948 was almost 148 billion vehicle-miles, of which about 77 percent was by passenger cars, 1 percent by busses, and 22 percent by freight-carrying vehicles.

Trucks and combinations hauled 13 percent more ton-mileage of freight in 1948 than in the previous year and 42 percent more than in 1941. These increases in freight carried were made, notwithstanding small drops in the proportion of trucks loaded, because of the rise in use of heavier commercial vehicles, beginning during the war and continued in 1948, although at a reduced rate. Truck-combination travel was 9 percent higher than in the previous year, 68 percent higher than in 1941, and 213 percent higher than in 1936. The average load carried by commercial vehicles in 1948 was 73 percent heavier than in 1936 and about 4 percent above the 1947 load weights.

In 1948, over 5 percent of all trucks and combinations, loaded and empty, exceeded a legal weight limit, and 18 percent of the combinations were overweight in some particular. The highest percentage of overloading was in the East North Central region where 8 percent of the vehicles of all types and 21 percent of the combinations were found to exceed legal weight limits. From 1947 to 1948 the percentage of overweight vehicles increased in all regions except the Pacific and New England regions.

TRAVEL on rural roads in 1948 broke all previous records for the third consecutive year. The 1948 volume of traffic was 6 percent higher than that of 1947 and 17 percent higher than that of 1941, the prewar peak. Regionally the increase over 1947 ranged from 5 percent in the Middle Atlantic and South Atlantic regions to 9 percent in the West North Central region. These facts were established from the records of about 700 automatic traffic recorders operated continuously throughout the year at permanent stations on rural roads, both main and local, in all of the States.

The variation in rural-road travel for three main geographic divisions and in the United States as a whole is illustrated in figure 1 for the year 1948, for 1947, and for 1941, the prewar peak year.

The chart shows that, with minor exceptions, travel in each month in each of the three geographic regions and in the United States as a whole was well above that of the corresponding month of the earlier years. Average monthly travel was higher in 1947 than in 1941 in each of the regions, and still higher in 1948.

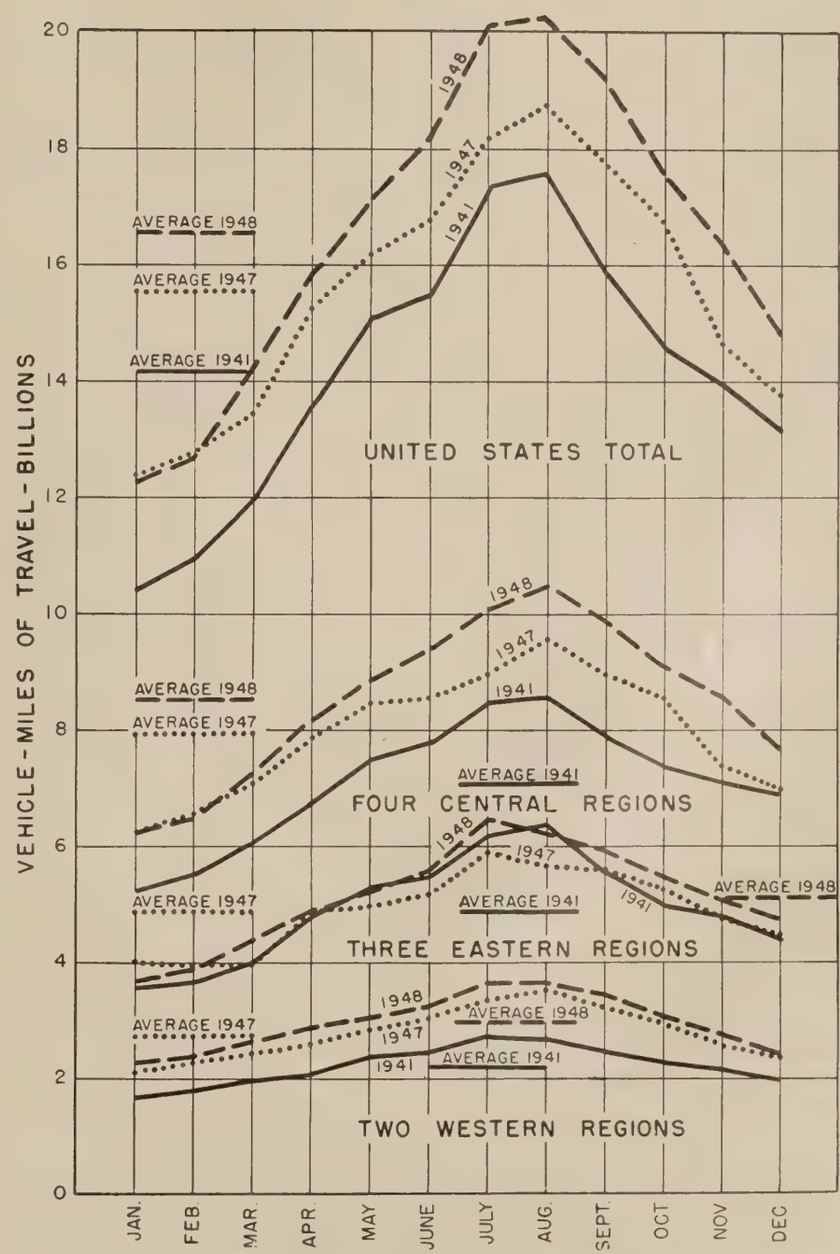


Figure 1.—Travel on all rural roads in 1941, 1947, and 1948, by months.

The summer travel peak, which was greatly diminished during the war, has slowly been regaining, during the postwar years, its former importance in the annual traffic pattern.

The flattening out of the summer traffic peak during the war years and the subsequent recovery of this peak to prewar proportions are shown in the ratios of the July-August

traffic each year to the average 2-month traffic for the year (one-sixth of the total annual traffic):

Year:	
1940	1. 23
1941	1. 23
1942	1. 13
1943	1. 13
1944	1. 14
1945	1. 14
1946	1. 17
1947	1. 19
1948	1. 22

It is not surprising to find that when we entered the war the summer peak traffic dropped from 23 percent above the annual average to only 13 percent above the annual average for 2-month periods. It is somewhat surprising, however, to find that not until 1948 has summer traffic assumed approximately the same relative importance in the annual traffic pattern that it had in the prewar years. Undoubtedly the shortage of automobiles tended to discourage vacation driving in the first 2 years following the close of the war.

1948 Summer Loadometer Survey

The machine counts from which the traffic-volume data were obtained provide no classification by vehicle type, since they record only the total number of vehicles of all types passing. However, trends in type, weight, and characteristics of commercial vehicles were established from data recorded in a summer survey, repeated each year since 1942, in nearly all of the States. In 1948, 544 stations in 44 States were operated at times and under conditions comparable to those existing in earlier surveys. The information obtained in these summer surveys, together with additional information concerning traffic classification collected in a number of States throughout the year, was used to determine the changes that had taken place since the comprehensive Nation-wide surveys of 1936 and 1937 were made.[1]

All States participated in the 1948 survey except Florida, Oregon, Pennsylvania, and Wyoming. In Pennsylvania an expanded weight survey was in progress and in Wyoming one was being completed, but reports from neither were available for inclusion in this analysis.

The majority of the weight stations were operated during July, August, and September. California completed most of the work in June; Texas operated its stations from May through August; Tennessee commenced in May and ended in October; while Minnesota conducted the operations from April to September.

The stations used in these surveys were selected initially to give a representative cross section of traffic on main rural roads, and were operated for one or more 8-hour periods on a weekday, generally from either 6 a. m. to 2 p. m., or from 2 p. m. to 10 p. m. All traffic passing through the stations during the period was counted and classified into the following categories: local passenger cars; foreign (out-of-State) passenger cars; panel and pick-up trucks;[2] other two-axle, four-

Table 1.—*Survey period, number of stations operated, number of vehicles counted, and number weighed in each State in the special weight survey during the summer of 1948*

Region and State	Survey period	Number of stations	Vehicles counted		Trucks and combinations weighed
			All vehicles	Trucks and truck combinations	
New England:					
Connecticut	July 26–Aug. 10	10	28, 037	5, 494	2, 203
Maine	July 26–Aug. 6	10	22, 446	3, 430	1, 673
Massachusetts	Aug. 9–20	10	34, 114	5, 812	2, 077
New Hampshire	Aug. 6–13	5	14, 724	1, 846	522
Rhode Island	July 26–30	5	12, 063	2, 331	986
Vermont	Aug. 2–6	5	9, 151	742	742
Subtotal		45	120, 535	19, 655	8, 203
Middle Atlantic:					
New Jersey	Aug. 2–19	10	72, 065	12, 608	2, 026
New York	Sept. 20–24	20	39, 202	10, 762	3, 693
Pennsylvania	[1]	-------	-------	-------	-------
Subtotal		30	111, 267	23, 370	5, 719
South Atlantic:					
Delaware	Aug. 9–18	4	15, 189	3, 863	745
Florida	[1]	-------	-------	-------	-------
Georgia	Aug. 16–Sept. 2	6	13, 668	3, 368	2, 290
Maryland	July 26–Aug. 12	9	6, 912	1, 985	1, 093
North Carolina	Aug. 10–31	12	24, 083	6, 000	3, 800
South Carolina	Sept. 8–22	10	16, 253	4, 350	2, 096
Virginia	Aug. 10–23	10	20, 600	5, 066	1, 714
West Virginia	Aug. 10–Sept. 2	9	11, 580	3, 180	1, 359
Subtotal		60	108, 285	27, 812	13, 097
Eastern regions, subtotal		135	340, 087	70, 837	27, 019
East North Central:					
Illinois	Aug. 24–Sept. 7	47	83, 658	15, 325	6, 324
Indiana	Aug. 5–Sept. 1	20	39, 099	9, 056	3, 768
Michigan	July 20–Aug. 7	8	20, 560	3, 119	1, 907
Ohio	July 27–Aug. 12	5	9, 062	2, 566	677
Wisconsin	Aug. 5–26	12	25, 717	3, 450	1, 951
Subtotal		92	178, 096	33, 516	14, 627
East South Central:					
Alabama	July 14–Aug. 5	10	9, 984	2, 692	1, 782
Kentucky	June 7–July 24	10	11, 175	3, 012	1, 228
Mississippi	Aug. 17–Sept. 7	13	18, 153	5, 021	3, 089
Tennessee	May 26–Oct. 30	10	9, 386	2, 378	1, 455
Subtotal		43	48, 698	13, 103	7, 554
West North Central:					
Iowa	July 26–Aug. 13	10	12, 790	2, 275	2, 180
Kansas	Aug. 5–18	10	9, 354	1, 967	1, 155
Minnesota	Apr. 19–Sept. 8	40	115, 839	22, 913	10, 038
Missouri	Aug. 16–Sept. 3	14	66, 067	13, 314	7, 302
Nebraska	July 22–Aug. 18	20	20, 869	4, 324	4, 262
North Dakota	July 22–Sept. 1	15	19, 711	4, 349	2, 668
South Dakota	July 26–Aug. 13	12	8, 076	1, 671	1, 493
Subtotal		121	252, 706	50, 813	29, 098
West South Central:					
Arkansas	July 9–Aug. 15	10	15, 376	4, 802	1, 350
Louisiana	July 26–Aug. 7	10	9, 209	2, 742	1, 397
Oklahoma	July 7–23	10	13, 538	3, 454	3, 454
Texas	May 18–Aug. 30	17	27, 374	6, 585	1, 799
Subtotal		47	65, 497	17, 583	8, 000
Central regions, subtotal		303	544, 997	115, 015	59, 279
Mountain:					
Arizona	July 26–Aug. 6	10	9, 385	1, 979	676
Colorado	Aug. 13–27	10	23, 939	3, 831	715
Idaho	Aug. 2–25	13	13, 658	2, 533	2, 336
Montana	Aug. 4–31	17	15, 063	2, 649	2, 190
Nevada	Aug. 3–17	10	7, 188	1, 041	836
New Mexico	Aug. 5–Sept. 7	6	6, 295	1, 383	691
Utah	July 26–Aug. 6	10	14, 765	2, 878	1, 187
Wyoming	[1]	-------	-------	-------	-------
Subtotal		76	90, 293	16, 294	8, 631
Pacific:					
California	June 2–July 2	20	[2] 67, 760	13, 620	5, 032
Oregon	[1]	-------	-------	-------	-------
Washington	Sept. 8–21	10	16, 926	3, 362	2, 185
Subtotal		30	84, 686	16, 982	7, 217
Western regions, subtotal		106	174, 979	33, 276	15, 848
United States total		544	1, 060, 063	219, 128	102, 146

[1] No survey made.
[2] Passenger cars not counted in California. Figure given is an estimate based on data from other reports.

[1] See *Traffic trends on rural roads in 1947*, by T. B. Dimmick, PUBLIC ROADS, vol. 25, No. 7, Mar. 1949; *Traffic trends on rural roads in 1946*, by T. B. Dimmick and M. E. Kipp, PUBLIC ROADS, vol. 25, No. 3, Mar. 1948; *Traffic trends on rural roads in 1945*, by T. B. Dimmick, PUBLIC ROADS, vol. 24, No. 10, Oct.-Nov.-Dec. 1946; and *Amount and characteristics of trucking on rural roads*, by J. T. Lynch and T. B. Dimmick, PUBLIC ROADS, vol. 23, No. 9, July-Aug.-Sept. 1943.

[2] Single-unit trucks with a carrying capacity of less than 1½ tons.

tire trucks; two-axle, six-tire trucks; three-axle trucks; tractor-semitrailer combinations; truck and trailer or tractor-semitrailer and trailer combinations; and busses. The combination-type vehicles were further subdivided according to the number of axles of each.

The survey period, number of stations operated, number of vehicles counted, and number weighed are shown for each State in table 1. Over a million vehicles were counted at all stations during the period of the survey. About one-fifth of the vehicles counted were freight-carrying vehicles, of which almost one-half were weighed.

Wherever traffic volume permitted, all trucks and truck combinations were stopped and weighed. Where this procedure was impracticable, a sample was obtained by weighing all of the less common types and omitting only vehicles of types sufficiently common to establish their characteristics from a sample. The type of vehicle, whether loaded or empty, the number of axles, and weight of each axle were recorded. The axle-spacing and total wheel-base length of the heavier vehicles [3] were measured. Passenger cars and busses were counted but not stopped for weighing.

Prewar Travel Trend Fulfilled

Figure 2 shows in chart form the vehicle-mileage of travel on all rural roads, by type of vehicle, for each year from 1936 to 1948, inclusive. It is apparent that the effect of the war on the long-term upward trend in traffic volumes has now been entirely overcome. A straight line from the top of the bar for 1936 to the top of the bar for 1948 fits very closely the prewar trend from 1936 to 1940. The bar for 1941 extends well above this line, but it is generally recognized that 1941 was a year of exceptional activity in preparation for the war.

In the case of travel of trucks and truck combinations,[4] the 1948 value fits the 1936 to 1940 trend, projected, almost exactly. For truck combinations alone, the 1936 to 1948 line lies above the tops of the bars for all intervening years, indicating an accelerating growth in traffic by vehicles of this type.

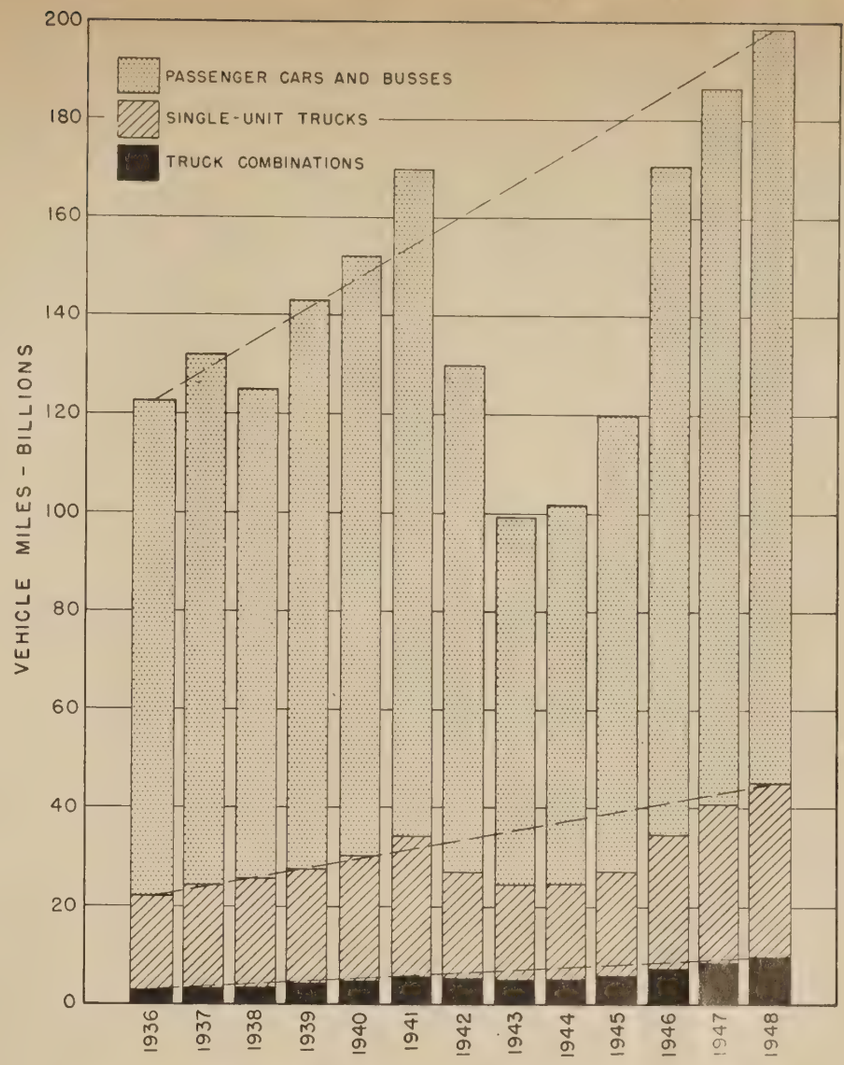


Figure 2.—Travel on all rural roads, 1936–48, by classes of vehicles.

The ratios of traffic volumes on main rural roads in 1948 to those in corresponding months of 1947 are shown in table 2. Main roads, totaling 345,000 miles, are considered to be those of the entire State system in most States, and those of the primary State system in such States as Virginia and Pennsylvania where all or a large part of the rural-road mileage is under State control. The consistent increase in travel by most types of vehicles and in all sections of the country is clearly shown. Passenger-car travel as a whole and that of trucks and truck combinations increased in all regions without exception. There were slight declines in some regions in travel of busses and foreign passenger cars, separately considered.

The percentage distribution of travel in 1948 is given for each census region and for the United States as a whole in table 3. In this table the single-unit trucks are divided into the four classification types based on axle and tire arrangement, while the truck combinations are divided according to the total number of axles of the combination. The classification of vehicles into these types, which has been used only in the last two annual surveys, permits more positive identification than the use of the old "light, medium,

[3] Trucks and truck combinations weighing 13 tons or more and, in addition, single-unit trucks having an axle weighing 18,000 pounds or more.

[4] In this article, the term *truck* is used to indicate a single-unit vehicle; *truck combination* to indicate tractor-truck semitrailer (with or without full trailer) and truck with full trailer; and *trucks and truck combinations* to indicate all of these vehicles together.

Table 2.—*Ratio of 1948 traffic on main rural roads to corresponding traffic in 1947* [1]

Vehicle type	Eastern regions				Central regions					Western regions			United States average
	New England	Middle Atlantic	South Atlantic	Average	East North Central	East South Central	West North Central	West South Central	Average	Mountain	Pacific	Average	
Passenger cars:													
Local	1.08	1.00	1.04	1.03	1.09	1.23	1.15	1.08	1.12	1.10	1.08	1.08	1.08
Foreign	1.03	1.14	1.08	1.09	1.02	.97	.90	.95	.97	1.03	.97	1.00	1.02
All passenger cars	1.07	1.02	1.05	1.04	1.07	1.15	1.09	1.05	1.08	1.06	1.06	1.06	1.07
Trucks and truck combinations:													
Single-unit trucks	1.07	1.17	1.05	1.09	1.07	1.10	1.14	1.22	1.14	1.11	1.08	1.10	1.12
Truck combinations	1.16	1.07	1.04	1.06	1.11	1.15	1.17	1.17	1.16	1.16	1.03	1.05	1.09
All trucks and truck combinations	1.09	1.14	1.04	1.09	1.10	1.11	1.15	1.20	1.14	1.12	1.05	1.08	1.11
Busses	1.11	.88	.85	.90	1.00	1.05	.95	1.14	1.03	1.10	.99	1.03	.98
All vehicles	1.07	1.05	1.05	1.05	1.07	1.14	1.10	1.09	1.09	1.08	1.05	1.06	1.07

[1] The ratios for "all vehicles" are based on year-round automatic recorder data, while those for the individual vehicle types are based principally on the summer counts.

Table 3.—*Percentage distribution of traffic, by vehicle types, in the summer of 1948*

Vehicle type	Eastern regions				Central regions					Western regions			United States average
	New England	Middle Atlantic	South Atlantic	Average	East North Central	East South Central	West North Central	West South Central	Average	Mountain	Pacific	Average	
Passenger cars:													
Local	58.34	60.40	57.62	58.79	60.00	58.76	61.00	57.71	59.53	41.37	69.93	60.28	59.43
Foreign	23.87	16.51	17.79	18.17	21.84	18.54	14.79	13.90	17.75	34.64	10.55	18.69	18.05
All passenger cars	82.21	76.91	75.41	76.96	81.84	77.30	75.79	71.61	77.28	76.01	80.48	78.97	77.48
Single-unit trucks:													
Panel and pickup	5.37	5.16	6.86	5.99	3.95	6.65	6.02	10.28	6.34	10.31	4.22	6.28	6.22
Other 2-axle, 4-tire	.69	.91	1.14	.99	.26	.66	1.10	.63	.61	.38	1.09	.85	.77
Other 2-axle, 6-tire	6.48	10.10	8.70	8.92	6.50	9.63	10.84	9.18	8.62	7.53	5.85	6.41	8.32
Three-axle	.30	.56	.34	.42	.21	.12	.22	.20	.20	.42	.90	.74	.37
	12.84	16.73	17.04	16.32	10.92	17.06	18.18	20.29	15.77	18.64	12.06	14.28	15.68
Tractor-truck and semitrailer combinations:													
3-axle	3.37	4.81	5.47	4.92	4.33	3.64	3.27	5.57	4.28	1.80	1.08	1.32	3.95
4-axle	.10	.62	.73	.60	1.74	.43	1.66	1.40	1.47	1.07	1.28	1.21	1.14
5-axle (or more)	(1)	.01	(1)	(1)	.22	.02	.08	.05	.12	.65	2.16	1.65	.36
All tractor-truck semitrailer combinations	3.47	5.44	6.20	5.52	6.29	4.09	5.01	7.02	5.87	3.52	4.52	4.18	5.45
Truck and trailer combinations:													
4-axle (or less)	.01	.02	.02	.02	.10	------	.17	.14	.11	.22	.46	.38	.13
5-axle	(1)	(1)	------	(1)	.10	------	.01	.01	.05	.21	.40	.33	.08
6-axle (or more)	------	------	------	------	.05	------	(1)	------	.02	.27	1.24	.92	.18
All truck and trailer combinations	.01	.02	.02	.02	.25	------	.18	.15	.18	.70	2.10	1.63	.39
All combinations	3.48	5.46	6.22	5.54	6.54	4.09	5.19	7.17	6.05	4.22	6.62	5.81	5.84
All trucks and truck combinations	16.32	22.19	23.26	21.86	17.46	21.15	23.37	27.46	21.82	22.86	18.68	20.09	21.52
Busses	1.47	.90	1.33	1.18	.70	1.55	.84	.93	.90	1.13	.84	.94	1.00
All vehicles	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

[1] Less than 0.005 percent.

and heavy" categories and, at the same time, the groups are more homogeneous than those formerly used.

The figures in table 3 indicate that truck travel on a percentage basis is heaviest in the West South Central region and only slightly lighter in the West North Central, South Atlantic, and Mountain regions, all of which have comparatively light total traffic. Other areas as, for instance, the New England, East North Central, and Pacific regions, where total traffic generally is heavy, have the smallest percentages of trucks. Certain types of vehicles, apparently favored by local conditions, are found principally in certain regions. For instance, the five-axle (or more) tractor-truck semitrailer combinations and the six-axle (or more) truck and trailer combinations are confined principally to the Western regions. The absence, on the other hand, of certain types in some regions as, for example, the truck and trailer combinations in the East South Central region, is noteworthy.

Average Weights Again Increasing

Figure 3 shows graphically the average weights of loaded and empty trucks and truck combinations, separately and combined, in each year from 1942 to 1948, inclusive, and in a prewar year, generally 1936 or 1937. The weights of single-unit trucks, both the loaded and the empty, increased each year from the 1936–37 period through 1945, then leveled off and even decreased slightly. At the same time weights of both loaded and empty truck combinations increased each year of the period shown. The increase in average weight of loaded combinations from the 1936–37 period to 1948 was 47 percent, compared to only 14 percent for single-unit trucks. The increase for all trucks and combinations was 54 percent, a figure higher than that for either type separately, because of the increased proportion of combinations in the latter year.

The average weights of the various types of loaded and empty trucks and truck combinations in the summer of 1948 are shown in table 4, for the different regions. This table brings out clearly the important differences that exist in the weight characteristics of the vehicles in the different groups. It will be noted, for example, that for the United States as a whole, the loaded three-axle, single-unit trucks weighed about twice as much as the two-axle, six-tire trucks. Similar differences existed throughout the various classifications. On the other hand, the regional differences in average weight for each of the vehicle types that are common throughout the country are surprisingly small. The extremely low weights of truck and trailer combinations in some regions, particularly the West North Central, indicate a predominance of small, home-made trailers of low capacity.

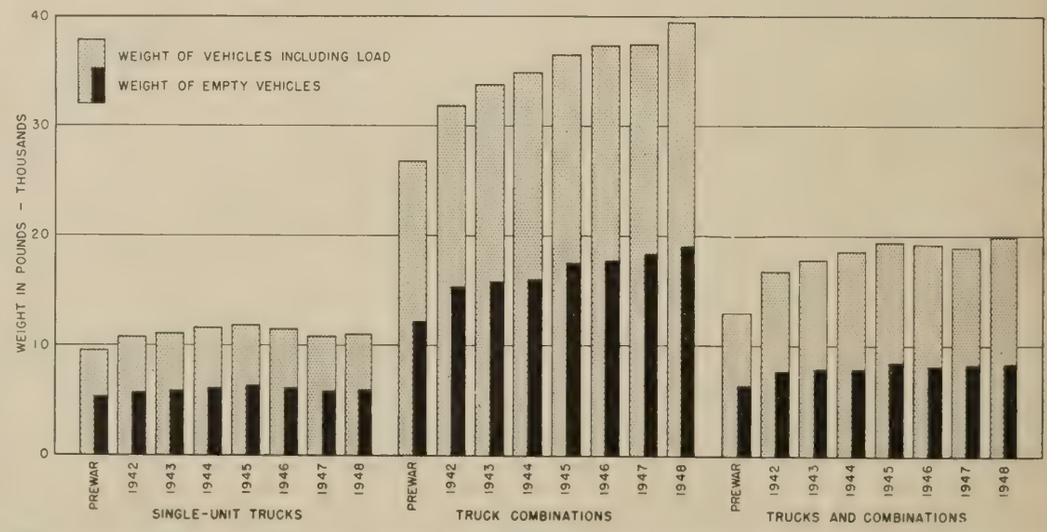


Figure 3.—Average weights of loaded and of empty trucks and truck combinations in the summers of 1942–48 and in a corresponding period of a prewar year.

Table 4.—*Average weights (in pounds) of loaded and empty trucks and truck combinations, by vehicle types, in the summer of 1948*

Vehicle type	Eastern regions				Central regions					Western regions			United States average
	New England	Middle Atlantic	South Atlantic	Average	East North Central	East South Central	West North Central	West South Central	Average	Mountain	Pacific	Average	
AVERAGE WEIGHTS OF LOADED VEHICLES													
Single-unit trucks:													
Panel and pick-up	4,619	4,942	4,666	4,760	4,755	5,094	4,909	6,615	5,545	4,967	4,357	4,627	5,143
Other 2-axle, 4-tire	6,321	8,126	9,320	8,668	6,384	6,596	6,730	10,706	7,465	7,542	6,647	6,755	7,788
Other 2-axle, 6-tire	14,290	15,364	13,342	14,299	13,265	14,156	13,191	14,057	13,504	13,471	12,541	12,864	13,679
3-axle	29,102	34,171	23,938	29,076	26,802	28,043	24,804	24,020	25,701	25,303	25,265	25,272	26,700
Average	10,827	13,007	10,914	11,736	10,948	11,792	10,680	10,417	10,808	10,232	10,648	10,501	11,064
Truck combinations:													
Tractor-truck and semitrailer	36,079	42,240	35,482	37,945	37,552	34,640	38,337	35,920	37,028	41,761	45,979	44,888	38,600
Truck and trailer	(1)	(1)	(1)	(1)	56,100	------	13,628	32,164	38,863	55,416	53,659	53,878	50,611
Average	36,087	42,170	35,402	37,883	38,107	34,640	37,513	35,846	37,094	43,942	48,299	47,328	39,455
Average, all trucks and truck combinations	17,541	21,691	18,268	19,502	22,914	18,409	17,932	18,076	19,793	18,999	22,689	21,571	20,034
AVERAGE WEIGHTS OF EMPTY VEHICLES													
Single-unit trucks:													
Panel and pick-up	3,685	4,052	3,703	3,809	3,932	3,891	3,959	4,456	4,139	3,804	3,543	3,705	3,958
Other 2-axle, 4-tire	5,003	4,863	5,188	5,028	4,756	4,798	5,260	6,337	5,425	4,993	4,980	4,983	5,189
Other 2-axle, 6-tire	8,583	8,931	7,186	8,108	7,671	7,493	7,694	7,873	7,712	7,440	7,633	7,542	7,824
3-axle	14,974	13,852	11,856	13,347	13,897	11,687	12,432	16,208	14,042	14,083	14,495	14,417	13,898
Average	6,105	7,067	5,313	6,080	6,022	5,698	6,081	6,157	6,030	5,114	6,089	5,572	5,976
Truck combinations:													
Tractor-truck and semitrailer	19,599	20,405	17,647	18,952	18,956	16,288	19,683	17,260	18,299	21,276	21,588	21,470	18,798
Truck and trailer	------	(1)	(1)	(1)	25,441	------	10,919	19,203	21,070	25,728	26,520	26,357	24,556
Average	19,599	20,411	17,643	18,953	19,413	16,288	19,366	17,300	18,425	22,127	23,341	22,949	19,140
Average, all trucks and truck combinations	8,172	9,455	7,374	8,276	9,864	6,911	8,707	8,477	8,648	7,161	9,516	8,343	8,481

[1] Data omitted because of insufficient sample.

Table 5.—*Comparison of estimated vehicle-miles of travel on main rural roads in 1936, 1941, 1946, 1947, and 1948*

Year	All vehicles, vehicle-miles	Passenger cars and busses[1]		All trucks and truck combinations		Single-unit trucks		Truck combinations	
		Percentage of all vehicles	Vehicle-miles	Percentage of all vehicles	Vehicle-miles	Percentage of all trucks and truck combinations	Vehicle-miles	Percentage of all trucks and truck combinations	Vehicle-miles
	Millions		*Millions*		*Millions*		*Millions*		*Millions*
1936	88,412	82.6	73,005	17.4	15,407	82.1	12,650	17.9	2,757
1941	122,505	80.3	98,320	19.7	24,185	78.8	19,057	21.2	5,128
1941: 1936 ratio	*1.39*	*.97*	*1.35*	*1.13*	*1.57*	*.96*	*1.51*	*1.18*	*1.86*
1946	124,149	80.4	99,803	19.6	24,346	73.3	17,838	26.7	6,508
1946: 1941 ratio	*1.01*	*1.00*	*1.02*	*.99*	*1.01*	*.92*	*.94*	*1.26*	*1.27*
1946: 1936 ratio	*1.40*	*.97*	*1.37*	*1.13*	*1.58*	*.89*	*1.41*	*1.49*	*2.36*
1947	137,512	79.2	108,880	20.8	28,632	72.5	20,746	27.5	7,886
1948	147,597	78.5	115,837	21.5	31,760	72.9	23,138	27.1	8,622
1948: 1947 ratio	*1.07*	*.99*	*1.06*	*1.03*	*1.11*	*1.01*	*1.12*	*.99*	*1.09*
1948: 1941 ratio	*1.20*	*.98*	*1.18*	*1.09*	*1.31*	*.93*	*1.21*	*1.28*	*1.68*
1948: 1936 ratio	*1.67*	*.95*	*1.59*	*1.24*	*2.06*	*.89*	*1.85*	*1.51*	*3.13*

[1] Percentages of total 1948 travel by passenger cars and by busses are reported separately in table 3.

Truck Travel Greater in 1948

A comparison of the estimated vehicle-miles of travel on main rural roads is shown in figure 4 for loaded and empty single-unit trucks and truck combinations, separately and combined, for each year from 1936 to 1948, inclusive. This chart further emphasizes the steady growth of truck traffic during the period 1936 to 1941, the temporary effect of the wartime restrictions, and the phenomenal upsurge in highway truck transportation subsequent to the end of the war in 1945.

Table 5 gives a comparison of the estimated vehicle-miles of travel by vehicles of different types on all main rural roads in 1936, the earliest year for which comprehensive weight data are available; in 1941, the peak prewar year, 5 years after the beginning of the surveys; in 1946, 10 years after the beginning of the surveys; and in 1947 and 1948, the latest years. The ratios of 1948 travel to that of the preceding years show that increases for trucks and combinations were much greater than for passenger cars in all cases; and that increases for truck combinations were greater

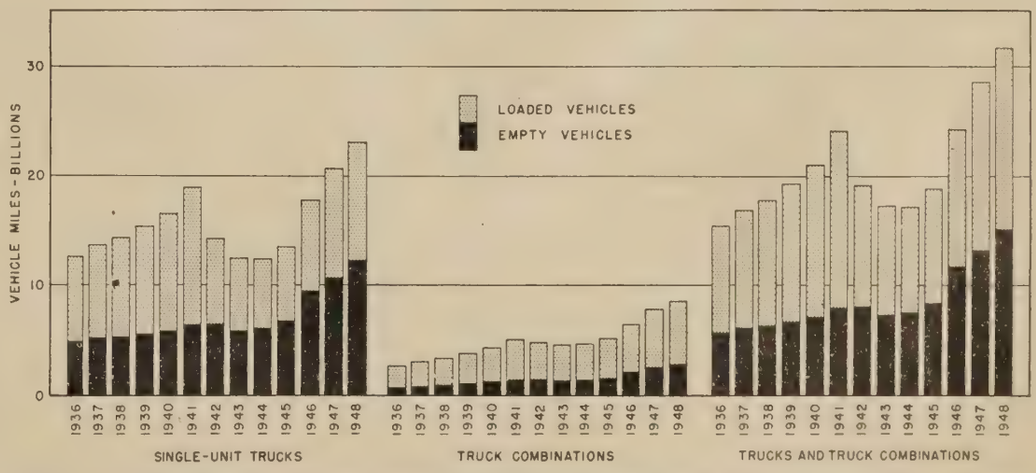


Figure 4.—Travel on main rural roads, 1936–48, by loaded and by empty trucks and truck combinations.

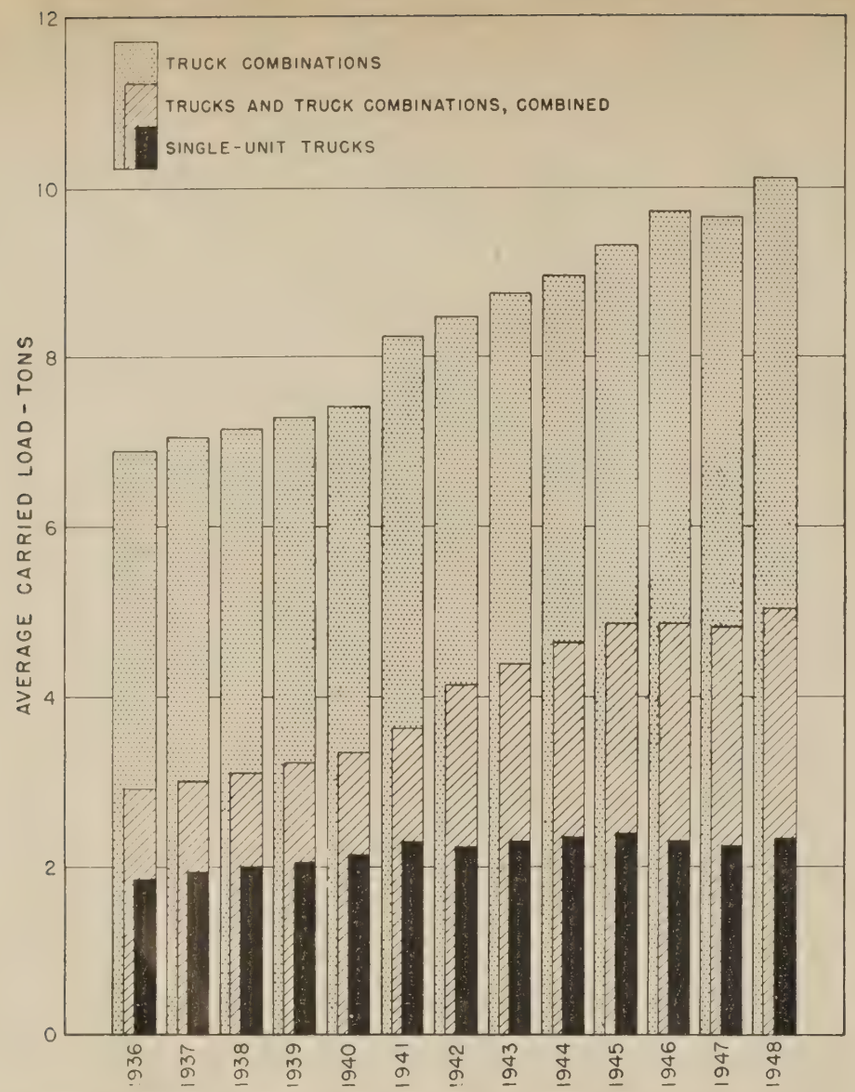


Figure 5.—Average load carried by trucks and truck combinations on main rural roads, 1936–48.

than for single-unit trucks except from 1947 to 1948. In the 12 years from 1936 to 1948, passenger-car travel increased about 60 percent, travel by all trucks and combinations doubled, and travel by truck combinations, considered separately, more than tripled.

Figure 5 gives a comparison of the average load carried by single-unit trucks, truck combinations, and all of these vehicles combined, in the 13 years that the planning surveys have been operating. The general trend of load weights was upward throughout the period. The slight decline in the weight of the load carried by single-unit trucks since 1945 has been more than offset by the increased use of combinations and the increased weight of the load of vehicles of this type.

Figure 6 shows a comparison for each year from 1936 through 1948 of the ton-miles of freight carried by trucks and truck combinations on main rural roads. The chart demonstrates clearly how truck combinations are transporting each year a larger portion of the total amount of highway freight. In 1936 the truck combinations hauled slightly less ton-mileage than the single-unit trucks, while in 1948 they hauled more than twice as much. The sharp increase in the total ton-mileage during the last 3 years is especially striking.

Percentage Loaded Remains Constant

In table 6 is shown a comparison of the percentage of vehicles carrying loads, the average carried load, and the ton-mileage carried for all trucks and combinations, for single-unit trucks, and for truck combinations in 1948 and the other significant periods used in table 5. The trend in average weight carried, shown graphically in figure 5, and that of the ton-mileage transported, shown in figure 6, have already been discussed. For the country as a whole, from 1947 to 1948, the percentage of trucks and truck combinations carrying loads decreased slightly. This decrease was not sufficient to offset a slight increase from 1946 to 1947, so the percentage loaded still remained slightly above that in 1946. It appears, then, that the downward trend in percentage loaded, noted each year from 1942 to 1946, inclusive, was halted in 1946, probably due to the fact that passenger cars were becoming more plentiful, and the tendency to use trucks in lieu of passenger cars began to decrease. Since 1946 the trend has not been clearly established. It was still true in 1948 that over half of the single-unit trucks passing the stations were empty, the percentage loaded being 47 percent in 1948 compared to 61 percent in 1936.

Table 7 gives a detailed comparison of the percentage of vehicle-miles of travel, percentage of vehicles loaded, average carried load, and percentage of total ton-miles carried by the various types of trucks and truck combinations traveling on main rural roads in 1947 and 1948. Many interesting comparisons can be made from this table, showing the relative importance from a freight-carrying standpoint of different portions of the traffic stream. For instance, it may be seen from the table that in 1948, while panel and pick-up trucks traveled almost 29 percent of the vehicle-miles, they accounted for less than 3 percent of the ton-mileage; likewise, while the tractor-truck and semi-trailer combinations

Table 6.—*Comparison of the estimated percentage of trucks and truck combinations loaded, average carried load, and ton-miles carried on main rural roads in 1936, 1941, 1946, 1947, and 1948*

Year	All trucks and truck combinations			Single-unit trucks			Truck combinations		
	Percentage loaded	Average weight of carried load	Ton-miles carried	Percentage loaded	Average weight of carried load	Ton-miles carried	Percentage loaded	Average weight of carried load	Ton-miles carried
		Tons	*Millions*		*Tons*	*Millions*		*Tons*	*Millions*
1936	62.8	2.90	28,005	60.7	1.86	14,258	72.2	6.90	13,747
1941	66.7	3.64	58,737	65.4	2.29	28,487	71.6	8.23	30,250
1941:1936 ratio	*1.06*	*1.26*	*2.10*	*1.08*	*1.23*	*2.00*	*.99*	*1.19*	*2.20*
1946	51.7	4.84	60,892	46.4	2.31	19,101	66.2	9.70	41,791
1946:1941 ratio	*.78*	*1.33*	*1.04*	*.71*	*1.01*	*.67*	*.92*	*1.18*	*1.38*
1946:1936 ratio	*.82*	*1.67*	*2.17*	*.76*	*1.24*	*1.34*	*.92*	*1.41*	*3.04*
1947	53.5	4.81	73,610	48.3	2.26	22,610	67.1	9.63	51,000
1948	52.2	5.02	83,119	46.8	2.33	25,219	66.5	10.10	57,900
1948:1947 ratio	*.98*	*1.04*	*1.13*	*.97*	*1.03*	*1.12*	*.99*	*1.05*	*1.14*
1948:1941 ratio	*.78*	*1.38*	*1.42*	*.72*	*1.02*	*.89*	*.93*	*1.23*	*1.91*
1948:1936 ratio	*.83*	*1.73*	*2.97*	*.77*	*1.25*	*1.77*	*.92*	*1.46*	*4.21*

traveled about 25 percent of the vehicle-mileage, they carried 63 percent of the ton-mileage.

From the portion of table 7 showing the percentage of vehicles carrying loads, by types, it can be observed that the percentage of vehicles carrying loads increases directly as the size of the vehicle type, extending from the light panel and pick-up trucks that are loaded 37 percent of the time to the heavy truck and trailer combinations that are loaded 70 percent of the time.

Frequency of Loads Above Legal Limit Increases

Table 8 shows the frequency of illegal loadings, expressed as the number of trucks and truck combinations of each type per 1,000 such vehicles counted, empties included, that exceeded the permissible axle, axle-group, or gross-weight legal limits in effect in the individual States in the summer of 1948. Violations of the State laws were most frequent in the East North Central region, where it was found that 84 of each 1,000 vehicles exceeded a State weight limit, 20 of these vehicles exceeding the limit by more than 20 percent. The Middle Atlantic region stood second in frequency of violations, for in this area 65 vehicles out of each 1,000 exceeded a load limit, and 17 such vehicles exceeded the limit by more than 20 percent.

A comparison of the frequency data concerning violations of State weight laws in 1948, as shown in table 8, with similar data collected in the previous year, indicates that these violations have increased in all areas except the Pacific and New England regions. In the Pacific region the frequency of violations decreased almost 25 percent, while in the New England region the frequency remained the same as in the previous year, at 35 per 1,000.

Comparison with Recommended Weight Limits

Uniform regulations concerning maximum allowable gross weights, axle weights, and axle-group weights have been adopted as a policy by the American Association of State Highway Officials and recommended to the various

(Text continued on page 298: tables 8–11 are on pages 294–5)

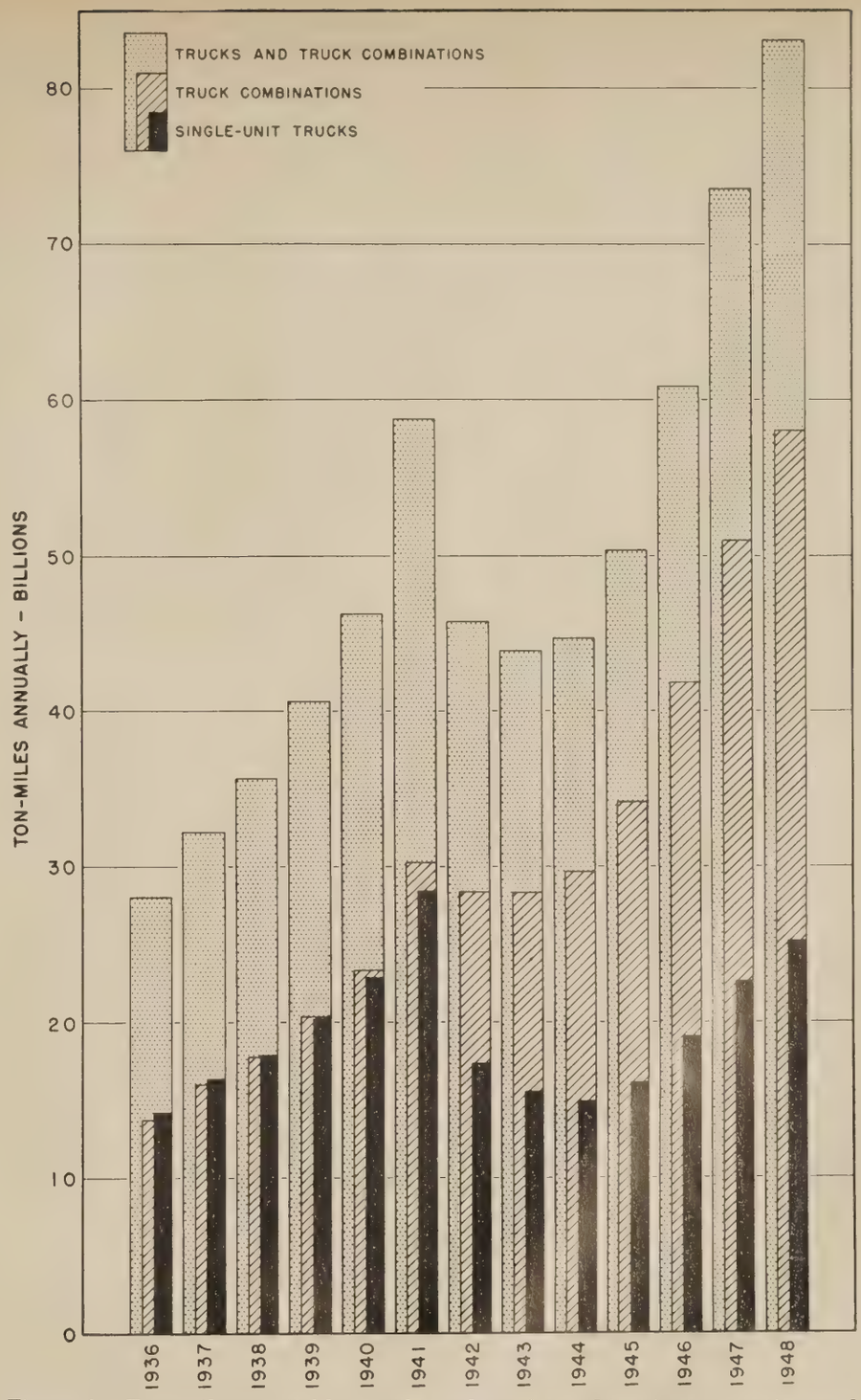


Figure 6.—Ton-miles carried by trucks and truck combinations on main rural roads, 1936–48.

Table 7.—*Percentage of vehicle-miles of travel, percentage loaded, average carried load, and percentage of total ton-miles carried by various types of trucks and truck combinations on main rural roads in 1948 compared to that in corresponding months of 1947*

Vehicle type	Percentage of vehicle-miles of travel		Percentage loaded		Average carried load		Percentage of ton-mileage carried	
	1948	1947	1948	1947	1948	1947	1948	1947
					Tons	*Tons*		
Single-unit trucks:								
Panel and pick-up	28.90	28.44	36.7	39.2	0.64	0.63	2.60	2.74
Other 2-axle, 4-tire	3.59	4.12	51.9	50.9	1.24	1.29	.88	1.06
Other 2-axle, 6-tire	38.66	36.18	53.6	54.4	3.10	2.91	24.51	22.26
3-axle	1.70	3.72	55.2	55.5	6.57	5.80	2.35	4.66
All single-unit trucks	72.85	72.46	46.8	48.3	2.33	2.26	30.34	30.72
Truck combinations:								
Tractor-truck and semitrailer	25.35	24.96	66.2	67.2	9.83	9.25	63.09	60.32
Truck and trailer	1.80	2.58	70.2	66.8	13.64	13.38	6.57	8.96
All truck combinations	27.15	27.54	66.5	67.1	10.10	9.63	69.66	69.28
All trucks and truck-combinations	100.00	100.00	52.2	53.5	5.02	4.81	100.00	100.00

Table 8.—*Number of trucks and truck combinations, per 1,000 loaded and empty vehicles, that exceeded the permissible axle, axle-group, or gross-weight laws in effect in the States by various percentages (maximum) of overload, in the summer of 1948*

Region and type of vehicle (panel and pick-up trucks excluded)	Number per 1,000 overloaded	Number per 1,000 overloaded more than —				
		5 percent	10 percent	20 percent	30 percent	50 percent
New England:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	18	14	8	3	1	(1)
3-axle	97	69	55	27	3	--
Average, single-unit trucks	11	9	5	2	1	(1)
Tractor-truck and semitrailer	124	90	62	30	16	2
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	124	90	62	30	16	2
Average, all trucks and combinations	35	26	17	8	4	(1)
Middle Atlantic:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	35	28	20	6	4	--
3-axle	133	106	86	56	56	12
Average, single-unit trucks	26	20	15	5	4	(1)
Tractor-truck and semitrailer	186	127	101	55	27	4
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	185	126	101	55	27	4
Average, all trucks and combinations	65	46	36	17	10	1
South Atlantic:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	9	7	6	2	1	--
3-axle	105	71	51	26	9	--
Average, single-unit trucks	7	5	4	2	1	--
Tractor-truck and semitrailer	190	126	84	34	15	1
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	190	126	84	34	15	1
Average, all trucks and combinations	56	37	25	11	5	(1)
East North Central:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	10	8	4	1	(1)	--
3-axle	62	32	32	26	19	--
Average, single-unit trucks	7	5	3	1	(1)	--
Tractor-truck and semitrailer	194	141	95	47	19	3
Truck and trailer	673	565	331	147	103	13
Average, truck combinations	212	157	104	51	22	3
Average, all trucks and combinations	84	62	41	20	8	1
East South Central:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	23	15	9	3	(1)	--
3-axle	74	57	57	34	17	17
Average, single-unit trucks	14	9	5	2	(1)	(1)
Tractor-truck and semitrailer	183	139	100	55	24	5
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	183	139	100	55	24	5
Average, all trucks and combinations	47	34	23	12	5	1
West North Central:						
2-axle, 4-tire	1	---	---	---	---	--
2-axle, 6-tire	4	1	1	(1)	(1)	--
3-axle	6	4	---	---	---	--
Average, single-unit trucks	3	1	1	(1)	(1)	--
Tractor-truck and semitrailer	222	149	84	32	13	2
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	214	144	81	31	13	2
Average, all trucks and combinations	50	33	19	7	3	(1)
West South Central:						
2-axle, 4-tire	11	8	8	---	---	--
2-axle, 6-tire	9	6	3	1	(1)	--
3-axle	13	13	13	13	7	7
Average, single-unit trucks	5	3	2	1	(1)	(1)
Tractor-truck and semitrailer	166	127	89	44	22	6
Truck and trailer	49	49	49	49	49	--
Average, truck combinations	164	125	88	44	23	6
Average, all trucks and combinations	47	35	24	12	6	2
Mountain:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	25	16	10	5	3	(1)
3-axle	8	8	4	4	---	--
Average, single-unit trucks	10	7	4	2	1	(1)
Tractor-truck and semitrailer	174	143	102	46	20	4
Truck and trailer	178	112	75	44	27	5
Average, truck combinations	175	138	98	46	21	4
Average, all trucks and combinations	40	31	21	10	5	1
Pacific:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	12	7	3	1	(1)	--
3-axle	26	11	5	---	---	--
Average, single-unit trucks	8	4	2	(1)	(1)	--
Tractor-truck and semitrailer	105	56	36	15	2	--
Truck and trailer	127	47	12	---	---	--
Average, truck combinations	112	53	28	10	1	--
Average, all trucks and combinations	45	21	11	4	(1)	--
United States average:						
2-axle, 4-tire	1	1	1	---	---	--
2-axle, 6-tire	15	10	7	2	1	(1)
3-axle	61	42	33	20	15	3
Average, single-unit trucks	9	6	5	2	1	(1)
Tractor-truck and semitrailer	179	125	85	41	18	3
Truck and trailer	186	114	59	25	18	2
Average, truck combinations	179	124	83	40	18	3
Average, all trucks and combinations	55	38	26	12	6	1

[1] Less than 5 per 10,000.

Table 9.—*Number of axles, per 1,000 loaded and empty trucks and truck combinations that exceeded the permissible axle-load limit of 18,000 pounds recommended by the A. A. S. H. O. by various percentages of overload, in the summer of 1948*

Region and type of vehicle (panel and pick-up trucks excluded)	Number per 1,000 overloaded	Number per 1,000 overloaded more than —				
		5 percent	10 percent	20 percent	30 percent	50 percent
New England:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	45	39	31	17	9	3
3-axle	95	62	39	17	---	--
Average, single-unit trucks	25	21	17	9	5	2
Tractor-truck and semitrailer	432	353	278	147	65	10
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	432	353	278	147	65	10
Average, all trucks and combinations	112	92	73	38	18	4
Middle Atlantic:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	78	67	58	38	26	6
3-axle	208	148	146	65	63	3
Average, single-unit trucks	54	45	40	25	18	4
Tractor-truck and semitrailer	672	583	499	313	152	41
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	669	580	497	312	151	41
Average, all trucks and combinations	205	177	153	96	51	13
South Atlantic:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	12	9	8	3	1	(1)
3-axle	96	64	64	6	---	--
Average, single-unit trucks	8	6	5	2	1	(1)
Tractor-truck and semitrailer	346	249	170	73	26	2
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	345	248	170	73	26	2
Average, all trucks and combinations	98	71	49	21	8	1
East North Central:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	11	8	4	1	(1)	--
3-axle	13	13	6	---	---	--
Average, single-unit trucks	7	5	2	1	(1)	--
Tractor-truck and semitrailer	221	152	91	36	12	2
Truck and trailer	792	369	161	21	4	--
Average, truck combinations	243	160	94	35	11	2
Average, all trucks and combinations	95	64	38	14	4	1
East South Central:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	23	15	9	3	(1)	--
3-axle	58	40	40	17	---	--
Average, single-unit trucks	13	9	5	2	(1)	--
Tractor-truck and semitrailer	236	174	120	56	23	4
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	236	174	120	56	23	4
Average, all trucks and combinations	56	41	27	12	4	1
West North Central:						
2-axle, 4-tire	(1)	---	---	---	---	--
2-axle, 6-tire	5	2	1	(1)	(1)	--
3-axle	3	---	---	---	---	--
Average, single-unit trucks	3	1	1	(1)	(1)	--
Tractor-truck and semitrailer	210	124	64	21	8	2
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	203	120	62	20	8	2
Average, all trucks and combinations	47	27	15	4	2	(1)
West South Central:						
2-axle, 4-tire	11	8	8	---	---	--
2-axle, 6-tire	8	7	3	1	(1)	--
3-axle	20	13	13	13	13	--
Average, all single-unit trucks	9	3	2	1	(1)	--
Tractor-truck and semitrailer	197	144	93	45	21	6
Truck and trailer	137	127	88	---	---	--
Average, truck combinations	196	143	92	44	21	6
Average, all trucks and combinations	58	40	26	12	5	2
Mountain:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	23	16	10	5	3	--
3-axle	4	4	4	4	---	--
Average, all single-unit trucks	9	7	4	2	1	--
Tractor-truck and semitrailer	135	95	66	20	7	--
Truck and trailer	112	73	52	37	18	5
Average, truck combinations	131	91	64	23	9	1
Average, all trucks and combinations	32	23	15	6	2	(1)
Pacific:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	12	7	4	(1)	(1)	--
3-axle	13	2	2	---	---	--
Average, single-unit trucks	7	4	2	(1)	(1)	--
Tractor-truck and semitrailer	79	42	20	6	1	--
Truck and trailer	97	36	10	---	---	--
Average, truck combinations	85	40	17	4	1	--
Average, all trucks and combinations	35	17	7	1	(1)	--
United States average:						
2-axle, 4-tire	1	1	1	---	---	--
2-axle, 6-tire	22	18	14	8	5	1
3-axle	64	43	41	15	12	1
Average, single-unit trucks	14	11	9	5	3	1
Tractor-truck and semitrailer	281	211	150	76	33	7
Truck and trailer	179	82	36	6	3	1
Average, truck combinations	274	202	142	71	31	6
Average, all trucks and combinations	85	63	45	23	11	2

[1] Less than 5 per 10,000.

Table 10.—*Number of trucks and truck combinations, per 1,000 loaded and empty vehicles, that exceeded the permissible axle-group loads recommended by the A. A. S. H. O. by various percentages of overload, in the summer of 1948*

Region and type of vehicle (panel and pick-up trucks excluded)	Number per 1,000 overloaded	Number per 1,000 overloaded more than —				
		5 percent	10 percent	20 percent	30 percent	50 percent
New England:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	1	1	(1)	---	---	--
3-axle	84	74	55	17	3	--
Average, single-unit trucks	2	2	1	(1)	(1)	--
Tractor-truck and semitrailer	66	46	26	9	3	(1)
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	66	46	26	9	3	(1)
Average, all trucks and combinations	16	11	6	2	1	(1)
Middle Atlantic:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6 tire	5	1	---	---	---	--
3-axle	154	136	98	59	47	30
Average, single-unit trucks	8	5	3	2	2	1
Tractor- truck and semitrailer	201	150	112	60	37	8
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	200	149	111	60	37	8
Average, all trucks and combinations	55	40	30	16	11	3
South Atlantic:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	---	---	---	---	---	--
3-axle	83	58	36	21	9	--
Average, single- unit trucks	2	1	1	(1)	(1)	--
Tractor-truck and semitrailer	45	31	22	11	7	1
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	45	31	22	11	7	1
Average, all trucks and combinations	14	9	7	3	2	(1)
East North Central:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	---	---	---	---	---	--
3-axle	30	13	---	---	---	--
Average, single-unit trucks	1	(1)	---	---	---	--
Tractor-truck and semitrailer	103	76	55	26	11	2
Truck and trailer	763	684	633	361	205	68
Average, truck combinations	128	99	77	39	18	4
Average, all trucks and combinations	49	37	29	15	7	1
East South Central:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	---	---	---	---	---	--
3-axle	17	17	17	17	---	--
Average, single-unit trucks	(1)	(1)	(1)	(1)	---	--
Tractor- truck and semitrailer	34	19	12	7	3	--
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	34	19	12	7	3	--
Average, all trucks and combinations	7	4	2	1	1	--
West North Central:						
2-axle, 4-tire	---	---	---	---	---	--
2 axle, 6 tire	---	---	---	---	---	--
3-axle	12	12	---	---	---	--
Average, single-unit trucks	(1)	(1)	---	---	---	--
Tractor-truck and semitrailer	109	73	45	12	4	(1)
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	105	70	43	12	4	(1)
Average, all trucks and combinations	23	16	10	3	1	(1)
West South Central:						
2-axle, 4-tire	11	8	8	---	---	--
2-axle, 6-tire	---	---	---	---	---	--
3-axle	7	7	7	7	7	7
Average, single-unit trucks	(1)	(1)	(1)	(1)	(1)	(1)
Tractor-truck and semitrailer	41	33	26	14	6	2
Truck and trailer	49	49	49	49	39	39
Average, truck combinations	41	33	26	15	7	4
Average, all trucks and combinations	11	9	7	4	2	1
Mountain:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	---	---	---	---	---	--
3-axle	15	8	4	---	---	--
Average, single-unit trucks	(1)	(1)	(1)	---	---	--
Tractor-truck and semitrailer	119	88	62	24	13	(1)
Truck and trailer	223	143	104	36	11	5
Average, truck combinations	136	97	69	26	13	1
Average, all trucks and combinations	25	18	13	5	2	(1)
Pacific:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	---	---	---	---	---	--
3-axle	11	2	2	---	---	--
Average, single-unit trucks	1	(1)	(1)	---	---	--
Tractor-truck and semitrailer	148	105	67	22	11	--
Truck and trailer	233	149	80	11	2	--
Average, truck combinations	175	119	71	19	8	--
Average, all trucks and combinations	63	42	25	7	3	--
United States average:						
2-axle, 4-tire	(1)	(1)	(1)	---	---	--
2-axle, 6-tire	(1)	(1)	(1)	---	---	--
3-axle	53	41	27	15	11	6
Average, single-unit trucks	1	1	1	(1)	(1)	(1)
Tractor-truck and semitrailer	97	70	49	22	11	2
Truck and trailer	272	198	143	58	29	11
Average, truck combinations	109	78	55	24	12	3
Average, all trucks and combinations	30	22	16	7	3	1

[1] Less than 5 per 10,000.

Table 11.—*Number of trucks and truck combinations, per 1,000 loaded and empty vehicles, that exceeded the permissible motor-vehicle loads recommended by the A. A. S. H. O. by various percentages (maximum) of overload, summer of 1948*

Region and type of vehicle (panel and pick-up trucks excluded)	Number per 1,000 overloaded	Number per 1,000 overloaded more than —				
		5 percent	10 percent	20 percent	30 percent	50 percent
New England:						
2-axle, 4 tire	---	---	---	---	---	--
2-axle, 6-tire	45	39	30	16	8	2
3-axle	99	77	59	17	3	--
Average, single-unit trucks	25	21	17	8	4	1
Tractor-truck and semitrailer	285	240	196	109	56	8
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	285	240	196	109	56	8
Average, all trucks and combinations	80	68	55	30	15	2
Middle Atlantic:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	78	67	58	38	26	6
3-axle	169	159	139	59	47	30
Average, single-unit trucks	53	46	40	25	17	5
Tractor-truck and semitrailer	433	404	362	256	138	42
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	431	402	360	255	137	42
Average, all trucks and combinations	146	134	119	82	47	14
South Atlantic:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	12	9	8	3	1	(1)
3-axle	108	84	58	27	11	2
Average, single-unit trucks	8	6	5	2	1	(1)
Tractor-truck and semitrailer	245	184	128	59	25	3
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	244	184	128	59	25	3
Average, all trucks and combinations	71	54	38	17	7	1
East North Central:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	10	8	4	1	(1)	--
3-axle	30	13	13	---	---	--
Average, single-unit trucks	7	4	3	1	(1)	--
Tractor-truck and semitrailer	196	149	100	44	17	4
Truck and trailer	821	739	637	400	209	68
Average, truck combinations	220	171	120	57	24	6
Average, all trucks and combinations	87	67	47	22	9	2
East South Central:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	23	15	9	3	(1)	--
3-axle	40	40	40	17	---	--
Average, single-unit trucks	13	9	5	2	(1)	--
Tractor-truck and semitrailer	172	131	91	46	20	4
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	172	131	91	46	20	4
Average, all trucks and combinations	44	33	22	11	4	1
West North Central:						
2-axle, 4-tire	1	---	---	---	---	--
2-axle, 6-tire	5	2	1	(1)	(1)	(1)
3-axle	15	15	---	---	---	--
Average, single-unit trucks	3	1	1	(1)	(1)	(1)
Tractor-truck and semitrailer	209	140	82	27	10	2
Truck and trailer	---	---	---	---	---	--
Average, truck combinations	202	135	79	26	10	2
Average, all trucks and combinations	47	31	18	6	2	(1)
West South Central:						
2-axle, 4-tire	11	8	8	---	---	--
2-axle, 6-tire	8	6	3	1	---	--
3-axle	13	13	13	13	7	7
Average, single-unit trucks	4	3	2	1	(1)	(1)
Tractor-truck and semitrailer	149	115	78	40	16	4
Truck and trailer	49	49	49	49	39	39
Average, truck combinations	147	114	77	40	16	5
Average, all trucks and combinations	41	32	22	11	4	1
Mountain:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	23	15	10	5	2	--
3-axle	15	8	4	4	---	--
Average, single-unit trucks	10	6	4	2	1	--
Tractor-truck and semitrailer	163	129	94	42	18	3
Truck and trailer	232	157	110	48	25	5
Average, truck combinations	174	134	97	43	19	3
Average, all trucks and combinations	40	30	21	10	4	1
Pacific:						
2-axle, 4-tire	---	---	---	---	---	--
2-axle, 6-tire	11	7	3	1	(1)	--
3-axle	19	5	5	---	---	--
Average, single-unit trucks	7	4	2	(1)	(1)	--
Tractor-truck and semitrailer	181	126	78	29	11	--
Truck and trailer	320	182	87	11	2	--
Average, truck combinations	225	144	81	23	8	--
Average, all trucks and combinations	84	54	30	8	3	--
United States average:						
2-axle, 4-tire	1	1	1	---	---	--
2-axle, 6-tire	22	17	14	8	5	1
3-axle	63	51	41	17	11	6
Average, single-unit trucks	13	10	8	5	3	1
Tractor-truck and semitrailer	226	178	131	70	33	8
Truck and trailer	336	228	149	64	31	11
Average, truck combinations	233	181	132	69	32	7
Average, all trucks and combinations	73	56	42	23	11	3

[1] Less than 5 per 10,000.

Trends in Motor-Vehicle Travel, 1948

BY THE FINANCIAL AND ADMINISTRATIVE RESEARCH BRANCH
BUREAU OF PUBLIC ROADS

Reported by G. P. St. CLAIR, Chief of Branch

Total motor-vehicle travel in 1948 is estimated as more than 397 billion vehicle-miles, about evenly divided between rural highways and urban roads and streets. Passenger cars accounted for 319 billion vehicle-miles of the total, busses 4 billion, and trucks and combinations 74 billion. Except for urban travel of busses, estimated travel in 1948 was greater than in 1947 for every category, although in all cases the increases were smaller than those from 1946 to 1947. As in the previous year, truck travel in 1948 increased at about twice the rate of passenger-vehicle travel.

The average vehicle in 1948 traveled 9,707 miles, using 741 gallons of motor fuel at a rate of 13 miles per gallon. Annual average passenger-car travel continued to decrease from the 1946 peak, while average truck-mileage, though maintaining a steady rise, was still below the 1941 maximum.

Total travel has been very nearly equally divided between rural highways and urban roads and streets since the end of the war. As indicated in this article, the ratios of rural to urban travel for the past 3 years vary in a range of less than 2 percent.

THIS article is the fourth of an annual series in PUBLIC ROADS [1] giving classified estimates of motor-vehicle travel in the United States. The procedures used in making these estimates were the same as those described in the previous reports, the principal factors controlling the calculations being (1) the annual estimates of rural-road traffic described in another article in this issue of PUBLIC ROADS; (2) the annual reports of highway use of motor fuel; and (3) reported motor-vehicle registrations. As in the previous calculations, the 1948 estimates were based on indicated changes from a previous year, the year 1947 being used as the base year in this instance.

Table 1 reports, for the various classes of motor vehicles, the estimates for 1948 of rural, urban, and total vehicle-miles traveled, average miles traveled per vehicle, motor-fuel consumption, in total and per vehicle, and average travel per gallon of motor fuel consumed. The numbers of registered motor vehicles, as modified for the purpose of these estimates, are also given.

The total travel of motor vehicles in 1948 is estimated as 397,589 million vehicle-miles, of which 198,507 million were traveled on rural highways, and 199,082 million on urban highways and streets. The total travel of passenger cars was 319,459 million vehicle-miles, of which the travel on rural roads was 151,275 million and the urban travel 168,184 million. The estimated travel of trucks and combinations, 73,847 million vehicle-miles, included 45,096 million traveled on rural roads, and 28,751 million on urban roads and streets.

[1] *Trends in motor-vehicle travel, 1936 to 1945*, PUBLIC ROADS, vol. 24, No. 10, Oct.-Nov.-Dec. 1946; *Trends in motor-vehicle travel, 1946*, PUBLIC ROADS, vol. 25, No. 3, March 1948; *Trends in motor-vehicle travel, 1947*, PUBLIC ROADS, vol. 25, No. 7, March 1949.

Percentage Changes in Annual Travel

Table 2 gives, for the major vehicle types, a comparison of the percentage changes in 1948 travel over that of 1947, with the corresponding changes in 1947 travel over that of 1946. Estimated travel in 1948 was greater than in 1947 in all categories except the urban travel of busses, which suffered a slight loss. The percentage increases over 1947, however, were somewhat less in most cases than those of 1947 over 1946. The increase in passenger-car travel was 6.39 percent, in contrast to a 1947 increase of 7.07 percent. Travel of trucks and combinations increased by 11.74 percent, as against an increase of 17.71 percent in 1947. The increase in total travel was reduced from 8.80 percent in 1947 to 7.28 in 1948.

The increase in the estimated travel of trucks and combinations, 11.74 percent, was nearly twice that found in the case of passenger cars. This finding, which continues a trend displayed in the 1947 estimates, is attributable in part to the fact that the numbers of truck registrations have been increasing more rapidly than those of passenger cars. In 1948 the registrations of trucks and combinations were 11 percent greater than in 1947, whereas passenger-car registrations increased only 8 percent.

The estimates of urban travel of both passenger cars and trucks show a greater increase

Table 1.—*Classified estimate of motor-vehicle travel in the United States in the calendar year 1948*

Vehicle type	Motor-vehicle travel			Number of registered vehicles [1]	Average travel per vehicle	Motor-fuel consumption		Average travel per gallon of fuel consumed
	Rural travel	Urban travel	Total travel			Total [2]	Average per vehicle	
	Million vehicle-miles	*Million vehicle-miles*	*Million vehicle-miles*	*Thousands*	*Miles*	*Million gallons*	*Gallons*	*Miles*
Passenger vehicles:								
Passenger cars [3]	151,275	168,184	319,459	33,394	9,566	21,369	640	14.95
Busses:								
Commercial	1,474	2,074	3,548	92	38,500	709	7,700	5.00
School and nonrevenue	662	73	735	92	8,000	71	769	10.40
All busses	2,136	2,147	4,283	184	23,268	780	4,239	5.49
All passenger vehicles	153,411	170,331	323,742	33,578	9,642	22,149	660	14.62
Trucks and combinations	45,096	28,751	73,847	7,379	10,008	8,189	1,110	9.02
All motor vehicles	198,507	199,082	397,589	40,957	9,707	30,338	741	13.11

[1] These registration totals differ from those given in Bureau of Public Roads table MV–1 for 1948 because of the following adjustments: (1) Approximate correction for defective classification in 3 States, as described in footnotes 9, 10, and 13 of that table; (2) inclusion of publicly owned vehicles, listed separately in table MV–1; (3) reduction of private and commercial truck registrations by 2.5 percent to allow for registrations in more than 1 State; and (4) substitution of bus totals as estimated by the bus industry to afford a complete segregation of commercial busses from school and nonrevenue busses and to allow for registrations in more than 1 State.

[2] Total highway use of motor fuel in 1948 is given as 30,461 million gallons in Bureau of Public Roads table G–21. For this analysis there was deducted from that total 123 million gallons estimated use by motorcycles (250 gallons per motorcycle).

[3] Including taxicabs.

Table 2.—*Percentage changes in motor-vehicle travel, 1948 over 1947, compared with corresponding changes, 1947 over 1946*

Vehicle type	Percentage change in travel—					
	1948 over 1947			1947 over 1946		
	Rural	Urban	Total	Rural	Urban	Total
Passenger cars	5.30	7.38	6.39	7.20	6.95	7.07
Busses	1.67	−.14	.75	5.10	4.72	4.91
All passenger vehicles	5.25	7.28	6.31	7.17	6.92	7.04
Trucks and combinations	10.61	13.56	11.74	17.86	17.47	17.71
All motor vehicles	6.42	8.15	7.28	9.34	8.26	8.80

over 1947 values than do those of travel on rural roads. This finding is a reversal of the relationships displayed by the 1947 estimates.

Table 3 gives values of the estimated rural, urban, and total travel volumes in the years 1941 through 1948. With respect to total travel, there are also given values of the ratio of the volume in each year to the 1941 volume, and the ratio to the volume in the preceding year. It will be observed that, after a recovery in 1946 to a value slightly above that of 1941, there has been a steady rise in the volume of total travel to a level in 1948 that was 19 percent above that of 1941. The travel estimates of recent years are indicative of a firm upward trend, with some tendency for the values to round over toward a position of stability which would appear to be far in the future.

Average Annual Mileages

Figure 1 gives a comparison of trends in the average miles per vehicle traveled by passenger cars and by trucks and combinations in the years 1936 to 1948, inclusive. It will be noted that the average mileage of passenger cars, after recovering from the wartime decline to a maximum of 9,942 miles in 1946, declined in 1947 to 9,727 miles, and again in 1948 to 9,566 miles. The average mileage of trucks and combinations, on the other hand, has been rising steadily from its low value in 1944, although the 1948 value is still well below that of 1941.

In the discussion of the 1947 estimates,[1] the observed decrease in the average annual mileage of passenger cars was attributed to the fact that the acute postwar shortage of automobiles caused those in service to be driven greater annual mileages than would have been the case had passenger cars been in full supply. As production increased and the demand for new cars was partly satisfied, there was a tendency for the average mileage driven to diminish. It was stated that "It is not unlikely that the trend toward somewhat decreased average annual mileage of passenger cars will continue for a year or two as a result of the greatly increased production of these vehicles." The 1948 estimate of 9,566 miles per passenger car tends to confirm this prediction.

The average mileages of trucks show a more normal trend than those of passenger cars, probably because the shortage in these vehicles was not as acute in relation to the demand as in the case of passenger cars. The failure of the average mileages of trucks and combinations to reach their prewar levels may reasonably be attributed to the fact, previously cited, that there has been an enormous increase in truck registrations during the postwar years, with the result that the large volume of increased trucking business can be carried at an average mileage per vehicle lower than that of the prewar years. Truck registrations in 1948 were more than 44 percent above those of 1941. Passenger-car registrations, on the other hand, were only about 12½ percent above their 1941 level.

As would be expected from the showing of passenger cars and trucks, the average annual mileages for all motor vehicles combined show a moderate decline, the successive values being 9,958 in 1946, 9,831 in 1947, and 9,707 in 1948.

[1] *Trends in motor-vehicle travel, 1947*, PUBLIC ROADS, vol. 25, No. 7, March 1949, p. 157.

Table 3.—*Comparison of estimates of rural, urban, and total travel in the years 1941–48*

Year	Rural travel	Urban travel	Ratio of rural to urban travel	Total travel		
				Amount	Ratio to 1941 total	Ratio to total in preceding year
	Million vehicle-miles	*Million vehicle-miles*		*Million vehicle-miles*		
1941	169,805	163,591	1.0380	333,396	1.0000	[1] 1.1034
1942	128,861	138,235	.9322	267,096	.8011	.8011
1943	97,757	108,990	.8969	206,747	.6201	.7741
1944	100,830	110,750	.9104	211,580	.6346	1.0234
1945	119,183	129,743	.9186	248,926	.7466	1.1765
1946	170,606	170,049	1.0033	340,655	1.0218	1.3685
1947	186,534	184,088	1.0133	370,622	1.1117	1.0880
1948	198,507	199,082	.9971	397,589	1.1925	1.0728

[1] The estimated total travel in 1940 was 302,143 million vehicle-miles.

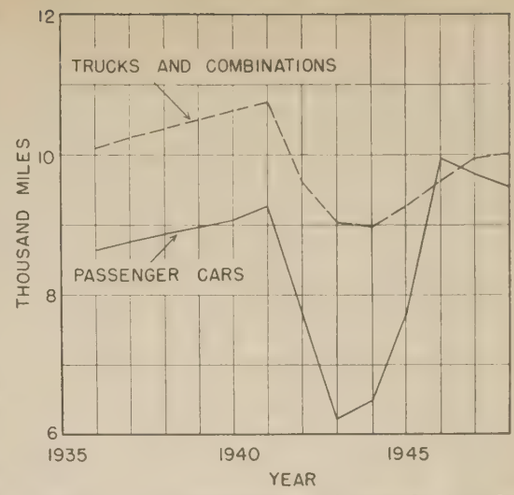


Figure 1.—Comparison of trends in the annual average miles per vehicle traveled by passenger cars and by trucks and combinations.

Relative Changes in Rural and Urban Travel

The fourth column of table 3 gives, for each year beginning with 1941, the ratio of total rural travel to total urban travel. In 1941, the volume of rural travel exceeded that of urban travel by 3.8 percent. The heavy restrictions on the use of vehicles and gasoline during the war period caused this ratio to decline to a value slightly under 0.9 in 1943. In 1946, the ratio of rural to urban travel crossed the line again at the value 1.0033. The 1947 value of 1.0133 seemed to indicate that the trend would be toward recovery of the prewar position, where the volume of rural travel was definitely greater than that of urban travel, although by only a small percentage. The 1948 estimates have resulted in a reduction of the ratio to the value 0.9971. In comparing these ratios, it will be noted that the 1946, 1947, and 1948 values vary within a range of less than 2 percent.

Pertinent factors

In table 4 there are given values for the years 1947 and 1948 of various pertinent factors which go far to explain why the vehicle-mile estimates caused the estimated urban travel to be slightly greater than that of rural travel in 1948. In the first two lines of the table, it is shown that, whereas the estimated travel on rural roads in 1948 was only 6.42 percent above the 1947 value, the highway use of motor fuel, as given by Public Roads table G–21, 1948, exceeded the 1947 value by 7.96 percent. In other words, motor-fuel use increased more rapidly in 1948 than did rural-road traffic. It is natural to conclude, therefore, that, unless there was some drastic change in miles-per-gallon relationships, urban travel must have increased in greater proportion than rural travel in order to absorb the increased use of gasoline.

It should be noted that the various factors listed in table 4 are independent of the procedures used in making the estimates of total travel and urban travel. They are derived from the rural traffic estimates, which are accepted unchanged, and from the annual

Table 4.—*Comparison, for the years 1947 and 1948, of various factors relating to travel on rural roads, motor-fuel consumption, and motor-vehicle registrations* [1]

Item	1947	1948	Percentage, 1948 of 1947
For all vehicles:			
Highway use of motor fuel [2] ..... thousand gallons	28,215,705	30,460,641	107.96
Rural-road travel ..... million vehicle-miles	186,534	198,507	106.42
Motor-vehicle registrations [3]	37,841,498	41,151,326	108.75
Rural-road travel per registered vehicle ..... miles	4,929	4,824	97.87
Motor-fuel consumption per registered vehicle ..... gallons	745.6	740.2	99.28
For passenger vehicles:			
Rural-road travel ..... million vehicle-miles	145,763	153,411	105.25
Passenger-vehicle registrations [3]	31,032,807	33,595,996	108.26
Rural-road travel per vehicle	4,697	4,566	97.21
For trucks and combinations:			
Rural-road travel ..... million vehicle-miles	40,771	45,096	110.61
Truck and tractor-truck registrations [3]	6,808,691	7,555,330	110.97
Rural-road travel per vehicle	5,988	5,969	99.68

[1] None of the values given in this table are dependent on approximations used in making the vehicle-mile estimates. They are derived from the rural-road travel estimates (based largely on automatic recorder data), and from the annual statistical tables published by the Bureau of Public Roads.

[2] From Bureau of Public Roads table G-21.

[3] From Bureau of Public Roads tables MV-1 and MV-7.

motor-vehicle registration and gasoline-consumption tables.

Table 4 also gives the numbers of motor-vehicle registrations in 1947 and 1948, and by the use of these figures indicates the amount of rural-road traffic in miles per registered motor vehicle, and the motor-fuel consumption in gallons per registered vehicle. Similar calculations are carried out for the rural-road traffic of passenger vehicles and of trucks and combinations. Although not all motor vehicles appear on rural roads, the use of the total registration figures give highly indicative averages. It will be observed that the rural-road travel per registered motor vehicle was less in 1948 than in 1947, the 1948 value being 97.87 percent of the 1947 value. Motor-fuel consumption per registered vehicle was very slightly less in 1948 than in 1947, the percentage being 99.28. These figures tend to confirm the estimate of a decreased annual mileage of motor vehicles in 1948, but they also show why the estimates of urban travel had to indicate a relatively greater increase in 1948 than the estimates of rural travel. It was, in effect, a question of absorbing gasoline consumption not accounted for by rural travel.

Similar indications are given by the calculations with respect to passenger vehicles and trucks and combinations in the lower portion of table 4. The rural-road travel of passenger vehicles in terms of miles per vehicle was in 1948 only 97.21 percent of its 1947 value. In the case of trucks and combinations the 1947 and 1948 values are much closer, the percentage being 99.68. Comparison of the passenger-car and truck figures tends to confirm the finding that the travel of trucks and combinations is increasing at a more rapid rate than the travel of passenger cars.

More data needed

The data given in table 4 have been included to make it plain that the variation from year to year in the ratios of rural and urban traffic volumes results from the findings with respect to rural-road traffic volumes, reported motor-fuel consumption, and reported motor-vehicle registrations. The difficulty experienced in this connection is illustrative of the fact that a more comprehensive accumulation of data is needed in order to increase the accuracy of annual estimates of motor-vehicle travel.

(*Continued from page 293*)

State governments for adoption.[5] This policy recommends that no axle shall carry a load in excess of 18,000 pounds and no group of axles shall carry a load in excess of amounts specified in a table of permissible weights based on the distance between the extremes of any group of axles.

In table 9 is shown the number of axles per 1,000 vehicles of various types that exceeded the axle-load limit of 18,000 pounds recommended by the A.A.S.H.O. and the number exceeding these limits by various percentages. This table emphasizes again the high frequency of heavy axle loads in the Middle Atlantic and New England regions. The number of axles, per 1,000 vehicles, weighing more than the recommended limits was 32 in the Mountain, 35 in the Pacific, 205 in the Middle Atlantic, and 112 in the New England region. For truck combinations, corresponding figures are: Mountain 131, Pacific 85, Middle Atlantic 669, and New England 432.

Eliminating the empty vehicles (which are included in table 9), there were in the Middle Atlantic region almost six axle loads in excess of the recommended limit for each five loaded truck combinations, while in the New England region the corresponding figures were about three excessive axle loads for each five truck combinations.

In considering the data concerning frequency of axles carrying over 18,000 pounds in the Middle Atlantic and New England regions, the fact should be recognized that higher limits generally are permissible in this area and therefore the axles exceeding the recommended limits by 25 percent may be within the legal limits of certain States in these two regions. Comparison of the frequency data given in table 9 with those in table 8 shows that, in these two regions, of each three vehicles exceeding the recommended axle limit, one vehicle actually exceeded a State legal limit.

For the United States as a whole, the frequency of 18,000-pound or heavier axle loads of all trucks and truck combinations in 1948 was almost 29 percent higher than in 1947, while the frequency of those axle loads that exceeded the recommendation by 20 percent or more was over 50 percent higher.

Table 10 shows the number of vehicles per 1,000 vehicles of various types with an axle-group load in excess of the limits recommended by the American Association of State Highway Officials, and in excess of these limits by various percentages. For the country as a whole, of each 1,000 loaded and empty trucks and truck combinations, 30 had axle-group loads weighing in excess of the recommended limits, 7 of which exceeded the limits by more than 20 percent. It was the truck combinations which produced most of the high load concentrations. Of each 1,000 combinations weighed in the United States as a whole, 109 had axle-group loads weighing more than the recommended limits, of which 24 exceeded the limits by more than 20 percent.

For the United States as a whole, the frequency of axle-group loads of all trucks and truck combinations in excess of the recommendations was 20 percent higher in 1948 than in the previous year, while loads 20 percent or more in excess of the recommendations were 40 percent higher.

As might be expected, many vehicles were so loaded that they exceeded more than one recommended weight limit; and some vehicles had more than one axle loaded in excess of the recommended limit. Counting each vehicle only once, regardless of the number of ways in which it exceeded any of the recommended limits, table 11 was derived showing the number of vehicles per 1,000 (both loaded and empty included) of each type that exceeded the limits by various percentages. Those vehicles which exceeded more than one provision of the recommended restrictions were tabulated in the column showing the highest percentage excess of any item.

In the United States as a whole, 73 vehicles out of every 1,000 were overloaded to some degree, according to American Association of State Highway Officials standards, and 23 out of every 1,000 exceeded some one of the provisions by more than 20 percent. The frequency of vehicles exceeding the recommendations by any amount in 1948 was almost 24 percent higher than in the previous year, and the frequency of those that exceeded the recommendations by more than 20 percent was over 53 percent higher.

[5] *Policy concerning maximum dimensions, weights, and speeds of motor vehicles to be operated over the highways of the United States*, adopted April 1, 1946, by the American Association of State Highway Officials; published by the Association in 1946.

U. S. GOVERNMENT PRINTING OFFICE: 1950

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STATUS OF FEDERAL-AID HIGHWAY PROGRAM

AS OF DECEMBER 31, 1949

(Thousand Dollars)

STATE	UNPROGRAMMED BALANCES	ACTIVE PROGRAM											
		PROGRAMMED ONLY			PLANS APPROVED, CONSTRUCTION NOT STARTED			CONSTRUCTION UNDER WAY			TOTAL		
		Total Cost	Federal Funds	Miles	Total Cost	Federal Funds	Miles	Total Cost	Federal Funds	Miles	Total Cost	Federal Funds	Miles
Alabama	$16,340	$15,852	$8,019	363.6	$4,117	$2,023	85.2	$10,599	$6,111	235.9	$30,568	$16,153	684.7
Arizona	1,973	7,604	5,246	200.8	1,311	836	13.6	4,547	3,084	46.9	13,462	9,166	261.3
Arkansas	7,864	11,885	6,427	338.9	3,268	1,593	69.9	14,207	6,905	227.8	29,360	14,925	636.6
California	7,257	46,812	19,254	227.6	4,727	2,085	30.6	36,100	18,220	187.4	87,639	39,559	445.6
Colorado	8,191	2,818	1,594	73.9	4,549	2,577	57.4	11,232	6,485	213.5	18,599	10,656	344.8
Connecticut	6,308	7,378	3,295	16.8	1,264	791	.6	5,517	2,986	6.7	14,159	7,072	24.1
Delaware	3,273	3,420	1,693	64.8	1,199	567	2.4	1,262	617	20.8	5,881	2,877	88.0
Florida	9,394	14,160	7,595	308.7	5,269	2,773	138.8	6,504	3,008	143.9	25,933	13,376	591.4
Georgia	11,121	14,292	7,520	427.9	13,644	5,546	166.1	32,918	16,624	585.1	60,854	29,690	1,179.1
Idaho	5,996	10,554	6,649	413.7	1,038	582	41.3	4,510	2,762	94.0	16,102	9,993	549.0
Illinois	27,528	45,554	24,514	468.8	14,980	7,726	94.6	38,118	18,629	309.8	98,652	50,869	873.2
Indiana	20,289	18,759	9,192	99.9	4,456	2,230	19.1	10,138	5,871	20.3	33,353	17,293	139.3
Iowa	11,624	10,354	3,738	468.9	1,699	800	53.6	15,161	7,735	441.8	27,214	12,273	964.3
Kansas	9,997	11,136	5,420	1,143.8	4,059	2,025	408.3	14,193	7,266	750.3	29,388	14,711	2,302.4
Kentucky	3,372	24,929	12,447	493.8	3,103	1,492	39.8	11,995	5,959	176.5	40,027	19,898	710.1
Louisiana	10,278	21,562	10,131	226.5	7,601	4,091	34.7	17,826	8,054	146.8	46,989	22,276	408.0
Maine	5,934	4,409	2,504	38.5	199	111	4.2	5,491	2,747	74.5	10,099	5,362	117.2
Maryland	3,506	8,079	3,877	39.1	1,065	533	2.1	15,422	7,506	51.6	24,566	11,916	92.8
Massachusetts	2,319	42,246	21,270	59.2	17,919	7,874	9.2	18,366	9,568	22.5	78,531	38,712	90.9
Michigan	17,212	12,770	6,366	480.1	5,518	2,765	91.9	32,115	13,001	137.8	50,403	22,132	709.8
Minnesota	9,591	15,784	8,682	764.1	1,314	672	3.5	12,962	6,637	160.7	30,060	15,991	928.3
Mississippi	15,280	1,302	645	43.3	810	391	27.2	10,888	5,674	281.0	13,000	6,710	351.5
Missouri	12,980	28,772	15,310	640.3	15,575	6,432	188.7	20,196	10,775	480.9	64,743	32,517	1,309.9
Montana	11,604	10,828	6,444	379.8	1,940	1,181	93.1	9,703	6,111	198.1	22,471	13,736	671.0
Nebraska	8,245	20,714	10,758	734.2	3,339	2,178	37.0	8,482	4,719	199.7	32,535	17,655	970.9
Nevada	5,031	4,354	3,601	119.5	81	65		4,308	3,547	103.9	8,743	7,213	223.4
New Hampshire	3,312	5,351	2,646	49.2	337	170	.9	1,736	839	11.1	7,424	3,655	61.2
New Jersey	4,592	11,155	4,834	20.9	4,144	2,070	2.9	21,656	10,313	29.5	36,955	17,217	53.3
New Mexico	2,198	13,358	8,546	499.9	3,244	2,083	45.9	5,332	3,489	177.2	21,934	14,118	723.0
New York	53,153	65,049	34,625	251.4	15,513	7,412	17.5	80,224	40,151	172.6	160,786	82,188	441.5
North Carolina	12,719	16,107	7,965	394.7	3,151	1,529	95.8	17,629	8,561	381.2	36,887	18,055	871.7
North Dakota	7,095	8,779	4,578	1,316.4	1,654	900	105.6	6,312	3,387	464.5	16,745	8,865	1,886.5
Ohio	15,627	68,616	32,109	300.1	9,425	4,657	59.5	35,354	17,610	119.3	113,395	54,376	478.9
Oklahoma	2,620	34,606	17,795	905.7	7,367	3,842	145.5	9,502	4,782	319.9	51,475	26,419	1,371.1
Oregon	3,084	9,846	5,751	203.9	1,531	888	59.2	10,559	5,493	83.2	21,936	12,132	346.3
Pennsylvania	29,277	8,782	4,391	11.8	15,057	7,732	23.8	63,215	30,920	150.0	87,054	43,043	185.6
Rhode Island	3,185	8,689	4,655	19.3	3,087	1,646	2.4	3,816	1,476	3.4	15,592	7,777	25.1
South Carolina	6,680	7,846	4,052	364.0	1,375	688	120.8	10,627	5,303	354.7	19,848	10,043	839.5
South Dakota	5,319	10,701	6,201	1,173.0	2,356	1,602	215.4	5,426	3,301	356.8	18,483	11,104	1,745.2
Tennessee	6,744	15,756	7,790	372.7	7,385	3,489	137.9	19,394	9,884	217.5	42,535	21,163	728.1
Texas	20,438	6,502	3,478	396.4	13,481	6,589	662.4	58,269	26,837	1,116.8	78,252	36,904	2,175.6
Utah	5,314	2,730	2,017	92.1	1,191	873	35.8	5,356	3,908	129.1	9,277	6,798	257.0
Vermont	2,163	2,737	1,368	33.8	67	32	.1	4,227	1,946	40.6	7,031	3,346	74.5
Virginia	14,368	16,349	8,245	476.6	3,825	1,870	118.7	12,192	6,021	130.9	32,366	16,136	726.2
Washington	4,574	18,189	7,710	158.6	4,719	2,349	46.4	13,326	6,114	80.6	36,234	16,173	285.6
West Virginia	2,810	18,227	7,724	202.9	3,955	2,009	24.1	6,453	3,196	36.0	28,635	12,929	263.0
Wisconsin	18,788	13,803	6,968	316.1	1,783	846	36.5	11,355	5,684	282.8	26,941	13,498	635.4
Wyoming	4,440	988	639	17.5	1,819	1,239	23.9	5,683	3,686	210.5	8,490	5,564	251.9
Hawaii	2,181	7,899	3,614	38.2	3,886	1,797	3.9	3,446	1,789	18.9	15,231	7,200	61.0
District of Columbia	2,752	3,370	1,897	.5	219	110	.2	11,188	5,551	2.2	14,777	7,558	2.9
Puerto Rico	5,722	8,676	3,912	35.8	1,293	548	5.6	9,463	3,493	46.3	19,432	7,953	87.7
TOTAL	491,662	800,638	405,701	16,288.0	235,908	116,909	3,703.6	804,500	404,335	10,253.8	1,841,046	926,945	30,245.4