F. B. FARRELL

PUBLIC ROADS

A JOURNAL OF HIGHWAY RESEARCH

FEDERAL WORKS AGENCY
PUBLIC ROADS ADMINISTRATION

VOL. 23, NO. 9 ▽ JULY-AUGUST-SEPTEMBER 1943

COLLECTING DATA ON TRUCK TRANSPORT

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington, D. C. - See page 2 of cover for prices

PUBLIC ROADS ▸ ▸ ▸ *A Journal of Highway Research*

Issued by the

FEDERAL WORKS AGENCY

PUBLIC ROADS ADMINISTRATION

D. M. BEACH, *Editor*

Volume 23, No. 9 July–August–September, 1943

The reports of research published in this magazine are necessarily qualified by the conditions of the tests from which the data are obtained. Whenever it is deemed possible to do so, generalizations are drawn from the results of the tests; and, unless this is done, the conclusions formulated must be considered as specifically pertinent only to described conditions.

In This Issue

THE PUBLIC ROADS ADMINISTRATION - - - - - North Interior Building, Washington, D. C.

REGIONAL HEADQUARTERS - - - - - - - - - - - - - - - - - - 720 Phelan Building, San Francisco, Calif.

▼

DISTRICT OFFICES

DISTRICT No. 1. Oregon, Washington, and Montana.
Post Office Building, Portland, Oreg.

DISTRICT No. 2. California, Arizona, and Nevada.
720 Phelan Building, San Francisco, Calif.

DISTRICT No. 3. Colorado, New Mexico, and Wyoming.
254 New Customhouse, Denver, Colo.

DISTRICT No. 4. Minnesota, North Dakota, South Dakota, and Wisconsin.
1109 Main Post Office Building, St. Paul, Minn.

DISTRICT No. 5. Iowa, Kansas, Missouri, and Nebraska.
729 U. S. Courthouse, Kansas City, Mo.

DISTRICT No. 6. Arkansas, Louisiana, Oklahoma, and Texas.
Room 502, United States Courthouse, Fort Worth, Tex.

DISTRICT No. 7. Illinois, Indiana, Kentucky, and Michigan.
South Chicago Post Office Building, Chicago, Ill.

DISTRICT No. 8. Alabama, Georgia, Florida, Mississippi, and Tennessee.
Post Office Building, Montgomery, Ala.

DISTRICT No. 9. Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.
76 State St., Albany, N. Y.

DISTRICT No. 10. Delaware, Maryland, Ohio, Pennsylvania, and District of Columbia.
North Interior Building, Washington, D. C.

DISTRICT No. 11. Alaska.
Room 419, Federal and Territorial Building, Juneau, Alaska.

DISTRICT No. 12. Idaho and Utah.
Federal Building, Ogden, Utah.

DISTRICT No. 14. North Carolina, South Carolina, Virginia, and West Virginia.
Montgomery Building, Spartanburg, S. C.

ALASKA HIGHWAY DISTRICT.
Empire Block, Edmonton, Canada.

Because of the necessarily limited edition of this publication it is impossible to distribute it free to any person or institution other than State and county officials actually engaged in planning or constructing public highways, instructors in highway engineering, and periodicals upon an exchange basis. At the present time additions to the free mailing list can be made only as vacancies occur. Those desiring to obtain PUBLIC ROADS can do so by sending 35 cents per year (foreign subscription 50 cents), or 10 cents per single copy, to the Superintendent of Documents, United States Government Printing Office, Washington, D. C.

CERTIFICATE By direction of the Commissioner of Public Roads, the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

AMOUNT AND CHARACTERISTICS OF TRUCKING ON RURAL ROADS

BY THE DIVISION OF HIGHWAY TRANSPORT, PUBLIC ROADS ADMINISTRATION

Reported by John T. Lynch, Senior Highway Economist and Thomas B. Dimmick, Associate Highway Engineer-Economist

Our highways play a vital role in the movement of goods, both in war and in peace, but because the trucking industry is made up mainly of numerous small carriers, statistical reports such as those compiled periodically for railways have not been made. The highway planning surveys, however, have afforded the means of estimating the amount and characteristics of trucking on rural roads.

This report presents estimates of vehicle-mileage, percent loaded, average carried load, and ton-mileage for trucks on main and local rural roads in 1940, and on main rural roads in 1942, prepared on the basis of data obtained principally in the initial and continuing phases of the highway planning surveys. Separate estimates are made for single-unit trucks and for truck combinations. The 1940 estimates are subdivided to show the nature of the haul as regards origin and destination, classified as rural or urban, and as within or without the State under consideration. For 16 States, analysis is made of trip extent on the basis of the number of counties traversed. The frequency of heavy gross weights and axle loads in 1940 and 1942, and the frequency of heavy load concentrations in 1942 are also presented.

Freight hauling by truck on rural roads in 1940 amounted to about 59 billion ton-miles—47 billion on main roads, and 12 billion on local roads. City-to-city hauling made up slightly more than half of this ton-mileage. Total rural hauling was about 68 percent intrastate, and only about 32 percent was interstate or transstate.

Truck vehicle-mileage fell off in 1942, but heavier loads resulted in approximately the same ton-mileage on main roads as in 1940. Use of truck combinations has increased greatly.

Frequency of both heavy gross loads and heavy axle loads increased from 1940 to 1942. Heavy gross loads were most frequent in the Pacific region, but heavy axle loads were most frequent in New England. Interior groups of axles were found to produce excessive load concentrations more frequently than the over-all wheel base.

LARGE VOLUMES of freight have moved over our highways for a number of years, but little has been known until recently concerning the amount and characteristics of this movement. The nature of the trucking industry makes impracticable the periodic reporting of comprehensive statistics such as those which have long been compiled for railroads. It is true that the large interstate common and contract carriers, having annual gross operating revenues in excess of $100,000, make extensive reports to the Interstate Commerce Commission, but these carriers constitute less than one percent of total truck operators. There are almost 3,000,000 truck owners in the United States, about 85 percent of whom own only one truck, and few of whom keep records useful as a basis for statistical reports. A truck and bus inventory, which will yield certain statistical data concerning vehicle types and annual mileages driven, is now being made as part of the program of the Highway Traffic Advisory Committee to the War Department, but this will not give information on the tonnages transported by truck or on the origins and destinations of trips.

HIGHWAY PLANNING SURVEY SUPPLIES BASIC DATA

The vital role of our highways in the movement of goods, both in war and in peace, makes a knowledge of the extent and characteristics of trucking highly desirable and such knowledge is a prerequisite to a thorough understanding of our national transportation problems. The obtaining of data which would supply such knowledge was one of the objectives of the highway planning surveys, conducted by the various States in cooperation with the Public Roads Administration, beginning in 1936. The measuring of road mileages, traffic counts by vehicle type, the weighing of trucks, the questioning of truck drivers concerning origin and destination, and the questioning of truck owners concerning the miles driven on different road systems during the preceding year, supplied the basic data on which estimates of vehicle-miles driven and ton-miles hauled on the different road systems, and between origins and destinations in different categories, could be based.

These highway planning survey operations were extensive. Measurements were made of the mileage of all rural roads open to public use and scheduled traffic counts were made during a 1-year period at times and places sufficient to permit fairly accurate estimates of the volume of traffic on all portions of this mileage. The road-use survey, in which representative owners were questioned concerning miles driven during the preceding year, afforded a check of the vehicle-miles calculated from the traffic survey and supplied this information for a few States that had not completed traffic tables. In the loadometer survey, more than 2½ million trucks were weighed. This operation was carried out principally on main roads, as the number of trucks passing a given point on a local road in the course of a day was generally so small that the results to be obtained would not justify the cost. Origin and destination information was obtained at all loadometer stations, and, in many States, at a number of additional stations on local roads.

In spite of the large volume of pertinent data available in the highway planning survey tables, there are still deficiencies in information needed to compute the ton-miles of load hauled in a specific year on main and local rural roads throughout the United States. For example, a few States have not compiled traffic tables, and several have not compiled loadometer tables. As pointed out in the preceding paragraph, there is a scarcity of data concerning weights of vehicles on local roads.

Since field surveys were made in different years in different States it was necessary to establish trends from the survey year to a common year. Continuing survey operations give ample data for estimating trends

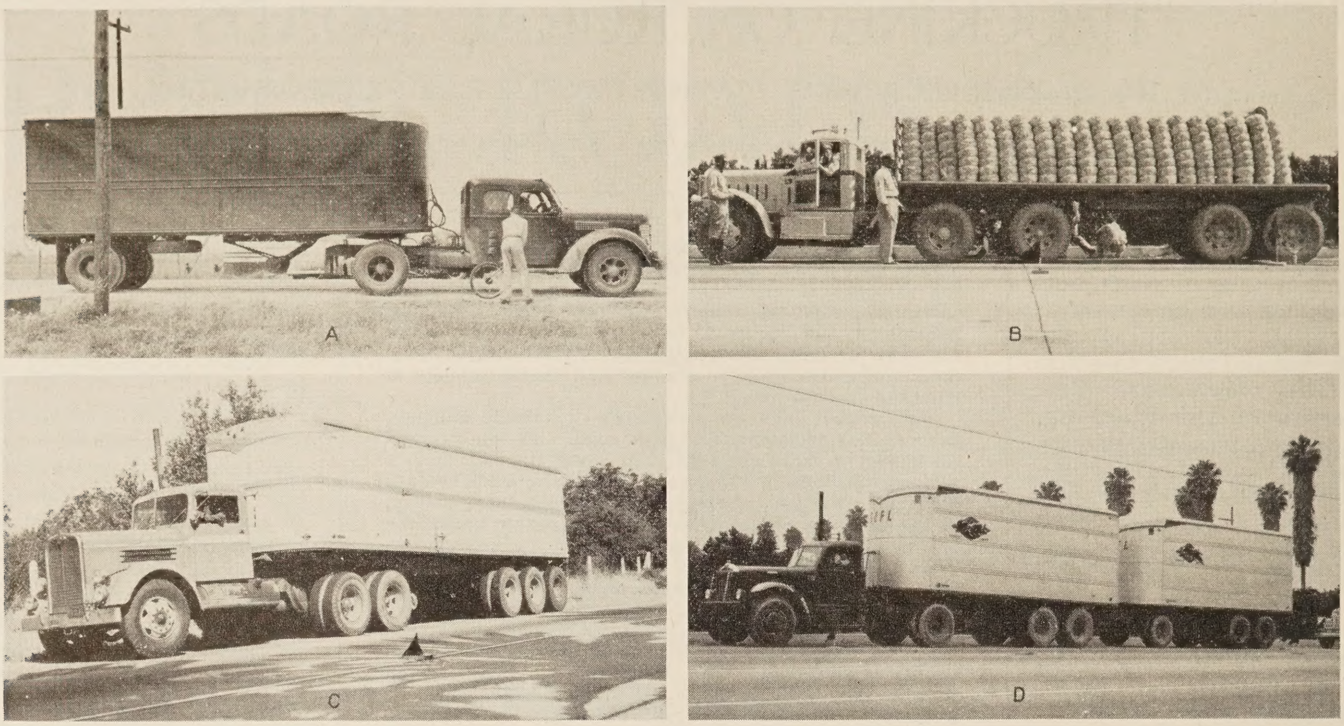


FIGURE 1.—SEVERAL KINDS OF TRUCK COMBINATIONS.

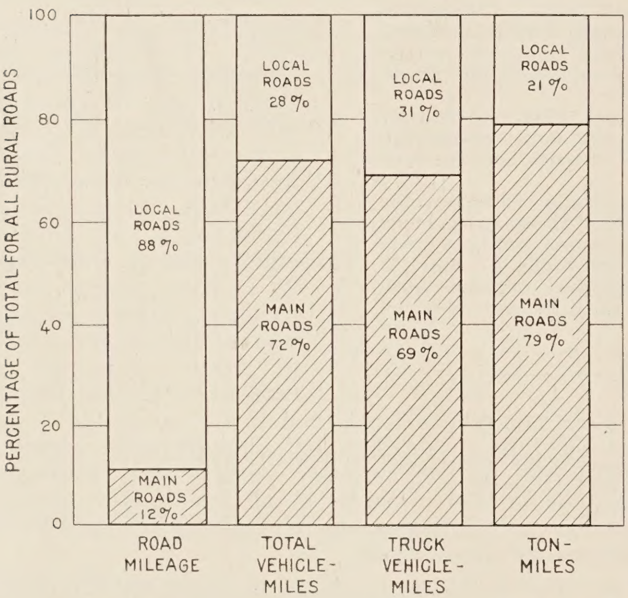


FIGURE 2.—COMPARISON OF ROAD MILEAGE, TOTAL VEHICLE-MILES, TRUCK VEHICLE-MILES AND TON-MILES OF CARRIED LOAD ON MAIN RURAL ROADS WITH THOSE ON LOCAL RURAL ROADS, IN THE YEAR 1940.

in vehicle-miles, but weighing operations were repeated in only a few States in the 1936–40 period, and the basis for estimating weight trends is therefore not entirely satisfactory. Fortunately, local roads carry only a small percentage of the total ton-mileage, and weight changes during the period considered were not large, so that errors of considerable proportions in estimating local-road tonnages and weight trends would introduce only small percentage errors in the over-all totals.

On the whole, it was thought that the available data were sufficient to permit the preparation of estimates which, though not entirely accurate in some details, would nevertheless give a comprehensive picture of the amount and characteristics of trucking on rural roads which would have considerable reliability in its broad outlines, and would lead to a better understanding of the function of highway transportation in the movement of commodities. Each figure used in the estimates was decided upon after all available data were carefully considered and an effort was made to find the reasons for any lack of agreement in data from two or more sources such as, for example, the traffic survey and the road-use survey. States lacking sufficient information to give a satisfactory basis for the estimates in a given table were lumped together in the table under the heading "Other States" though, in many cases, the estimates for the "Other States" group were arrived at by making the best estimate possible for each State in the group. The data on which each estimate is based, and the method of arriving at the figures will be described in detail in a later section of this article, after the estimates have been presented and discussed as to significance.

TRUCKING CHARACTERISTICS DIFFER ON MAIN AND LOCAL ROADS

The year 1940 was selected as the base for the estimates because it was the last year before war activities began to make important changes in traffic trends. Since trends were relatively stable between 1936 and 1940, estimates could be made with much greater assurance of accuracy for 1940 than for a later year. However, a special short survey made in the summer of 1942 afforded the basis for estimating wartime trends on main roads and estimates based on these data will be presented also.

Since trucking characteristics on local roads differ materially from those on main roads, it was thought advisable to prepare separate estimates for the two

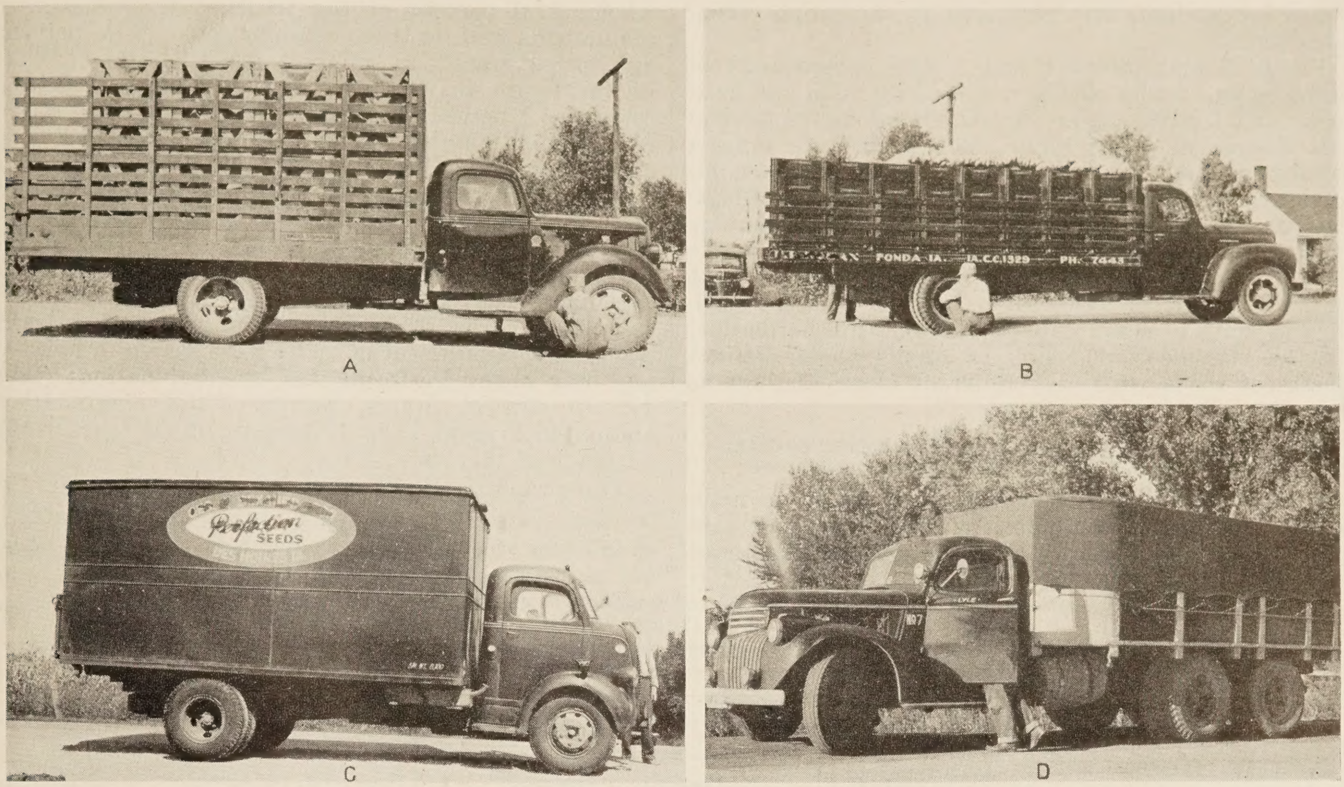


FIGURE 3.—TYPICAL SINGLE-UNIT TRUCKS.

TABLE 1.—*Percentage of total rural road mileage, percentage of total rural vehicle-mileage of all vehicles, and average daily traffic density on main and on local rural roads in each State in the year 1940*

State	Main roads			Local roads			All roads—average daily vehicles
	Percentage of total mileage	Percentage of total vehicle-mileage	Average daily vehicles	Percentage of total mileage	Percentage of total vehicle-mileage	Average daily vehicles	
Alabama	10.4	63.2	625	89.6	36.8	42	102
Arizona	12.2	65.5	551	87.8	34.5	40	103
Arkansas	16.2	83.7	429	83.8	16.3	16	83
California	12.7	71.7	1,555	87.3	28.3	89	276
Colorado	15.8	83.7	373	84.2	16.3	14	70
Connecticut	21.2	84.4	1,885	78.8	15.6	94	473
Florida	22.4	76.8	779	77.6	23.2	68	227
Georgia	13.2	69.4	600	86.8	30.6	40	114
Idaho	13.6	73.2	478	86.4	26.8	27	89
Illinois	9.3	78.7	1,441	90.7	21.3	40	170
Indiana	11.5	70.0	1,206	88.5	30.0	67	198
Iowa	8.3	63.6	846	91.7	36.4	37	111
Kansas	7.1	62.7	621	92.9	37.3	28	70
Kentucky	15.4	78.7	631	84.6	21.3	31	124
Louisiana	9.1	70.2	1,028	90.9	29.8	44	134
Maryland	24.3	83.8	1,426	75.7	16.2	88	412
Massachusetts	10.1	55.7	3,532	89.9	44.3	316	641
Michigan	9.3	71.8	1,575	90.7	28.2	64	203
Minnesota	9.2	63.3	653	90.8	36.7	38	95
Mississippi	9.5	70.8	925	90.5	29.2	40	124
Missouri	11.8	80.5	981	88.2	19.5	20	91
Montana	7.7	64.5	370	92.3	35.5	18	47
Nebraska	8.0	64.3	436	92.0	35.7	21	54
Nevada	11.5	79.4	311	88.5	20.6	11	45
New Hamsphire	10.9	69.2	1,367	89.1	30.8	74	214
New Mexico	5.8	65.7	530	94.2	34.3	17	47
North Carolina	18.0	75.1	636	82.0	24.9	54	176
North Dakota	6.4	67.8	183	93.6	32.2	6	17
Ohio	17.7	76.5	1,089	82.3	23.5	65	251
Oklahoma	8.1	71.6	795	91.9	28.4	28	89
Oregon	13.6	73.2	597	86.4	26.8	34	111
Pennsylvania	14.7	73.0	1,347	85.3	27.0	86	272
Rhode Island	29.5	85.0	1,697	70.5	15.0	125	589
South Carolina	19.8	80.1	574	80.2	19.9	35	142
South Dakota	6.0	59.5	317	94.0	40.5	14	32

TABLE 1.—*Percentage of total rural road mileage, percentage of total rural vehicle-mileage of all vehicles, and average daily traffic density on main and on local rural roads in each State in the year 1940*—Continued

State	Main roads			Local roads			All roads—average daily vehicles
	Percentage of total mileage	Percentage of total vehicle-mileage	Average daily vehicles	Percentage of total mileage	Percentage of total vehicle-mileage	Average daily vehicles mileage	
Tennessee	10.8	71.6	770	89.2	28.4	37	116
Texas	11.2	70.8	921	88.8	29.2	48	146
Utah	13.0	75.0	847	87.0	25.0	30	102
Vermont	12.6	76.6	776	87.4	23.4	35	128
Virginia	19.8	78.6	889	80.2	21.4	60	224
Washington	12.1	72.7	996	87.9	27.3	41	137
West Virginia	13.6	68.0	869	86.4	32.0	65	174
Wisconsin	11.2	65.8	838	88.8	34.2	55	142
Wyoming	15.0	80.1	448	85.0	19.9	20	84
Subtotal	11.4	69.0	841	88.6	31.0	42	133
Other States [1]	15.5	71.9	1,545	84.5	28.1	127	347
Totals and averages	11.6	71.6	883	88.4	28.4	46	143

[1] Includes Delaware, Maine, New Jersey, and New York.

classes of roads. Another reason for this decision was that the data for main roads were much more extensive than those for local roads and the separate treatment of the two systems permitted the segregation of the estimates well supported by data from those which were more speculative.

There is considerable difference in the manner of classifying roads into administrative systems in the different States, but in general the State system, or the primary State system in some States, comprises the mileage classed as "main." The term "local roads," as used in this analysis, includes important county roads and secondary State roads, as well as the roads which render little service except to the people living along them.

Figure 2 and tables 1 and 2 give comparisons of mileages and traffic service rendered by main and local roads and tend to define the classifications, as used in this discussion. The main roads constitute only a small percentage of the rural road mileage, but accommodate a high percentage of the vehicle-mileage of both passenger cars and trucks, and a still higher percentage of the ton-mileage of commodities hauled. Average daily traffic density was nearly twenty times as great on main roads as on local roads. It can be seen, then, that in spite of some indefiniteness at the borderline, the two classifications represent on the whole, distinct classes of roads with very different characteristics as regards traffic service.

TON-MILEAGE ON MAIN ROADS DIVIDED ALMOST EQUALLY BETWEEN SINGLE-UNIT TRUCKS AND COMBINATIONS

A considerable portion of the truck traffic on main roads consisted of combinations like those shown in figure 1. Table 3 shows that, for the country as a whole, 21.0 percent of the truck vehicle-mileage on main roads was by these combinations. The percentage varied greatly in different States, however. The highest figure was 40.0 percent in Indiana and the lowest was 5.1 percent in nearby Kentucky. The reason for the small number of combinations in Kentucky was a State law which limited gross weights to 18,000 pounds and made uneconomical the use of any type of vehicle larger than a single-unit truck. This law has not yet been changed permanently, though the restriction has been relaxed to some extent during the war, on roads designated as "National Emergency Highways."

On local roads, the major portion of the truck traffic was by single-unit trucks such as are shown in figure 3, and only about 6 percent was by combinations (table 4). In several States, however, the combinations amounted to from 10 to 17 percent of the truck traffic on roads of this class.

The proportion of loaded vehicles was greater for combinations than for single-unit trucks. Table 5 shows that for all rural roads, both main and local,

TABLE 2.—*Vehicle-mileage of all vehicles and of trucks and combinations on main and on local rural roads in each State in the year 1940*

State	Main roads			Local roads			All roads		
	All vehicles	Trucks and combinations		All vehicles	Trucks and combinations		All vehicles	Trucks and combinations	
	Thousands of vehicle-miles	*Percent*	*Thousands of vehicle-miles*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*
Alabama	1, 393, 588	21. 4	298, 228	811, 456	34. 2	277, 518	2, 205, 044	26. 1	575, 746
Arizona	675, 909	17. 1	115, 580	356, 013	23. 7	84, 375	1, 031, 922	19. 4	199, 955
Arkansas	1, 376, 409	28. 1	386, 771	268, 046	34. 2	91, 672	1, 644, 455	29. 1	478, 443
California	7, 171, 423	15. 2	1, 090, 056	2, 830, 561	23. 1	653, 860	10, 001, 984	17. 4	1, 743, 916
Colorado	1, 617, 112	22. 6	365, 467	314, 921	27. 8	87, 548	1, 932, 033	23. 4	453, 015
Connecticut	1, 685, 135	15. 5	261, 196	311, 470	21. 5	66, 966	1, 996, 605	16. 4	328, 162
Florida	1, 843, 854	24. 8	457, 276	556, 997	31. 2	173, 783	2, 400, 851	26. 3	631, 059
Georgia	2, 816, 554	21. 5	605, 559	1, 241, 881	25. 0	310, 470	4, 058, 435	22. 6	916, 029
Idaho	797, 605	21. 1	168, 295	292, 019	31. 7	92, 570	1, 089, 624	23. 9	260, 865
Illinois	5, 019, 360	16. 9	848, 272	1, 358, 480	25. 9	351, 846	6, 377, 840	18. 8	1, 200, 118
Indiana	3, 795, 926	21. 0	797, 144	1, 626, 825	24. 0	390, 438	5, 422, 751	21. 9	1, 187, 582
Iowa	2, 607, 397	18. 0	469, 331	1, 492, 284	16. 0	238, 765	4, 099, 681	17. 3	708, 096
Kansas	2, 060, 368	19. 7	405, 892	1, 225, 706	22. 5	275, 784	3, 286, 074	20. 7	681, 676
Kentucky	2, 001, 003	20. 4	408, 204	541, 568	25. 8	139, 725	2, 542, 571	21. 6	547, 929
Louisiana	1, 306, 449	21. 9	286, 112	554, 590	29. 1	161, 386	1, 861, 039	24. 0	447, 498
Maryland	2, 016, 661	21. 3	429, 549	389, 856	18. 6	72, 513	2, 406, 517	20. 9	502, 062
Massachusetts	2, 267, 270	15. 0	340, 091	1, 803, 233	18. 0	324, 582	4, 070, 503	16. 3	664, 673
Michigan	4, 739, 382	16. 1	763, 041	1, 861, 429	17. 5	325, 750	6, 600, 811	16. 5	1, 088, 791
Minnesota	2, 383, 904	18. 2	433, 872	1, 382, 137	16. 8	232, 199	3, 766, 041	17. 7	666, 071
Mississippi	1, 942, 736	27. 4	532, 310	801, 241	30. 0	240, 372	2, 743, 977	28. 1	772, 682
Missouri	3, 111, 217	22. 3	693, 801	753, 649	23. 9	180, 122	3, 864, 866	22. 6	873, 923
Montana	864, 395	21. 1	182, 387	475, 753	24. 7	117, 511	1, 340, 148	22. 4	299, 898
Nebraska	1, 270, 841	20. 0	254, 168	705, 583	22. 2	156, 639	1, 976, 424	20. 8	410, 807
Nevada	304, 573	16. 2	49, 341	79, 020	33. 1	26, 156	383, 593	19. 7	75, 497
New Hampshire	677, 918	14. 4	97, 620	301, 733	16. 2	48, 881	979, 651	15. 0	146, 501
New Mexico	686, 210	23. 8	163, 318	358, 249	31. 5	112, 848	1, 044, 459	26. 4	276, 166
North Carolina	2, 738, 509	24. 7	676, 412	907, 974	17. 9	162, 527	3, 646, 483	23. 0	838, 939
North Dakota	470, 539	20. 4	95, 990	223, 472	20. 6	46, 035	694, 011	20. 5	142, 025
Ohio	5, 783, 870	17. 1	989, 042	1, 776, 745	21. 2	376, 670	7, 560, 615	18. 1	1, 365, 712
Oklahoma	2, 378, 667	20. 6	490, 005	943, 493	21. 7	204, 738	3, 322, 160	20. 9	694, 743
Oregon	1, 386, 134	17. 0	235, 643	507, 491	18. 5	93, 886	1, 893, 625	17. 4	329, 529
Pennsylvania	6, 143, 806	17. 3	1, 062, 878	2, 272, 366	15. 8	359, 034	8, 416, 172	16. 9	1, 421, 912
Rhode Island	424, 127	12. 5	53, 016	74, 846	15. 0	11, 227	498, 973	12. 9	64, 243
South Carolina	1, 850, 967	20. 2	373, 895	459, 853	23. 5	108, 065	2, 310, 820	20. 8	481, 960
South Dakota	700, 406	20. 2	141, 482	476, 747	22. 2	105, 838	1, 177, 153	21. 0	247, 320
Tennessee	1, 903, 731	20. 1	382, 650	755, 111	30. 4	229, 554	2, 658, 842	23. 0	612, 204
Texas	6, 982, 043	20. 4	1, 424, 337	2, 879, 600	19. 3	555, 763	9, 861, 643	20. 1	1, 980, 100
Utah	601, 706	18. 4	110, 714	200, 568	24. 4	48, 939	802, 274	19. 9	159, 653
Vermont	481, 600	13. 7	65, 979	147, 121	28. 8	42, 371	628, 721	17. 2	108, 350
Virginia	2, 960, 243	19. 7	583, 168	805, 970	21. 0	169, 254	3, 766, 213	20. 0	752, 422
Washington	2, 218, 585	15. 7	348, 318	833, 114	17. 4	144, 962	3, 051, 699	16. 2	493, 280
West Virginia	1, 405, 272	17. 6	247, 328	661, 305	21. 7	143, 503	2, 066, 577	18. 9	390, 831
Wisconsin	2, 816, 531	17. 5	492, 893	1, 463, 911	20. 8	304, 493	4, 280, 442	18. 6	797, 386
Wyoming	604, 242	17. 5	105, 742	150, 118	29. 9	44, 885	754, 360	20. 0	150, 627
Subtotal	98, 284, 177	19. 1	18, 782, 373	38, 234, 505	21. 9	8, 386, 023	136, 518, 682	19. 9	27, 168, 396
Other States [1]	11, 345, 443	15. 7	1, 775, 933	5, 081, 169	17. 8	905, 972	16, 426, 612	16. 3	2, 681, 905
Totals and averages	109, 629, 620	18. 8	20, 558, 306	43, 315, 674	21. 5	9, 291, 995	152, 945, 294	19. 5	29, 850, 301

[1] Includes Delaware, Maine, New Jersey, and New York.

about 72 percent of the combinations compared to about 64 percent of the single-unit trucks were loaded. Figure 4 shows separately the vehicle-mileage of loaded and empty single-unit trucks and combinations on main and local rural roads for the entire year 1940.

Figure 5 was plotted from data in tables 3 and 4. The vehicle-mileage of loaded vehicles is represented by a horizontal measurement and the average carried load is represented by a vertical measurement so that ton-mileage, the product of the two, is represented by a rectangular area. The ton-mileage of load carried on main roads was divided about equally between single-unit trucks and combinations, in spite of the fact that 79 percent of the vehicles in the traffic stream were single-unit trucks. This is the result of the heavier loads carried by the combinations, averaging 7.58 tons compared to 2.24 tons for single-unit trucks. The average carried loads of combinations were much heavier in the western States than in other sections of the country, being over 10 tons in California, Nevada, and Washington, and, at the other extreme, under 5 tons in Arkansas, Kentucky, South Dakota, and Texas. The reason for the high average carried load in the western States was the prevalence of vehicles like those

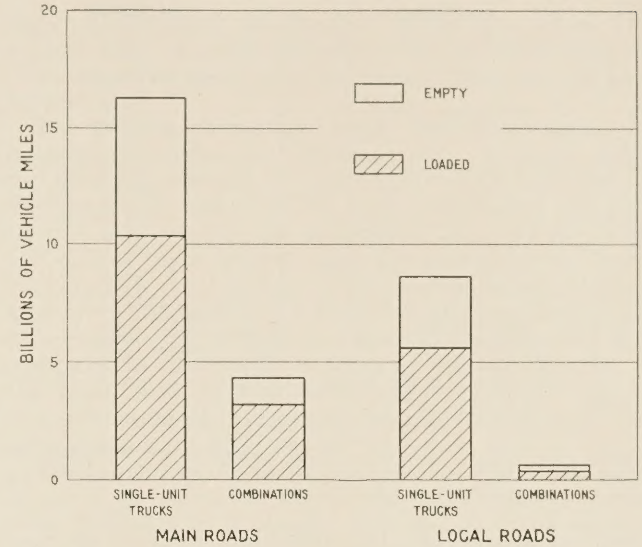


Figure 4.—Vehicle-Miles of Loaded and Empty Single-Unit Trucks and Combinations on Main and Local Rural Roads, in the Year 1940.

Table 3.—*Vehicle-mileage of trucks and combinations, percentage loaded, average carried load, and ton-mileage of carried load, on MAIN RURAL ROADS in each State in the year 1940*

State	Single-unit trucks					Truck combinations					All trucks and combinations			
	Percentage of all trucks	Vehicle-miles	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Percentage of all trucks	Vehicle-miles	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Vehicle-miles	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles
		Thousands		*Tons*	*Thousands*		*Thousands*		*Tons*	*Thousands*	*Thousands*		*Tons*	*Thousands*
Alabama	83.3	248, 424	58.2	2.20	318, 083	16.7	49, 804	63.6	6.15	194, 801	298, 228	59.1	2.91	512, 884
Arizona	79.8	92, 233	59.9	2.79	154, 142	20.2	23, 347	72.1	9.89	166, 478	115, 580	62.3	4.45	320, 620
Arkansas	83.2	321, 793	59.0	1.64	311, 367	16.8	64, 978	69.5	4.84	218, 574	386, 771	60.8	2.25	529, 941
California	72.7	792, 471	69.1	2.22	1, 215, 665	27.3	297, 585	80.5	12.63	3, 025, 592	1, 090, 056	72.2	5.39	4, 241, 257
Colorado	92.3	337, 326	68.4	2.42	558, 369	7.7	28, 141	71.1	6.69	133, 854	365, 467	68.6	2.76	692, 223
Florida	83.2	380, 454	47.1	2.77	496, 367	16.8	76, 822	62.0	7.83	372, 943	457, 276	49.6	3.83	869, 310
Georgia	76.1	460, 830	68.4	2.45	772, 260	23.9	144, 729	70.3	7.30	742, 731	605, 559	68.9	3.63	1, 514, 991
Idaho	92.3	155, 336	59.7	1.82	168, 780	7.7	12, 959	78.1	5.50	55, 666	168, 295	61.1	2.18	224, 446
Illinois	72.5	614, 997	63.7	2.35	920, 620	27.5	233, 275	71.7	7.43	1, 242, 727	848, 272	65.9	3.87	2, 163, 347
Indiana	60.0	478, 286	66.3	1.95	618, 353	40.0	318, 858	78.6	6.93	1, 737, 810	797, 144	71.2	4.15	2, 356, 163
Iowa	81.2	381, 097	70.1	2.04	544, 984	18.8	88, 234	74.1	7.38	482, 512	469, 331	70.9	3.09	1, 027, 496
Kansas	66.2	268, 701	61.2	1.97	323, 957	33.8	137, 191	63.5	6.80	592, 389	405, 892	62.0	3.64	916, 346
Kentucky	94.9	387, 386	68.0	2.76	727, 045	5.1	20, 818	75.8	4.68	73, 850	408, 204	68.4	2.87	800, 895
Louisiana	78.9	225, 742	58.5	2.17	286, 568	21.1	60, 370	60.7	5.12	187, 622	286, 112	59.0	2.81	474, 190
Maryland	80.4	345, 357	67.3	2.57	597, 332	19.6	84, 192	74.3	8.00	500, 440	429, 549	68.7	3.72	1, 097, 772
Massachusetts	88.9	302, 341	72.8	2.65	583, 276	11.1	37, 750	79.7	9.30	279, 809	340, 091	73.6	3.45	863, 085
Michigan	71.1	542, 522	69.1	1.78	667, 292	28.9	220, 519	68.9	7.46	1, 133, 457	763, 041	69.0	3.42	1, 800, 749
Minnesota	85.2	369, 659	68.3	2.22	560, 499	14.8	64, 213	79.4	6.37	324, 774	433, 872	69.9	2.92	885, 273
Mississippi	88.6	471, 627	60.6	1.79	511, 593	11.4	60, 683	65.9	6.18	247, 138	532, 310	61.2	2.33	758, 731
Missouri	83.4	578, 630	60.6	2.42	848, 573	16.6	115, 171	72.3	7.12	592, 875	693, 801	62.5	3.32	1, 441, 448
Montana	87.9	160, 318	50.0	2.81	225, 247	12.1	22, 069	63.5	7.96	111, 551	182, 387	51.6	3.58	336, 798
Nebraska	85.9	218, 330	68.4	2.23	333, 024	14.1	35, 838	70.2	6.22	156, 483	254, 168	68.7	2.81	489, 507
Nevada	87.6	43, 223	62.0	2.62	70, 211	12.4	6, 118	78.8	10.21	49, 222	49, 341	64.1	3.78	119, 433
New Hampshire	90.8	88, 639	73.6	2.37	154, 614	9.2	8, 981	77.1	6.33	43, 829	97, 620	73.9	2.75	198, 443
New Mexico	89.4	146, 006	60.2	2.47	217, 103	10.6	17, 312	68.8	6.34	75, 516	163, 318	61.1	2.93	292, 619
North Carolina	72.8	492, 428	63.7	2.17	680, 679	27.2	183, 984	71.8	8.04	1, 062, 092	676, 412	65.9	3.91	1, 742, 771
North Dakota	87.9	84, 375	65.5	2.79	154, 192	12.1	11, 615	81.4	5.75	54, 366	95, 990	67.4	3.22	208, 558
Ohio	66.0	652, 768	57.5	3.01	1, 129, 779	34.0	336, 274	72.7	8.53	2, 085, 338	989, 042	62.7	5.19	3, 215, 117
Oklahoma	73.8	361, 624	55.8	1.96	395, 501	26.2	128, 381	70.6	6.29	570, 107	490, 005	59.7	3.30	965, 608
Pennsylvania	86.8	922, 578	66.6	2.35	1, 443, 927	13.2	140, 300	69.5	8.08	787, 873	1, 062, 878	66.7	3.13	2, 231, 800
Rhode Island	92.2	48, 881	65.1	2.30	73, 191	7.8	4, 135	73.2	6.72	20, 341	53, 016	65.7	2.68	93, 532
South Carolina	64.8	242, 284	66.3	2.19	351, 788	35.2	131, 611	65.4	7.16	616, 290	373, 895	66.0	3.92	968, 078
South Dakota	91.3	129, 173	63.6	2.01	165, 130	8.7	12, 309	75.1	4.71	43, 539	141, 482	64.6	2.28	208, 669
Tennessee	91.8	351, 273	63.7	2.41	539, 264	8.2	31, 377	77.0	5.85	141, 336	382, 650	64.8	2.75	680, 600
Texas	80.0	1, 139, 470	59.6	1.76	1, 195, 258	20.0	284, 867	66.0	4.25	799, 051	1, 424, 337	60.9	2.30	1, 994, 309
Utah	90.0	99, 643	63.5	2.35	148, 692	10.0	11, 071	70.3	7.77	60, 474	110, 714	64.2	2.94	209, 166
Virginia	82.1	478, 781	65.7	2.43	764, 378	17.9	104, 387	72.2	7.99	602, 182	583, 168	66.3	3.50	1, 366, 560
Washington	85.5	297, 812	59.7	2.31	410, 704	14.5	50, 506	68.7	10.41	361, 206	348, 318	61.0	3.63	771, 910
West Virginia	94.1	232, 736	60.4	2.34	328, 941	5.9	14, 592	71.5	6.75	70, 423	247, 328	61.1	2.64	399, 364
Wisconsin	75.5	372, 134	72.7	1.68	454, 509	24.5	120, 759	81.1	7.00	685, 552	492, 893	74.7	3.09	1, 140, 061
Wyoming	77.3	81, 739	56.0	3.26	149, 223	22.7	24, 003	64.7	6.64	103, 119	105, 742	58.0	4.12	252, 342
Subtotal	79.0	14, 399, 427	63.7	2.24	20, 570, 480	21.0	3, 820, 128	71.8	7.58	20, 805, 932	18, 219, 555	65.4	3.47	41, 376, 412
Other States [1]	79.0	1, 847, 613	63.7	2.24	2, 636, 321	21.0	491, 138	71.8	7.58	2, 672, 988	2, 338, 751	65.4	3.47	5, 309, 309
Totals and averages	79.0	16, 247, 040	63.7	2.24	23, 206, 801	21.0	4, 311, 266	71.8	7.58	23, 478, 920	20, 558, 306	65.4	3.47	46, 685, 721

[1] Includes Connecticut, Delaware, Maine, New Jersey, New York, Oregon, and Vermont.

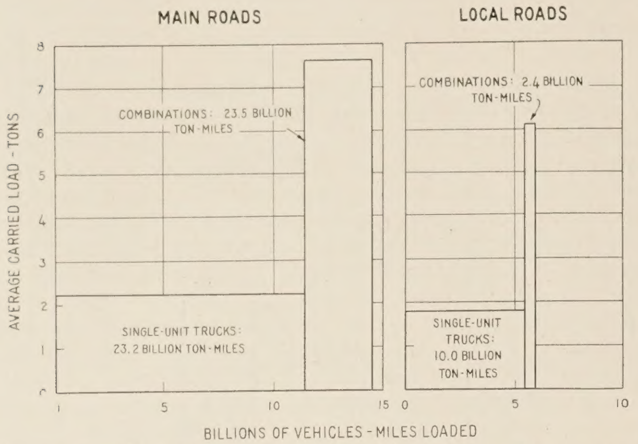


FIGURE 5.—TON-MILES OF LOAD CARRIED BY SINGLE-UNIT TRUCKS AND COMBINATIONS ON MAIN AND LOCAL RURAL ROADS, IN THE YEAR 1940.

shown in figures 1B, 1C, and 1D. Because of State laws, and for other reasons, the use of these large vehicles is confined mainly to the western States, while 3-axle combinations of the type shown in figure 1A are widely used throughout the country.

Figure 5 shows that, on local roads, about one-fifth of the total tonnage was hauled by combinations. This is a surprisingly high portion, when it is considered that less than 1 truck in 15 found on these roads was a combination.

ORIGINS AND DESTINATIONS CLASSIFIED AS RURAL AND URBAN

One of the questions in which students of the economics of transportation are especially interested is the extent to which the movement of freight by highway is competitive with movement by rail or water, and the extent to which it is tributary, or supplemental to other transport. This question could be clearly answered only after a thorough study of origins and destinations of individual trucks passing specific stations, as recorded in the survey notes. It would be necessary to consider the possibility of alternate means of transport in each individual case in order to evaluate accurately the competitive movement. To make such a detailed study on a Nation-wide, or even a State-wide

TABLE 4.—*Vehicle-mileage of trucks and combinations, percentage loaded, average carried load, and ton-mileage of carried load, on LOCAL RURAL ROADS in each State in the year 1940*

State	Single-unit trucks					Truck combinations					All trucks and combinations			
	Percentage of all trucks	Vehicle-miles	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Percentage of all trucks	Vehicle-miles	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Vehicle-miles	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles
		Thousands		*Tons*	*Thousands*		*Thousands*		*Tons*	*Thousands*	*Thousands*		*Tons*	*Thousands*
Alabama	86.9	241,163	58.2	1.76	247,028	13.1	36,355	63.6	4.92	113,760	277,518	58.9	2.21	360,788
Arizona	95.0	80,156	59.9	2.23	107,069	5.0	4,219	72.1	7.91	24,062	84,375	60.5	2.57	131,131
Arkansas	83.2	76,271	59.0	1.31	58,950	16.8	15,401	69.5	3.88	41,532	91,672	60.8	1.80	100,482
California	91.7	599,590	69.1	1.77	733,341	8.3	54,270	80.5	10.10	441,239	653,860	70.6	2.56	1,174,580
Colorado	97.3	85,184	68.4	1.94	113,036	2.7	2,364	71.1	5.35	8,993	87,548	68.5	2.04	122,029
Florida	95.1	165,268	47.1	2.22	172,807	4.9	8,515	62.0	6.26	33,047	173,783	47.8	2.48	205,854
Georgia	92.8	288,116	68.4	1.96	386,259	7.2	22,354	70.3	5.84	91,776	310,470	68.5	2.25	478,035
Idaho	94.1	87,108	59.7	1.46	75,924	5.9	5,462	78.1	4.40	18,770	92,570	60.8	1.68	94,694
Illinois	90.8	319,476	63.7	1.88	382,591	9.2	32,370	71.7	5.95	138,094	351,846	64.4	2.30	520,685
Indiana	96.2	375,601	66.3	1.56	388,476	3.8	14,837	78.6	5.54	64,607	390,438	66.8	1.73	453,083
Iowa	98.9	236,139	70.1	1.63	269,819	1.1	2,626	74.1	5.91	11,501	238,765	70.1	1.68	281,320
Kansas	96.2	265,304	61.2	1.57	254,915	3.8	10,480	63.5	5.44	36,203	275,784	61.3	1.72	291,118
Kentucky	99.1	138,467	68.0	2.21	208,089	0.9	1,258	75.8	3.74	3,568	139,725	68.1	2.23	211,657
Louisiana	89.8	144,925	58.5	1.73	146,671	10.2	16,461	60.7	4.10	40,967	161,386	58.7	1.98	187,638
Maryland	83.5	60,548	67.3	2.06	83,943	16.5	11,965	74.3	6.40	56,896	72,513	68.5	2.84	140,839
Massachusetts	96.7	313,871	72.8	2.12	484,416	3.3	10,711	79.7	7.44	63,515	324,582	73.0	2.31	547,931
Michigan	97.4	317,280	68.2	1.42	307,267	2.6	8,470	64.3	5.97	32,513	325,750	68.1	1.53	339,780
Minnesota	95.6	221,982	68.3	1.78	269,873	4.4	10,217	79.4	5.10	41,371	232,199	68.8	1.95	311,244
Mississippi	96.6	232,199	60.6	1.43	201,220	3.4	8,173	65.9	4.95	26,661	240,372	60.8	1.56	227,881
Missouri	95.3	171,656	60.0	1.93	198,778	4.7	8,466	72.3	5.70	34,890	180,122	60.6	2.14	233,668
Montana	96.4	113,281	50.0	2.25	127,442	3.6	4,230	63.5	6.37	17,110	117,511	50.5	2.44	144,552
Nebraska	99.4	155,699	68.4	1.79	190,631	.6	940	70.2	4.97	3,280	156,639	68.4	1.81	193,911
Nevada	98.7	25,816	62.0	2.10	33,613	1.3	340	78.8	8.17	2,190	26,156	62.2	2.20	35,803
New Hampshire	88.9	43,455	73.6	1.89	60,448	11.1	5,426	77.1	5.06	21,166	48,881	74.0	2.26	81,614
New Mexico	96.8	109,237	60.2	1.98	130,207	3.2	3,611	68.8	5.07	12,594	112,848	60.5	2.09	142,801
North Carolina	91.8	149,200	63.7	1.73	164,419	8.2	13,327	71.8	6.43	61,529	162,527	64.4	2.16	225,948
North Dakota	96.4	44,378	65.5	2.23	64,821	3.6	1,657	81.4	4.60	6,205	46,035	66.1	2.34	71,026
Ohio	89.8	338,250	57.5	2.41	468,731	10.2	38,420	72.7	6.83	190,769	376,670	59.1	2.97	659,500
Oklahoma	94.6	193,682	55.8	1.57	169,678	5.4	11,056	70.8	5.03	39,375	204,738	56.6	1.80	209,053
Pennsylvania	95.2	341,800	66.6	1.88	427,961	4.8	17,234	69.5	6.46	77,378	359,034	66.7	2.11	505,339
Rhode Island	97.7	10,969	65.1	1.84	13,139	2.3	258	73.2	5.37	1,015	11,227	65.3	1.93	14,154
South Carolina	89.4	96,610	66.3	1.75	112,091	10.6	11,455	65.4	5.72	42,854	108,065	66.2	2.17	154,945
South Dakota	91.3	96,630	63.6	1.60	98,331	8.7	9,208	75.1	3.77	26,070	105,838	64.6	1.82	124,401
Tennessee	99.0	227,258	63.7	1.93	279,393	1.0	2,296	77.0	4.68	8,274	229,554	63.8	1.96	287,667
Texas	94.0	522,417	59.6	1.41	439,019	6.0	33,346	66.0	3.40	74,827	555,763	60.0	1.54	513,846
Utah	97.0	47,471	63.5	1.88	56,671	3.0	1,468	70.3	6.22	6,419	48,939	63.7	2.02	63,090
Virginia	94.8	160,453	65.7	1.95	205,565	5.2	8,801	72.2	6.39	40,602	169,254	66.0	2.20	246,167
Washington	94.5	136,989	59.7	1.85	151,297	5.5	7,973	68.7	8.33	45,623	144,962	60.1	2.26	196,920
West Virginia	99.2	142,355	60.4	1.88	161,646	.8	1,148	71.5	5.40	4,433	143,503	60.5	1.91	166,079
Wisconsin	92.6	281,961	72.7	1.34	274,681	7.4	22,532	81.1	5.60	102,329	304,493	73.3	1.69	377,010
Wyoming	97.2	43,628	56.0	2.61	63,768	2.8	1,257	64.7	5.31	4,317	44,885	56.2	2.70	68,085
Subtotal	94.1	7,701,843	64.0	1.78	8,784,024	5.9	480,957	71.6	6.13	2,112,324	8,182,800	64.4	2.07	10,896,348
Other States [1]	94.1	1,043,752	64.0	1.78	1,189,042	5.9	65,443	71.6	6.13	287,233	1,109,195	64.4	2.07	1,476,275
Totals and averages	94.1	8,745,595	64.0	1.78	9,973,066	5.9	546,400	71.6	6.13	2,399,557	9,291,995	64.4	2.07	12,372,623

[1] Includes Connecticut, Delaware, Maine, New Jersey, New York, Oregon, and Vermont.

basis, would be a vast undertaking, at a cost entirely out of proportion to the results achieved. However, a study of the estimates based on the general origin and destination tables of the highway planning survey will permit the placing of probable minimum and maximum limits on the extent of the competitive movement and will lead, in other respects, to a clearer understanding of the function of trucks, and the highways on which they travel, in the movement of goods.

In tables 6 to 11, inclusive, the origins and destinations are classified as urban or rural. Urban areas are defined as compactly built-up places with more than 1,000 inhabitants, whether incorporated or not, and all other places are classed as rural. In some sections of the country a town of eight or nine hundred inhabitants may be of considerable importance but it is nevertheless classed as rural under this definition.

A large part of the movement from rural origin to rural destination is undoubtedly between the farm and the nearest small town or railroad siding, and is therefore tributary or supplemental rather than competitive. It is possible that some freight travels by highway from a rural area to a distant small town or rural area, but it is improbable that such movements are of large proportions.

The movement between cities with more than 1,000 population, classed as "urban-urban," is more largely competitive, though it is probable that some of this movement is induced by the availability of truck service and would not otherwise take place. There are special cases where cities are separated by only a very narrow rural area and the movement is practically intracity, but because of the short distance traveled on rural roads, the vehicle-mileage or ton-mileage is small compared to the traffic volume or tonnage hauled. If the boundaries of two cities are actually contiguous, the movement does not enter into the tables since there is no driving on rural roads.

The movement from rural origin to urban destination is, to a considerable extent, a short-haul movement from the farm to a market or a rail or water shipping point, but the classification also includes some long-haul

TABLE 5.—*Vehicle-mileage of trucks and combinations, percentage loaded, average carried load, and ton-mileage of carried load on ALL RURAL ROADS in each State in the year 1940*

State	Single-unit trucks					Truck combinations					All trucks and combinations			
	Percentage of all trucks	Vehicle-miles	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Percentage of all trucks	Vehicle-miles	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Vehicle-miles	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles
		Thousands		*Tons*	*Thousands*		*Thousands*		*Tons*	*Thousands*	*Thousands*		*Tons*	*Thousands*
Alabama	85.0	489,587	58.2	1.98	565,111	15.0	86,159	63.6	5.63	308,561	575,746	59.0	2.57	873,672
Arizona	86.2	172,389	59.9	2.53	261,211	13.8	27,566	72.1	9.59	190,540	199,955	61.6	3.67	451,751
Arkansas	83.2	398,064	59.0	1.58	370,317	16.8	80,379	69.5	4.66	260,106	478,443	60.8	2.17	630,423
California	79.8	1,392,061	69.0	2.03	1,949,006	20.2	351,855	80.5	12.24	3,466,831	1,743,916	71.4	4.35	5,415,837
Colorado	93.3	422,510	68.4	2.32	671,405	6.7	30,505	71.1	6.59	142,847	453,015	68.6	2.62	814,252
Florida	86.5	545,722	47.1	2.60	669,174	13.5	85,337	62.0	7.67	405,990	631,059	49.1	3.47	1,075,164
Georgia	81.8	748,946	68.4	2.26	1,158,519	18.2	167,083	70.3	7.10	834,507	916,029	68.7	3.16	1,993,026
Idaho	92.9	242,444	59.7	1.69	244,704	7.1	18,421	78.1	5.17	74,436	260,865	61.0	2.01	319,140
Illinois	77.9	934,473	63.7	2.19	1,303,211	22.1	265,645	71.7	7.25	1,380,821	1,200,118	65.5	3.42	2,684,032
Indiana	71.9	853,887	66.3	1.78	1,006,829	28.1	333,695	78.6	6.87	1,802,417	1,187,582	69.8	3.39	2,809,246
Iowa	87.2	617,236	70.1	1.88	814,803	12.8	90,860	74.1	7.34	494,013	708,096	70.6	2.62	1,308,816
Kansas	78.3	534,005	61.2	1.77	578,872	21.7	147,671	63.5	6.70	628,592	681,676	61.7	2.87	1,207,464
Kentucky	96.0	525,853	68.0	2.62	935,134	4.0	22,076	75.8	4.63	77,418	547,929	68.3	2.71	1,012,552
Louisiana	82.8	370,667	58.5	2.00	433,239	17.2	76,831	60.7	4.90	228,589	447,498	58.9	2.51	661,828
Maryland	80.8	405,905	67.3	2.49	681,275	19.2	96,157	74.3	7.80	557,336	502,062	68.6	3.59	1,238,611
Massachusetts	92.7	616,212	72.8	2.38	1,067,692	7.3	48,461	79.7	8.89	343,324	664,673	73.3	2.90	1,411,016
Michigan	79.0	859,802	68.8	1.65	974,559	21.0	228,989	68.7	7.41	1,165,970	1,088,791	68.8	2.86	2,140,529
Minnesota	88.8	591,641	68.3	2.05	830,372	11.2	74,430	79.4	6.20	366,145	666,071	69.5	2.58	1,196,517
Mississippi	91.1	703,826	60.6	1.67	712,813	8.9	68,856	65.9	6.03	273,799	772,682	61.1	2.09	986,612
Missouri	85.9	750,286	60.5	2.31	1,047,351	14.1	123,637	72.3	7.02	627,765	873,923	62.1	3.08	1,675,116
Montana	91.2	273,599	50.0	2.58	352,689	8.8	26,299	63.5	7.70	128,661	299,898	51.2	3.14	481,350
Nebraska	91.0	374,029	68.4	2.05	523,655	9.0	36,778	70.2	6.19	159,763	410,807	68.6	2.43	683,418
Nevada	91.4	69,039	62.0	2.43	103,824	8.6	6,458	78.8	10.10	51,412	75,497	63.4	3.24	155,236
New Hampshire	90.2	132,094	73.6	2.21	215,062	9.8	14,407	77.1	5.85	64,995	146,501	73.9	2.59	280,057
New Mexico	92.4	255,243	60.2	2.26	347,310	7.6	20,923	68.8	6.12	88,110	276,166	60.9	2.59	435,420
North Carolina	76.5	641,628	63.7	2.07	845,098	23.5	197,311	71.8	7.93	1,123,621	838,939	65.6	3.58	1,968,719
North Dakota	90.7	128,753	65.5	2.60	219,013	9.3	13,272	81.4	5.61	60,571	142,025	67.0	2.94	279,584
Ohio	72.6	991,018	57.5	2.81	1,598,510	27.4	374,694	72.7	8.36	2,276,107	1,365,712	61.7	4.60	3,874,617
Oklahoma	79.9	555,306	55.8	1.82	565,179	20.1	139,437	70.6	6.19	609,482	694,743	58.8	2.88	1,174,661
Pennsylvania	88.9	1,264,378	66.6	2.22	1,871,888	11.1	157,534	69.5	7.90	865,251	1,421,912	66.9	2.88	2,737,139
Rhode Island	93.2	59,850	65.1	2.22	86,330	6.8	4,393	73.2	6.64	21,356	64,243	65.7	2.55	107,686
South Carolina	70.3	338,894	66.3	2.06	463,879	29.7	143,066	65.4	7.04	659,144	481,960	66.0	3.53	1,123,023
South Dakota	91.3	225,803	63.6	1.83	263,461	8.7	21,517	75.1	4.31	69,609	247,320	64.6	2.08	333,070
Tennessee	94.5	578,531	63.7	2.22	818,657	5.5	33,673	77.0	5.77	149,610	612,204	64.4	2.45	968,267
Texas	83.9	1,661,887	59.6	1.65	1,634,277	16.1	318,213	66.0	4.16	873,878	1,980,100	60.6	2.09	2,508,155
Utah	92.1	147,114	63.5	2.20	205,363	7.9	12,539	70.3	7.59	66,893	159,653	64.0	2.66	272,256
Virginia	85.0	639,234	65.7	2.31	969,943	15.0	113,188	72.2	7.87	642,784	752,422	66.7	3.21	1,612,727
Washington	88.1	434,801	59.7	2.17	562,001	11.9	58,479	68.7	10.13	406,829	493,280	60.8	3.23	968,830
West Virginia	96.0	375,091	60.4	2.17	490,587	4.0	15,740	71.5	6.65	74,856	390,831	60.8	2.38	565,443
Wisconsin	82.0	654,095	72.7	1.53	729,190	18.0	143,291	81.1	6.78	787,881	797,386	74.2	2.56	1,517,071
Wyoming	83.2	125,367	56.0	3.03	212,991	16.8	25,260	64.7	6.57	107,436	150,627	57.5	3.70	320,427
Subtotal	83.7	22,101,270	63.8	2.08	29,354,504	16.3	4,301,085	71.8	7.42	22,918,256	26,402,355	65.1	3.04	52,272,760
Other States [1]	83.9	2,891,365	63.8	2.07	3,825,363	16.1	556,581	71.8	7.41	2,960,221	3,447,946	65.1	3.02	6,785,584
Totals and averages	83.7	24,992,635	63.8	2.08	33,179,867	16.3	4,857,666	71.8	7.42	25,878,477	29,850,301	65.1	3.04	59,058,344

[1] Includes Connecticut, Delaware, Maine, New Jersey, New York, Oregon, and Vermont.

TABLE 6.—*Vehicle-mileage of trucks and combinations with both origin and destination rural, with one rural and the other urban, and with both urban on MAIN RURAL ROADS in each State in the year 1940*

State	Total truck travel	Origin and destination					
		Both rural		One rural—one urban		Both urban	
	Thousands of vehicle-miles	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*
Alabama	298,228	15.5	46,225	52.4	156,272	32.1	95,731
Arizona	115,580	13.5	15,603	45.8	52,936	40.7	47,041
California	1,090,056	8.0	87,204	40.3	439,293	51.7	563,559
Colorado	365,467	15.7	57,378	53.0	193,698	31.3	114,391
Florida	457,276	14.5	66,305	42.9	196,171	42.6	194,800
Idaho	168,295	22.3	37,530	52.2	87,850	25.5	42,915
Illinois	848,272	6.8	57,683	33.5	284,171	59.7	506,418
Indiana	797,144	10.3	82,106	35.3	281,392	54.4	433,646
Iowa	469,331	11.4	53,504	50.8	238,420	37.8	177,407
Kansas	405,892	9.3	37,748	42.3	171,692	48.4	196,452
Kentucky	408,204	11.7	47,760	43.3	176,752	45.0	183,692
Louisiana	286,112	11.3	32,330	41.6	119,023	47.1	134,759
Maryland	429,549	8.4	36,082	40.6	174,397	51.0	219,070
Massachusetts	340,091	5.6	19,045	16.5	56,115	77.9	264,931
Michigan	763,041	7.8	59,517	27.9	212,889	64.3	490,635
Minnesota	433,872	17.6	76,361	46.4	201,317	36.0	156,194
Mississippi	532,310	14.1	75,056	49.1	261,364	36.8	195,890
Missouri	693,801	21.6	149,861	48.4	335,800	30.0	208,140
Montana	182,387	19.1	34,836	56.8	103,596	24.1	43,955
Nebraska	254,168	15.4	39,142	44.8	113,867	39.8	101,159
Nevada	49,341	19.9	9,819	53.9	26,595	26.2	12,927
New Hampshire	97,620	13.3	12,983	39.5	38,560	47.2	46,077
New Mexico	163,318	21.0	34,297	47.5	77,576	31.5	51,445
North Carolina	676,412	8.4	56,819	34.2	231,333	57.4	388,260
North Dakota	95,990	28.3	27,165	50.3	48,283	21.4	20,542
Ohio	989,042	1.5	14,835	25.3	250,228	73.2	723,979
Oklahoma	490,005	11.6	56,841	42.6	208,742	45.8	224,422
Oregon	235,643	15.5	36,525	56.2	132,431	28.3	66,687
Pennsylvania	1,062,878	7.6	80,779	36.1	383,699	56.3	598,400
Rhode Island	53,016	3.9	2,068	31.8	16,859	64.3	34,089
South Carolina	373,895	9.9	37,016	41.7	155,914	48.4	180,965
South Dakota	141,482	15.0	21,222	57.1	80,786	27.9	39,474
Tennessee	382,650	12.7	48,597	45.6	174,488	41.7	159,565
Texas	1,424,337	11.1	158,101	46.2	658,044	42.7	608,192
Utah	110,714	14.6	16,164	55.9	61,889	29.5	32,661
Virginia	583,168	15.6	90,974	44.0	256,594	40.4	235,600
Washington	348,318	10.1	35,180	51.2	178,339	38.7	134,799
West Virginia	247,328	19.4	47,981	37.8	93,490	42.8	105,857
Wisconsin	492,893	16.1	79,356	40.1	197,650	43.8	215,887
Wyoming	105,742	11.2	11,843	47.0	49,699	41.8	44,200
Subtotal	17,462,868	11.4	1,989,841	41.1	7,178,214	47.5	8,294,813
Other States [1]	3,095,438	9.2	285,145	36.3	1,122,940	54.5	1,687,353
Total and averages	20,558,306	11.1	2,274,986	40.4	8,301,154	48.5	9,982,166

[1] Includes Arkansas, Connecticut, Delaware, Georgia, Maine, New Jersey, New York, and Vermont.

TABLE 7.—*Vehicle-mileage of trucks and combinations with both origin and destination rural, with one rural and the other urban, and with both urban on LOCAL RURAL ROADS in each State in the year 1940*

State	Total truck travel	Origin and destination					
		Both rural		One rural—one urban		Both urban	
	Thousands of vehicle-miles	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*
Alabama	277,518	50.1	139,037	43.1	119,610	6.8	18,871
Arizona	84,375	50.4	42,525	43.0	36,281	6.6	5,569
California	653,860	35.2	230,159	49.6	324,314	15.2	99,387
Colorado	87,548	57.9	50,690	39.7	34,757	2.4	2,101
Florida	173,783	43.7	75,943	45.9	79,766	10.4	18,074
Idaho	92,570	51.0	47,211	45.7	42,304	3.3	3,055
Illinois	351,846	50.8	178,738	42.8	150,590	6.4	22,518
Indiana	390,438	48.8	190,534	44.9	175,307	6.3	24,597
Iowa	238,765	46.6	111,265	47.5	113,413	5.9	14,087
Kansas	275,784	52.9	145,890	41.9	115,553	5.2	14,341
Kentucky	139,725	52.9	73,914	41.9	58,545	5.2	7,266
Louisiana	161,386	49.0	79,079	43.6	70,364	7.4	11,943
Maryland	72,513	44.4	32,196	41.2	29,875	14.4	10,442
Massachusetts	324,582	25.1	81,470	56.7	184,038	18.2	59,074
Michigan	325,750	25.2	82,089	49.3	160,595	25.5	83,066

TABLE 7.—*Vehicle-mileage of trucks and combinations with both origin and destination rural, with one rural and the other urban, and with both urban on LOCAL RURAL ROADS in each State in the year 1940*—Continued

State	Total truck travel	Origin and destination					
		Both rural		One rural—one urban		Both urban	
	Thousands of vehicle-miles	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*
Minnesota	232,199	54.8	127,245	40.6	94,273	4.6	10,681
Mississippi	240,372	47.9	115,138	44.1	106,004	8.0	19,230
Missouri	180,122	56.1	101,048	40.5	72,950	3.4	6,124
Montana	117,511	56.8	66,746	40.2	47,240	3.0	3,525
Nebraska	156,639	57.9	90,694	36.4	57,017	5.7	8,928
Nevada	26,156	55.4	14,490	40.8	10,672	3.8	994
New Hampshire	48,881	39.6	19,357	44.7	21,850	15.7	7,674
New Mexico	112,848	61.2	69,063	36.0	40,625	2.8	3,160
North Carolina	162,527	45.5	73,950	45.1	73,300	9.4	15,277
North Dakota	46,035	60.0	27,621	38.8	17,862	1.2	552
Ohio	376,670	25.1	94,544	56.7	213,572	18.2	68,554
Oklahoma	204,738	53.6	109,740	41.6	85,171	4.8	9,827
Oregon	93,886	46.6	43,751	49.8	46,755	3.6	3,380
Pennsylvania	359,034	36.6	131,406	49.0	175,927	14.4	51,701
Rhode Island	11,227	25.1	2,818	56.7	6,366	18.2	2,043
South Carolina	108,065	45.8	49,494	46.8	50,574	7.4	7,997
South Dakota	105,838	57.3	60,645	37.2	39,372	5.5	5,821
Tennessee	229,554	41.2	94,576	53.3	122,353	5.5	12,625
Texas	555,763	47.9	266,210	44.1	245,092	8.0	44,461
Utah	48,939	30.6	14,975	58.9	28,825	10.5	5,139
Virginia	169,254	45.1	76,334	45.3	76,672	9.6	16,248
Washington	144,962	50.1	72,626	43.1	62,479	6.8	9,857
West Virginia	143,503	49.1	70,460	41.7	59,841	9.2	13,202
Wisconsin	304,493	52.9	161,077	42.0	127,887	5.1	15,529
Wyoming	44,885	69.4	31,150	28.1	12,613	2.5	1,122
Subtotal	7,874,544	45.0	3,545,898	45.6	3,590,604	9.4	738,042
Other States [1]	1,417,451	38.1	540,676	48.8	691,741	13.1	185,034
Totals and averages	9,291,995	44.0	4,086,574	46.1	4,282,345	9.9	923,076

[1] Includes Arkansas, Connecticut, Delaware, Georgia, Maine, New Jersey, New York, and Vermont.

TABLE 8.—*Vehicle-mileage of trucks and combinations with both origin and destination rural, with one rural and the other urban, and with both urban on ALL RURAL ROADS in each State in the year 1940*

State	Total truck travel	Origin and destination					
		Both rural		One rural—one urban		Both urban	
	Thousands of vehicle-miles	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*
Alabama	575,746	32.2	185,262	47.9	275,882	19.9	114,602
Arizona	199,955	29.1	58,128	44.6	89,217	26.3	52,610
California	1,743,916	18.2	317,363	43.8	763,607	38.0	662,946
Colorado	453,015	43.9	108,068	50.4	228,455	25.7	116,492
Florida	631,059	22.6	142,248	43.7	275,937	33.7	212,874
Idaho	260,865	32.5	84,741	49.9	130,154	17.6	45,970
Illinois	1,200,118	19.7	236,421	36.2	434,761	44.1	528,936
Indiana	1,187,582	23.0	272,640	38.4	456,699	38.6	458,243
Iowa	708,096	23.3	164,769	49.7	351,833	27.0	191,494
Kansas	681,676	27.0	183,638	42.1	287,245	30.9	210,793
Kentucky	547,929	22.2	121,674	42.9	235,297	34.9	190,958
Louisiana	447,498	24.9	111,409	42.3	189,387	32.8	146,702
Maryland	502,062	13.6	68,278	40.7	204,272	45.7	229,512
Massachusetts	664,673	15.1	100,515	36.1	240,153	48.8	324,005
Michigan	1,088,791	13.0	141,606	34.3	373,484	52.7	573,701
Minnesota	666,071	30.6	203,606	44.4	295,590	25.0	166,875
Mississippi	772,682	24.6	190,194	47.6	367,368	27.8	215,120
Missouri	873,923	28.7	250,909	46.8	408,750	24.5	214,264
Montana	299,898	33.9	101,582	50.3	150,836	15.8	47,480
Nebraska	410,807	31.6	129,836	41.6	170,884	26.8	110,087
Nevada	75,497	32.2	24,309	49.4	37,267	18.4	13,921
New Hampshire	146,501	22.1	32,340	41.2	60,410	36.7	53,751
New Mexico	276,166	37.4	103,360	42.8	118,201	19.8	54,605
North Carolina	838,939	15.6	130,769	36.3	304,633	48.1	403,537
North Dakota	142,025	38.6	54,786	46.6	66,145	14.8	21,094
Ohio	1,365,712	8.0	109,379	10.7	463,800	58.0	792,533
Oklahoma	694,743	24.0	166,581	42.3	293,913	33.7	234,249
Oregon	329,529	24.4	80,276	54.4	179,186	21.2	70,067
Pennsylvania	1,421,912	14.9	212,185	39.4	559,626	45.7	650,101
Rhode Island	64,243	7.6	4,886	36.2	23,225	56.2	36,132

TABLE 8.—*Vehicle-mileage of trucks and combinations with both origin and destination rural, with one rural and the other urban, and with both urban on ALL RURAL ROADS in each State in the year 1940*—Continued

State	Total truck travel	Origin and destination: Both rural		One rural—one urban		Both urban	
	Thousands of vehicle-miles	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*
South Carolina	481, 960	17.9	86, 510	42.9	206, 488	39.2	188, 962
South Dakota	247, 320	33.1	81, 867	48.6	120, 158	18.3	45, 295
Tennessee	612, 204	23.4	143, 173	48.5	296, 841	28.1	172, 190
Texas	1, 980, 100	21.4	424, 311	45.6	903, 136	33.0	652, 653
Utah	159, 653	19.5	31, 139	56.8	90, 714	23.7	37, 800
Virginia	752, 422	22.2	167, 308	44.3	333, 266	33.5	251, 848
Washington	493, 280	21.9	107, 806	48.8	240, 818	29.3	144, 656
West Virginia	390, 831	30.3	118, 441	39.2	153, 331	30.5	119, 059
Wisconsin	797, 386	30.2	240, 433	40.8	325, 537	29.0	231, 416
Wyoming	150, 627	28.5	42, 993	41.4	62. 312	30.1	45, 322
Subtotal	25, 337, 412	21.8	5, 535. 739	42.5	10. 768, 818	35.7	9, 032, 855
Other States [1]	4, 512, 889	18.3	825, 821	40.2	1, 814, 681	41.5	1, 872, 387
Totals and averages	29, 850, 301	21.3	6, 361, 560	42.2	12, 583, 499	36.5	10, 905, 242

[1] Includes Arkansas, Connecticut, Delaware, Georgia, Maine, New Jersey, New York, and Vermont.

movement. For example, fruit and vegetables are shipped directly by truck from rural areas in the south to the large cities of the north.

Figure 6, which was prepared from data in tables 6, 7, and 8, shows the percentage relations of the mileage of trucks between urban areas, between urban and rural areas, and between rural areas, on main and local roads, separately and combined. On both main and local roads the movement between rural and urban areas, or what might be called the farm-to-city and city-to-farm movement, was between 40 percent and 50 percent of the total. On main roads, the balance was mostly urban-urban with only about 11 percent rural-rural, while on local roads the movement between rural areas made up most of the balance, the city-to-city movement amounting to only about 10 percent.

Stated another way, most of the travel between cities took place on main roads, considerable travel between urban and rural areas took place on both main and local roads, and most of the travel between rural areas took place on local roads. Figure 7 shows the

TABLE 9.—*Percentage loaded, average carried load, and ton-mileage of carried load, of trucks and combinations, with both origin and destination rural, with one rural and the other urban, and with both urban, on MAIN RURAL ROADS in each State in the year 1940*

State	Origin and destination: Both rural: Percentage loaded	Both rural: Carried load: Average weight	Both rural: Carried load: Ton-miles	Both rural: Carried load: Percentage of State total	One rural—one urban: Percentage loaded	One rural—one urban: Carried load: Average weight	One rural—one urban: Carried load: Ton-miles	One rural—one urban: Carried load: Percentage of State total	Both urban: Percentage loaded	Both urban: Carried load: Average weight	Both urban: Carried load: Ton-miles	Both urban: Carried load: Percentage of State total	Total ton-miles
		Tons	*Thousands*			*Tons*	*Thousands*			*Tons*	*Thousands*		*Thousands*
Alabama	44.4	2.81	57, 727	11.3	56.4	2.73	241, 189	47.0	70.5	3.17	213, 968	41.7	512, 884
Arizona	47.1	2.78	20, 450	6.4	55.2	2.76	80, 552	25.1	75.5	6.18	219, 618	68.5	320. 620
California	66.9	3.94	229, 701	5.4	73.4	4.30	1, 387, 196	32.7	72.1	6.46	2, 624, 360	61.9	4, 241, 257
Colorado	67.4	2.51	97, 123	14.0	64.1	2.50	310, 147	44.8	76.9	3.24	284, 953	41.2	692, 223
Florida	36.3	3.08	74, 104	3.5	46.2	3.38	306, 059	35.2	57.5	4.36	489, 147	56.3	869, 310
Idaho	54.3	2.29	46, 733	20.8	59.4	1.88	98, 277	43.8	70.5	2.63	79, 436	35.4	224, 446
Illinois	55.0	3.33	105, 612	4.9	58.9	3.10	519, 371	24.0	71.1	4.27	1, 538, 364	71.1	2, 163, 347
Indiana	60.4	2.74	135, 855	5.8	64.4	2.65	481, 006	20.4	77.7	5.16	1, 739, 302	73.8	2, 356, 163
Iowa	65.9	3.57	125, 899	12.2	66.1	2.55	401, 575	39.1	78.7	3.58	500, 022	48.7	1, 027, 496
Kansas	53.0	2.20	44, 069	4.8	58.0	2.90	288, 531	31.5	67.1	4.43	583, 746	63.7	916, 346
Kentucky	55.1	2.85	74, 909	9.3	63.6	2.96	332, 872	41.6	76.5	2.80	393, 114	49.1	800, 895
Louisiana	44.9	2.12	30, 861	6.5	55.2	2.01	131, 894	27.8	65.6	3.52	311, 435	65.7	474, 190
Maryland	56.8	2.52	51, 730	4.7	65.1	3.06	347, 113	31.6	73.4	4.34	698. 929	63.7	1, 097, 772
Massachusetts	37.3	2.03	14, 388	1.7	79.5	2.42	107, 987	12.5	74.9	3.73	740, 710	85.8	863, 085
Michigan	50.8	2.44	73, 886	4.1	64.3	3.11	425, 724	23.6	73.3	3.62	1, 301, 139	72.3	1, 800, 749
Minnesota	55.6	2.81	119, 305	13.5	65.6	2.59	342, 836	38.7	82.5	3.28	423, 132	47.8	885, 273
Mississippi	51.3	2.35	90, 585	11.9	58.6	2.16	331, 655	43.7	68.4	2.51	336, 491	44.4	758, 731
Missouri	51.8	2.92	226, 691	15.7	62.3	2.55	532, 601	37.0	70.7	4.64	682, 156	47.3	1, 441, 448
Montana	48.7	2.55	43, 215	12.8	47.5	3.71	182, 585	54.2	63.7	3.96	110, 998	33.0	336, 798
Nebraska	57.9	2.68	60, 791	12.4	68.0	2.32	179, 768	36.7	73.6	3.34	248, 948	50.9	489, 507
Nevada	62.8	3.70	22, 796	19.1	60.6	2.91	46, 866	39.2	72.2	5.33	49, 771	41.7	119, 433
New Hampshire	61.3	3.17	25, 208	12.7	70.1	2.45	66, 209	33.4	80.6	2.88	107, 026	53.9	198, 443
New Mexico	53.2	2.45	44, 580	15.2	55.8	2.55	110, 270	37.7	74.4	3.60	137, 769	47.1	292, 619
North Carolina	48.9	1.32	36, 609	2.1	59.3	1.84	252, 498	14.5	72.3	5.18	1, 453, 664	83.4	1, 742, 771
North Dakota	55.2	3.67	55, 106	26.4	69.8	2.99	100, 974	48.4	77.9	3.28	52, 478	25.2	208, 558
Ohio	53.5	3.23	25, 613	0.7	54.7	3.39	464, 831	14.5	65.6	5.74	2, 724, 673	84.8	3, 215, 117
Oklahoma	53.2	2.91	87, 948	9.1	55.1	2.86	328, 561	34.0	65.6	3.73	549, 099	56.9	965, 608
Pennsylvania	53.4	3.00	129, 251	5.8	59.8	2.84	651, 987	29.2	73.4	3.30	1, 450, 562	65.0	2, 231, 800
Rhode Island	55.2	2.18	2, 492	2.7	64.1	2.73	29, 488	31.5	67.2	2.69	61, 552	65.8	93, 532
South Carolina	56.6	3.31	69, 367	7.2	63.2	3.58	352, 879	36.4	70.3	4.29	545, 832	56.4	968, 078
South Dakota	68.4	2.41	34, 933	16.7	57.8	1.87	87, 179	41.8	76.6	2.86	86, 557	41.5	208, 669
Tennessee	46.4	2.40	54, 266	8.0	60.8	2.43	257, 273	37.8	74.7	3.09	369, 061	54.2	680, 600
Texas	55.4	2.32	202, 953	10.2	57.3	2.04	770, 840	38.6	66.1	2.54	1, 020, 516	51.2	1, 994, 309
Utah	57.5	3.09	28, 749	13.8	60.0	2.95	109, 470	52.3	75.5	2.88	70, 947	33.9	209, 166
Virginia	52.5	3.31	157, 936	11.5	66.8	2.86	490, 425	35.9	72.5	4.21	718, 199	52.6	1, 366, 560
Washington	47.7	3.51	58, 851	7.6	56.3	2.81	282, 332	36.6	70.6	4.52	430, 727	55.8	771, 910
West Virginia	52.3	2.83	71, 004	17.8	57.7	2.09	112, 612	28.2	68.0	3.00	215, 748	54.0	399, 364
Wisconsin	62.3	2.15	106, 401	9.3	70.8	2.37	331, 153	29.1	83.0	3.92	702, 507	61.6	1, 140, 061
Wyoming	54.7	3.54	22, 908	9.1	52.4	3.88	101, 158	40.1	65.1	4.46	128, 276	50.8	252, 342
Subtotal	54.3	2.79	2, 960, 605	7.5	61.2	2.78	11, 975, 943	30.5	71.5	4.15	24, 394, 932	62.0	39, 331, 480
Other States [1]	48.9	3.08	483, 625	6.6	60.3	2.91	2, 200, 331	29.9	72.3	3.68	4, 670, 285	63.5	7, 354, 241
Totals and averages	53.5	2.83	3, 444, 230	7.4	61.1	2.80	14, 176, 274	30.3	71.6	4.06	29, 065, 217	62.3	46, 685, 721

[1] Includes Arkansas, Connecticut, Delaware, Georgia, Maine, New Jersey, New York, Oregon, and Vermont.

vehicle-miles in each of the three origin and destination categories, divided between main and local roads, in each case. For all rural roads, main and local combined, the truck-mileage between rural and urban areas amounted to about 12.6 billion, compared to about 10.9 billion for urban-urban travel and 6.4 billion for rural-rural travel.

Though the truck mileage from city to city was less than that between rural and urban areas, and little more than a third of the total for all three classifications, the ton-mileage hauled between cities was greater than that of the other two origin and destination classifications combined. This is because a greater proportion of the trucks operating between cities were loaded, and the average load was greater than for other trucks. Figure 8 shows that 72.2 percent of the trucks operating between cities were loaded, compared to 63.4 percent of those operating between urban and rural areas and 56.2 percent of those operating between rural areas. Figure 9 and table 11 show that the average carried load was about 4.0 tons for the urban-urban trucks, 2.5 for the rural-urban and urban-rural trucks, and 2.3 tons for the rural-rural trucks. The resulting ton-miles of carried load were 31.1 billion for the urban-urban, 19.9 billion for the urban-rural and rural-urban, and 8.1 billion for the rural-rural classifications, as indicated by the areas of the rectangles in figure 9.

TRUCKING CLASSIFIED AS INTRASTATE, INTERSTATE, AND TRANSSTATE

The classification of origins and destinations on the basis of location within or without the State in which the vehicle was observed is helpful from the point of view of jurisdiction or extent of interest. A trip occurring wholly within a State would presumably be of interest mainly to the State in which it occurred, while one across a state line would be of interest to two States and to the Federal Government. This classification also gives some indication of trip extent and aids in evaluating the need for through routes.

Table 10.—*Percentage loaded, average carried load, and ton-mileage of carried load, of trucks and combinations, with both origin and destination rural, with one rural and the other urban, and with both urban, on LOCAL RURAL ROADS in each State in the year 1940*

State	Origin and destination												Total ton-miles
	Both rural				One rural—one urban				Both urban				
	Percentage loaded	Carried load			Percentage loaded	Carried load			Percentage loaded	Carried load			
		Average weight	Ton-miles	Percentage of State total		Average weight	Ton-miles	Percentage of State total		Average weight	Ton-miles	Percentage of State total	
		Tons	*Thousands*			*Tons*	*Thousands*			*Tons*	*Thousands*		*Thousands*
Alabama	50.9	2.21	156,133	43.3	64.7	2.15	166,718	46.2	80.9	2.48	37,937	10.5	360,788
Arizona	54.3	2.32	53,437	40.8	63.8	2.28	52,764	40.2	87.1	5.14	24,930	19.0	131,131
California	64.3	2.21	328,096	27.9	70.6	2.42	553,401	47.1	81.3	3.63	293,083	25.0	1,174,580
Colorado	69.6	2.02	71,376	58.5	66.1	2.01	46,298	37.9	79.4	2.61	4,355	3.6	122,029
Florida	40.3	2.24	68,524	33.3	51.4	2.46	100,693	48.9	63.8	3.18	36,637	17.8	205,854
Idaho	57.6	1.83	49,634	52.4	63.0	1.50	39,956	42.2	79.9	2.09	5,104	5.4	94,694
Illinois	61.4	2.31	253,987	48.8	65.8	2.16	213,609	41.0	79.4	2.97	53,089	10.2	520,685
Indiana	63.7	1.65	200,172	44.2	67.7	1.60	190,272	42.0	82.0	3.11	62,639	13.8	453,083
Iowa	69.2	1.94	149,539	53.2	69.5	1.38	109,104	38.8	82.7	1.95	22,677	8.0	281,320
Kansas	58.1	1.43	121,207	41.6	63.7	1.90	139,588	48.0	73.6	2.87	30,323	10.4	291,118
Kentucky	62.7	2.19	101,506	48.0	72.4	2.28	96,535	45.6	87.2	2.15	13,616	6.4	211,657
Louisiana	53.2	1.90	79,869	42.6	61.3	1.80	77,609	41.4	80.1	3.15	30,160	16.0	187,638
Maryland	62.1	2.34	46,874	33.3	71.2	2.83	60,132	42.7	80.3	4.04	33,833	24.0	140,839
Massachusetts	40.0	1.78	57,864	10.6	85.3	2.13	334,799	61.1	80.4	3.27	155,268	28.3	547,931
Michigan	56.2	1.20	55,468	16.3	71.1	1.53	174,800	51.4	74.1	1.78	109,512	32.3	339,780
Minnesota	62.8	2.00	159,361	51.2	74.2	1.84	128,688	41.3	93.2	2.33	23,195	7.5	311,244
Mississippi	55.8	1.61	103,315	45.3	63.7	1.48	100,006	43.9	74.4	1.72	24,560	10.8	227,881
Missouri	55.4	2.12	118,310	50.6	66.6	2.06	99,824	42.7	75.5	3.36	15,534	6.7	233,668
Montana	50.6	2.03	68,480	47.4	49.2	2.96	68,710	47.5	66.2	3.16	7,362	5.1	144,552
Nebraska	63.4	1.88	108,025	55.7	74.4	1.63	69,036	35.6	80.6	2.34	16,850	8.7	193,911
Nevada	62.8	2.32	21,068	58.8	60.6	1.91	12,340	34.5	72.1	3.34	2,395	6.7	35,803
New Hampshire	66.5	2.56	32,991	40.4	76.0	1.99	33,031	40.5	87.2	2.33	15,592	19.1	81,614
New Mexico	58.8	2.03	82,184	57.6	61.7	2.11	52,864	37.0	82.3	2.98	7,753	5.4	142,801
North Carolina	56.4	1.40	58,241	25.8	68.4	1.95	97,795	43.3	83.4	5.49	69,912	30.9	225,948
North Dakota	59.7	2.55	41,982	59.1	75.4	2.08	27,988	39.4	84.1	2.28	1,056	1.5	71,026
Ohio	56.0	2.49	131,607	20.0	57.3	2.61	319,880	48.5	68.7	4.42	208,013	31.5	659,500
Oklahoma	55.2	1.79	108,254	51.8	57.1	1.76	85,469	40.9	68.0	2.29	15,330	7.3	209,053
Pennsylvania	58.2	2.13	163,240	32.3	69.1	2.01	244,798	48.4	80.2	2.35	97,301	19.3	505,339
Rhode Island	57.7	1.62	2,639	18.6	67.1	2.02	8,648	61.1	70.1	2.00	2,867	20.3	14,154
South Carolina	61.7	2.03	62,123	40.1	69.0	2.20	76,666	49.5	76.6	2.64	16,156	10.4	154,945
South Dakota	65.3	1.95	77,071	62.0	62.2	1.53	37,476	30.1	73.1	2.32	9,854	7.9	124,401
Tennessee	53.3	1.91	96,273	33.5	69.7	1.93	164,733	57.3	85.8	2.46	26,661	9.2	287,667
Texas	58.2	1.61	249,626	48.6	60.2	1.42	209,725	40.8	69.5	1.76	54,495	10.6	513,846
Utah	60.2	2.10	18,926	30.0	62.8	2.00	36,230	57.4	79.1	1.95	7,934	12.6	63,090
Virginia	56.9	2.28	99,279	40.3	72.4	1.98	109,783	44.6	78.6	2.91	37,105	15.1	246,167
Washington	54.2	2.41	94,973	48.2	64.0	1.93	77,324	39.3	80.3	3.11	24,623	12.5	196,920
West Virginia	56.5	2.12	84,359	50.8	62.3	1.61	59,950	36.1	73.5	2.24	21,770	13.1	166,079
Wisconsin	68.3	1.54	169,363	44.9	77.5	1.69	168,023	44.6	90.9	2.81	39,624	10.5	377,010
Wyoming	56.6	2.60	45,989	67.6	54.4	2.86	19,620	28.8	67.4	3.27	2,476	3.6	68,085
Subtotal	58.6	1.94	3,991,365	38.7	67.1	1.96	4,664,885	45.2	77.6	2.92	1,661,581	16.1	10,317,831
Other States [1]	52.0	2.04	620,119	30.2	71.6	1.97	1,042,306	50.7	79.9	2.61	392,367	19.1	2,054,792
Totals and averages	57.7	1.96	4,611,484	37.3	67.9	1.96	5,707,191	46.1	78.0	2.85	2,053,948	16.6	12,372,623

[1] Includes Askansas, Connecticut, Delaware, Georgia, Maine, New Jersey, New York, Oregon, and Vermont.

In tables 12 to 17, inclusive, the term "intrastate" describes movements with both origin and destination within a single State, "interstate" describes movements with either origin or destination, but not both, in the State for which data are given, and "transstate" describes movements with neither origin nor destination in the State for which data are given. It is to be noted that "interstate" traffic, according to these definitions, does not include "transstate" traffic as it does in the common usage of the term.

For correct understanding of the origin and destination tables it must be borne in mind that vehicle-mileages in different categories are computed by multiplying the average number of vehicles in each category passing over a section of road, within a given period of time, by the length of the road section, and not by considering individual trips. The same vehicle on a given trip may have been differently classified in different States. Thus, if a vehicle makes a trip originating in one State, crossing another State and ending in a third State, the travel in the first and third States would be classed as interstate and that in the intervening State would be classed as transstate.

The distinction between interstate traffic and transstate traffic is important to individual States because interstate traffic results in imports and exports, whereas transstate traffic, except in cases of the taking on or putting off of partial loads en route, contributes nothing to the commerce of the State and yet must be accommodated on its highways. From a national point of view the distinction is of less importance and, for many purposes, the two classes may well be combined in considering the national totals. They do, however, tend to provide a rough division on the basis of trip extent since all of the transstate travel is by trucks on trips extending into at least three States, whereas the interstate travel is largely by trucks extending into only two States, though it includes some travel of greater extent.

The travel by trucks across States in which the trip neither begins nor ends is not as great as might be supposed. In only 6 of the 41 States shown separately in table 12 did it amount to as much as 10 percent of the total truck travel on main roads. These were New

TABLE 11.—*Percentage loaded, average carried load, and ton-mileage of carried load, of trucks and combinations with both origin and destination rural, with one rural and the other urban, and with both urban, on* ALL RURAL ROADS *in each State in the year 1940*

State	Origin and destination												Total ton-miles
	Both rural				One rural—one urban				Both urban				
	Percentage loaded	Carried load			Percentage loaded	Carried load			Percentage loaded	Carried load			
		Average weight	Ton-miles	Percentage of State total		Average weight	Ton-miles	Percentage of State total		Average weight	Ton-miles	Percentage of State total	
		Tons	*Thousands*			*Tons*	*Thousands*			*Tons*	*Thousands*		*Thousands*
Alabama	49.3	2.34	213,860	24.5	60.0	2.46	407,907	46.7	72.3	3.04	251,905	28.8	873,672
Arizona	52.3	2.43	73,887	16.4	58.7	2.55	133,316	29.5	76.7	6.06	244,548	54.1	451,751
California	65.0	2.70	557,797	10.3	72.2	3.52	1,940,597	35.8	73.5	5.99	2,917,443	53.9	5,415,837
Colorado	68.5	2.28	168,499	20.7	64.4	2.42	356,445	43.8	76.9	3.23	289,308	35.5	814,252
Florida	38.4	2.61	142,628	13.3	47.7	3.09	406,752	37.8	58.1	4.25	525,784	48.9	1,075,164
Idaho	56.1	2.03	96,367	30.2	60.6	1.75	138,233	43.3	71.1	2.59	84,540	26.5	319,140
Illinois	59.8	2.54	359,599	13.4	61.3	2.75	732,980	27.3	71.4	4.21	1,591,453	59.3	2,684,032
Indiana	62.7	1.97	336,027	12.0	65.8	2.24	671,278	23.9	77.9	5.05	1,801,941	64.1	2,809,246
Iowa	68.2	2.45	275,438	21.1	67.2	2.16	510,679	39.0	79.0	3.46	522,699	39.9	1,308,816
Kansas	57.1	1.58	165,276	13.7	60.3	2.47	428,119	35.4	67.6	4.31	614,069	50.9	1,207,464
Kentucky	59.7	2.43	176,415	17.4	65.8	2.77	429,407	42.4	76.9	2.77	406,730	40.2	1,012,552
Louisiana	50.8	1.96	110,730	16.7	57.5	1.92	209,503	31.7	66.8	3.49	341,595	51.6	661,828
Maryland	59.3	2.43	98,604	8.0	66.0	3.02	407,245	32.9	73.7	4.33	732,762	59.1	1,238,611
Massachusetts	39.5	1.82	72,252	5.1	84.0	2.20	442,786	31.4	75.9	3.64	895,978	63.5	1,411,016
Michigan	54.0	1.69	129,354	6.0	67.2	2.39	600,524	28.1	73.4	3.35	1,410,651	65.9	2,140,529
Minnesota	60.1	2.28	278,666	23.3	68.4	2.33	471,524	39.4	83.2	3.22	446,327	37.3	1,196,517
Mississippi	54.0	1.89	193,900	19.6	60.1	1.96	431,661	43.8	69.0	2.43	361,051	36.6	986,612
Missouri	53.2	2.58	345,001	20.6	63.1	2.45	632,425	37.7	70.8	4.60	697,690	41.7	1,675,116
Montana	50.0	2.20	111,695	23.2	48.0	3.47	251,295	52.2	63.9	3.90	118,360	24.6	481,350
Nebraska	61.8	2.10	168,816	24.7	70.1	2.08	248,804	36.4	74.2	3.26	265,798	38.9	683,418
Nevada	62.8	2.87	43,864	28.3	60.6	2.62	59,206	38.1	72.2	5.19	52,166	33.6	155,236
New Hampshire	64.4	2.79	58,199	20.8	72.2	2.27	99,240	35.4	81.6	2.80	122,618	43.8	280,057
New Mexico	56.9	2.16	126,764	29.1	57.8	2.39	163,134	37.5	74.9	3.56	145,522	33.4	435,420
North Carolina	53.2	1.36	94,850	4.8	61.5	1.87	350.293	17.8	72.7	5.19	1,523,576	77.4	1,968,719
North Dakota	57.5	3.08	97,088	34.7	71.3	2.73	128,962	46.1	78.0	3.25	53,534	19.2	279,584
Ohio	55.6	2.58	157,220	4.0	55.9	3.03	784,711	20.3	65.9	5.62	2,932,686	75.7	3,874,617
Oklahoma	54.5	2.16	196,202	16.7	55.7	2.53	414,030	35.2	65.7	3.67	564,429	48.1	1,174,661
Pennsylvania	56.4	2.44	292,491	10.7	62.7	2.55	896,785	32.8	74.0	3.22	1,547,863	56.5	2,737,139
Rhode Island	56.6	1.85	5,131	4.8	64.9	2.53	38,136	35.4	67.4	2.65	64,419	59.8	107,686
South Carolina	59.5	2.55	131,490	11.7	64.7	3.22	429,545	38.2	70.5	4.22	561,988	50.1	1,123,023
South Dakota	66.1	2.08	112,004	33.6	59.2	1.75	124,655	37.4	76.1	2.80	96,411	29.0	333,070
Tennessee	51.0	2.06	150,539	15.5	64.5	2.20	422,006	43.6	75.6	3.04	395,722	40.9	968,267
Texas	57.1	1.87	452,579	18.0	58.1	1.87	980,565	39.1	66.4	2.48	1,075,011	42.9	2,508,155
Utah	58.8	2.61	47,675	17.5	60.9	2.64	145,700	53.5	76.0	2.75	78,881	29.0	272,256
Virginia	54.5	2.82	257,215	15.9	68.1	2.64	600,208	37.3	72.9	4.12	755,304	46.8	1,612,727
Washington	52.1	2.74	153,824	15.9	58.3	2.56	359,656	37.1	71.3	4.41	455,350	47.0	968,830
West Virginia	54.8	2.39	155,363	27.5	59.5	1.89	172,562	30.5	68.6	2.91	237,518	42.0	565,443
Wisconsin	66.3	1.73	275,764	18.2	73.4	2.09	499,176	32.9	83.5	3.84	742,131	48.9	1,517,071
Wyoming	56.1	2.86	68,897	21.5	52.8	3.67	120,778	37.7	65.1	4.43	130,752	40.8	320,427
Subtotal	57.1	2.23	6,951,970	14.0	63.2	2.49	16,640,828	33.5	72.0	4.04	26,056,513	52.5	49,649,311
Other States [1]	50.9	2.39	1,103,744	11.7	64.5	2.52	3,242,637	34.5	73.0	3.57	5,062,652	53.8	9,409,033
Totals and averages	56.2	2.25	8,055,714	13.6	63.4	2.49	19,883,465	33.7	72.2	3.95	31,119,165	52.7	59,058,344

[1] Includes Arkansas, Connecticut, Delaware, Georgia, Maine, New Jersey, New York, Oregon, and Vermont.

TABLE 12.—*Vehicle-mileage of trucks and combinations which traveled intrastate, interstate, and transstate on MAIN RURAL ROADS in each State in the year 1940*

State	Total truck travel	Intrastate		Interstate		Transstate	
	Thousands of vehicle-miles	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*
Alabama	298, 228	76. 9	229, 337	20. 5	61, 137	2. 6	7, 754
Arizona	115, 580	72. 3	83, 564	20. 9	24, 156	6. 8	7, 860
California	1, 090, 056	96. 3	1, 049, 724	3. 6	39, 242	. 1	1, 090
Colorado	365, 467	79. 0	288, 719	20. 4	74, 555	. 6	2, 193
Florida	457, 276	82. 7	378, 167	17. 1	78, 194	. 2	915
Idaho	168, 295	84. 3	141, 873	13. 9	23, 393	1. 8	3, 029
Illinois	848, 272	67. 4	571, 735	26. 0	220, 551	6. 6	55, 986
Indiana	797, 144	63. 0	502, 201	24. 0	191, 314	13. 0	103, 629
Iowa	469, 331	74. 8	351, 059	20. 2	94, 805	5. 0	23, 467
Kansas	405, 892	63. 2	256, 524	31. 3	127, 044	5. 5	22. 324
Kentucky	408, 204	71. 5	291, 866	19. 7	80, 416	8. 8	35, 922
Louisiana	286, 112	81. 0	231, 751	17. 6	50, 356	1. 4	4, 005
Maryland	429, 549	48. 0	206, 183	40. 4	173, 538	11. 6	49, 828
Massachusetts	340, 091	74. 4	253, 028	23. 7	80, 601	1. 9	6, 462
Michigan	763, 041	87. 0	663, 617	13. 0	99, 119	[1] . 0	305
Minnesota	433, 872	84. 0	364, 453	14. 7	63, 779	1. 3	5, 640
Mississippi	532, 310	76. 7	408, 282	18. 2	96, 880	5. 1	27, 148
Missouri	693, 801	71. 9	498, 843	24. 1	167, 206	4. 0	27, 752
Montana	182, 387	86. 4	157, 582	12. 1	22, 069	1. 5	2, 736
Nebraska	254, 168	76. 6	194, 692	20. 6	52, 359	2. 8	7, 117
Nevada	49, 341	75. 0	37, 006	16. 0	7, 895	9. 0	4, 440
New Hampshire	97, 620	58. 4	57, 010	29. 0	28, 310	12. 6	12, 300
New Mexico	163, 318	69. 2	113, 016	22. 2	36, 257	8. 6	14, 045
North Carolina	676, 412	72. 9	493, 104	20. 5	138, 665	6. 6	44, 643
North Dakota	95, 990	84. 6	81, 207	12. 7	12, 191	2. 7	2, 592
Ohio	989, 042	70. 5	697, 275	23. 6	233, 414	5. 9	58, 353
Oklahoma	490, 005	72. 4	354, 764	24. 9	122, 011	2. 7	13, 230
Oregon	235, 643	88. 0	207, 366	10. 6	24, 978	1. 4	3, 299
Pennsylvania	1, 062, 878	77. 1	819, 479	19. 2	204, 073	3. 7	39, 326
Rhode Island	53, 016	59. 8	31, 704	33. 8	17, 919	6. 4	3, 393
South Carolina	373, 895	63. 1	235, 928	24. 0	89, 735	12. 9	48, 232
South Dakota	141, 482	75. 1	106, 253	23. 9	33, 814	1. 0	1, 415
Tennessee	382, 650	76. 4	292, 345	19. 1	73, 086	4. 5	17, 219
Texas	1, 424, 337	92. 0	1, 310, 390	7. 5	106, 825	. 5	7, 122
Utah	110, 714	88. 5	97, 982	10. 2	11, 293	1. 3	1, 439
Vermont	65, 979	70. 3	46, 383	26. 4	17, 419	3. 3	2, 177
Virginia	583, 168	63. 2	368, 562	25. 8	150, 457	11. 0	64, 149
Washington	348, 318	87. 6	305, 127	11. 5	40, 056	. 9	3, 135
West Virginia	247, 328	76. 2	188, 464	19. 3	47, 734	4. 5	11, 130
Wisconsin	492, 893	81. 4	401, 215	15. 7	77, 384	2. 9	14, 294
Wyoming	105, 742	60. 6	64, 080	26. 4	27, 916	13. 0	13, 746
Subtotal	17, 528, 847	76. 6	13, 431, 860	19. 0	3, 322, 146	4. 4	774, 841
Other States [2]	3, 029, 459	67. 3	2, 039, 959	26. 4	798, 884	6. 3	190, 616
Totals and averages	20, 558, 306	75. 3	15, 471, 819	20. 0	4, 121, 030	4. 7	965, 457

[1] Less than 0.05 percent.
[2] Includes Arkansas, Connecticut, Delaware, Georgia, Maine, New Jersey, and New York.

Hampshire, Maryland, Virginia, and South Carolina along the eastern seaboard where there is much long-distance hauling north and south; Indiana which is crossed by most of the traffic between Chicago and the south and east, and Wyoming through which much of the hauling between the Pacific coast and the east or midwest funnels.

For the United States as a whole, this transstate travel amounted to only 4.7 percent of the total truck travel on main roads, 0.2 percent of that on local roads, and 3.3 percent of that on main and local roads combined (fig. 10). In fact, about 82 percent of the truck travel on all rural roads was confined to trips not extending beyond State borders. The annual vehicle-mileage of intrastate, interstate, and transstate truck

TABLE 13.—*Vehicle-mileage of trucks and combinations which traveled intrastate, interstate, and transstate on LOCAL RURAL ROADS in each State in the year 1940*

State	Total truck travel	Intrastate		Interstate		Transstate	
	Thousands of vehicle-miles	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicles-miles*	*Percent*	*Thousands of vehicle-miles*
Idaho	92, 570	93. 6	86, 646	6. 2	5, 739	0. 2	185
Indiana	390, 438	97. 0	378, 725	2. 9	11, 323	. 1	390
Iowa	238, 765	96. 6	230, 647	3. 3	7, 879	. 1	239
Michigan	325, 750	97. 4	317, 280	2. 5	8, 144	. 1	326
Minnesota	232, 199	97. 5	226, 394	2. 4	5, 573	. 1	232
Nebraska	156, 639	96. 5	151, 157	3. 3	5, 169	. 2	313
Nevada	26, 156	94. 8	24, 796	5. 1	1, 334	. 1	26
New Hampshire	48, 881	82. 7	40, 424	15. 3	7, 479	2. 0	978
New Mexico	112, 848	97. 8	110, 365	2. 1	2, 370	. 1	113
Ohio	376, 670	96. 7	364, 240	3. 1	11, 677	. 2	753
Oregon	93, 886	98. 9	92, 853	1. 1	1, 033	[1] . 0	----------
South Carolina	108, 065	95. 9	103, 635	3. 8	4, 106	. 3	324
South Dakota	105, 838	92. 7	98, 112	7. 2	7, 620	. 1	106
Tennessee	229, 554	96. 4	221, 290	3. 4	7, 805	. 2	459
Utah	48, 939	97. 6	47, 764	2. 4	1, 175	[1] . 0	----------
West Virginia	143, 503	93. 7	134, 462	5. 9	8, 467	. 4	574
Wisconsin	304, 493	97. 5	296, 881	2. 4	7, 308	. 1	304
Wyoming	44, 885	94. 6	42, 461	5. 0	2, 244	. 4	180
Subtotal	3, 080, 079	96. 3	2, 968, 132	3. 5	106, 445	. 2	5, 502
Other States [2]	6, 211, 916	96. 3	5, 979, 994	3. 5	220, 604	. 2	11, 318
Totals and averages	9, 291, 995	96. 3	8, 948, 126	3. 5	327, 049	. 2	16, 820

[1] Less than 0.05 percent.
[2] Includes Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Illinois, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Mississippi, Missouri, Montana, New Jersey, New York, North Carolina, North Dakota, Oklahoma, Pennsylvania, Rhode Island, Texas, Vermont, Virginia, and Washington.

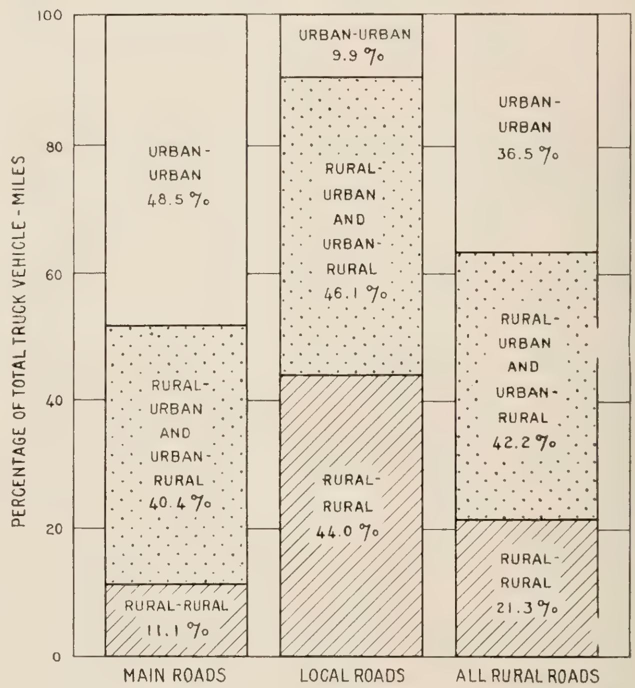


FIGURE 6.—PERCENTAGE DISTRIBUTION OF VEHICLE-MILES OF TRUCKS ON THE BASIS OF RURAL AND URBAN ORIGINS AND DESTINATIONS ON MAIN AND LOCAL RURAL ROADS IN THE YEAR 1940.

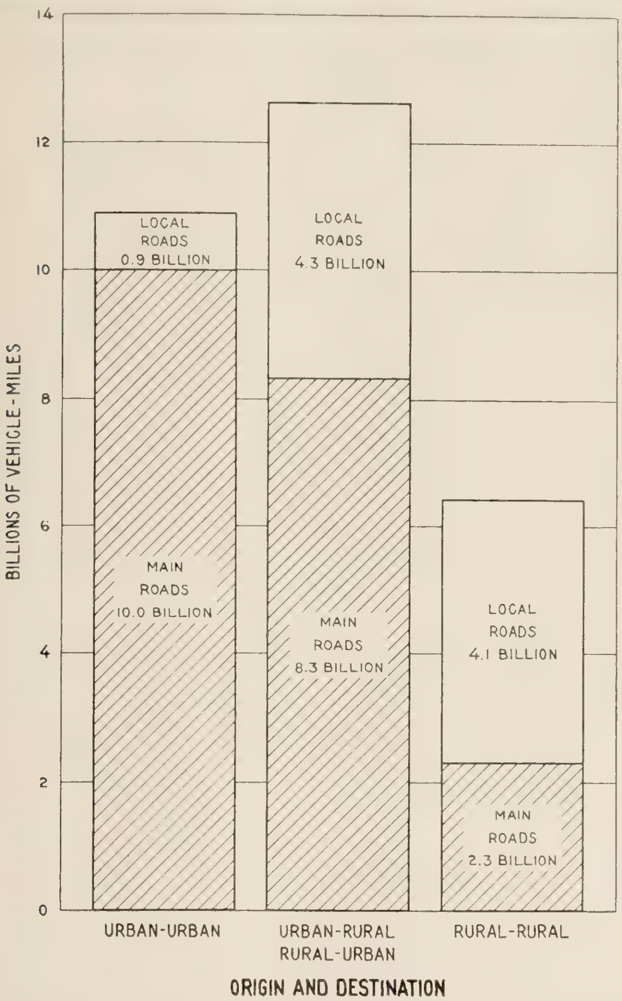


FIGURE 7.—VEHICLE-MILES OF TRUCKS WITH ORIGIN AND DESTINATION BOTH URBAN, WITH ONE URBAN AND THE OTHER RURAL, AND WITH BOTH RURAL, ON MAIN AND LOCAL RURAL ROADS IN THE YEAR 1940.

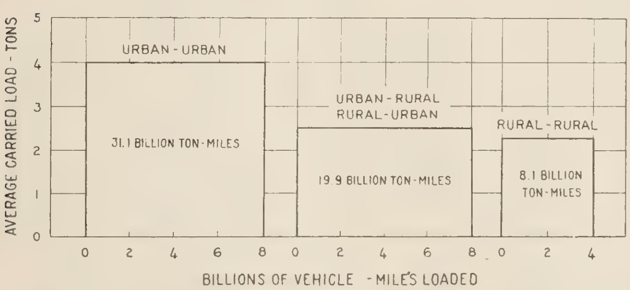


FIGURE 9.—TON-MILES OF LOAD CARRIED BY TRUCKS WITH ORIGIN AND DESTINATION BOTH URBAN, WITH ONE URBAN AND THE OTHER RURAL, AND WITH BOTH RURAL ON ALL RURAL ROADS IN THE YEAR 1940.

travel, shown separately for main and local roads, in each case, is given in figure 11.

The interstate and transstate movement of commodities in ton-miles was of much larger proportions than would appear from consideration of the vehicle-mileage

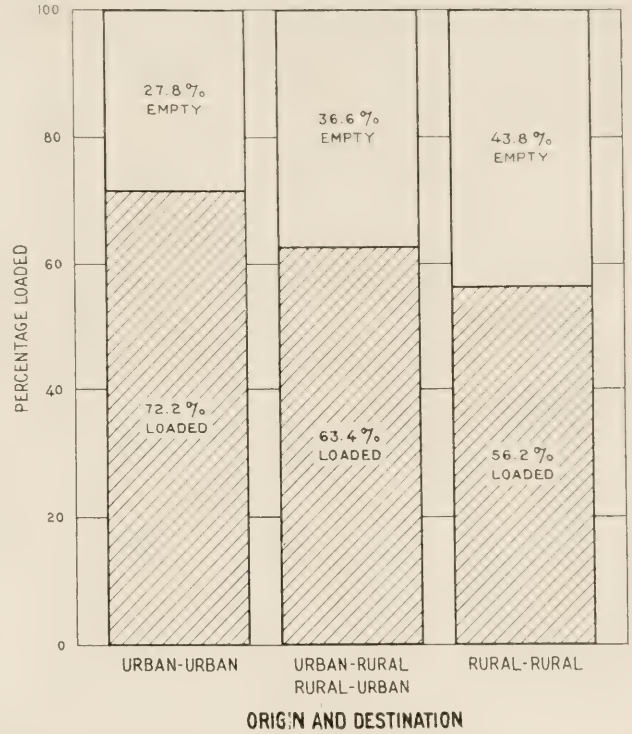


FIGURE 8.—LOADED AND EMPTY TRUCKS AS PERCENTAGES OF TRUCKS WITH ORIGIN AND DESTINATION BOTH URBAN, WITH ONE URBAN AND THE OTHER RURAL, AND WITH BOTH RURAL, ON ALL RURAL ROADS IN THE YEAR 1940.

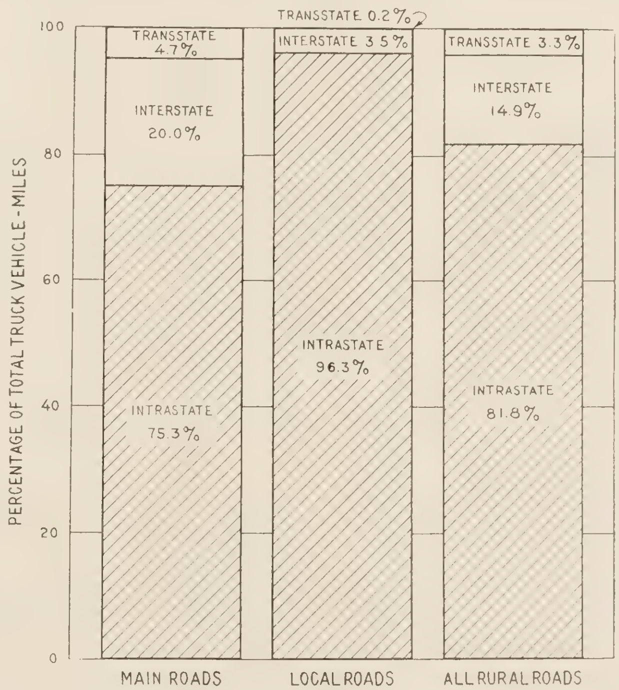


FIGURE 10.—PERCENTAGE DISTRIBUTION OF VEHICLE-MILES OF TRUCKS ON THE BASIS OF INTRASTATE, INTERSTATE, AND TRANSSTATE TRIP CLASSIFICATIONS ON MAIN AND LOCAL RURAL ROADS IN THE YEAR 1940.

TABLE 14.—*Vehicle-mileage of trucks and combinations which traveled intrastate, interstate, and transstate on ALL RURAL ROADS in each State in the year 1940*

State	Total truck travel	Intrastate		Interstate		Transstate	
	Thousands of vehicle-miles	*Per-cent*	*Thousands of vehicle-miles*	*Per-cent*	*Thousands of vehicle-miles*	*Per-cent*	*Thousands of vehicle-miles*
Alabama	575, 746	86. 2	496, 587	12. 4	71, 127	1. 4	8, 032
Arizona	199, 955	82. 4	164, 648	13. 6	27, 278	4. 0	8, 029
California	1, 743, 916	97. 4	1, 699, 661	2. 5	43, 165	. 1	1, 090
Colorado	453, 015	82. 3	373, 115	17. 2	77, 707	. 5	2, 193
Florida	631, 059	86. 7	546, 737	13. 2	83, 407	. 1	915
Idaho	260, 865	87. 6	228, 519	11. 2	29, 132	1. 2	3, 214
Illinois	1, 200, 118	75. 6	906, 692	19. 7	236, 736	4. 7	56, 690
Indiana	1, 187, 582	74. 2	880, 926	17. 1	202, 637	8. 7	104, 019
Iowa	708, 096	82. 2	581, 706	14. 5	102, 684	3. 3	23, 706
Kansas	681, 676	75. 7	516, 313	20. 9	142, 488	3. 4	22, 875
Kentucky	547, 929	77. 8	426, 282	15. 6	85, 306	6. 6	36, 341
Louisiana	447, 498	86. 7	388, 134	12. 4	55, 359	. 9	4. 005
Maryland	502, 062	54. 4	273, 185	35. 6	178, 759	10. 0	50, 118
Massachusetts	664, 673	84. 8	563, 653	14. 2	94, 233	1. 0	6, 787
Michigan	1, 088, 791	90. 1	980, 897	9. 8	107, 263	. 1	631
Minnesota	666, 071	88. 7	590, 847	10. 4	69, 352	. 9	5, 872
Mississippi	772, 682	82. 9	640, 481	13. 5	104, 572	3. 6	27, 629
Missouri	873, 923	76. 8	671, 040	20. 0	174, 951	3. 2	27, 932
Montana	299, 898	90. 9	272, 508	8. 2	24, 654	. 9	2, 736
Nebraska	410, 807	84. 2	345, 849	14. 0	57, 528	1. 8	7, 430
Nevada	75, 497	81. 9	61, 802	12. 2	9, 229	5. 9	4, 466
New Hampshire	146, 501	66. 5	97, 434	24. 4	35, 789	9. 1	13, 278
New Mexico	276, 166	80. 9	223, 381	14. 0	38, 627	5. 1	14, 158
North Carolina	838, 939	77. 1	646, 529	17. 2	144, 516	5. 7	47, 894
North Dakota	142, 025	88. 8	126, 137	9. 3	13, 250	1. 9	2, 638

TABLE 14.—*Vehicle-mileage of trucks and combinations which traveled intrastate, interstate, and transstate on ALL RURAL ROADS in each State in the year 1940*—Continued

State	Total truck travel	Intrastate		Interstate		Transstate	
	Thousands of vehicle-miles	*Per-cent*	*Thousands of vehicle-miles*	*Per-cent*	*Thousands of vehicle-miles*	*Per-cent*	*Thousands of vehicle-miles*
Ohio	1, 365, 712	77. 7	1, 061, 515	18. 0	245, 091	4. 3	59, 106
Oklahoma	694, 743	79. 2	550, 289	18. 9	131, 019	1. 9	13, 435
Oregon	329, 529	91. 1	300, 219	7. 9	26, 011	1. 0	3. 299
Pennsylvania	1, 421, 912	82. 0	1, 165, 947	15. 2	216, 280	2. 8	39, 685
Rhode Island	64, 243	65. 4	42, 033	29. 0	18, 593	5. 6	3, 617
South Carolina	481, 960	70. 4	339, 563	19. 5	93, 841	10. 1	48, 556
South Dakota	247, 320	82. 6	204, 365	16. 8	41, 434	. 6	1, 521
Tennessee	612, 204	83. 9	513, 635	13. 2	80, 891	2. 9	17, 678
Texas	1, 980, 100	93. 9	1, 858, 928	5. 7	114, 050	. 4	7, 122
Utah	159, 653	91. 3	145, 746	7. 8	12, 468	. 9	1, 439
Vermont	108, 350	80. 0	86, 720	17. 9	19, 411	2. 1	2, 219
Virginia	752, 422	70. 4	529, 522	21. 0	158, 243	8. 6	64, 657
Washington	493, 280	90. 7	447, 190	8. 7	42, 955	. 6	3, 135
West Virginia	390, 831	82. 6	322, 926	14. 4	56, 201	3. 0	11, 704
Wisconsin	797, 386	87. 6	698, 096	10. 6	84, 692	1. 8	14, 598
Wyoming	150. 627	70. 7	106, 541	20. 0	30, 160	9. 3	13, 926
Subtotal	25, 445, 762	82. 8	21, 076, 298	14. 1	3, 581, 089	3. 1	788, 375
Other States [1]	4, 404, 539	75. 9	3, 343, 647	19. 7	866, 990	4. 4	193, 902
Totals and averages	29, 850, 301	81. 8	24, 419, 945	14. 9	4, 448, 079	3. 3	982, 277

[1] Includes Arkansas, Connecticut, Delaware, Georgia, Maine, New Jersey, and New York.

TABLE 15.—*Percentage loaded, average weight of load and ton-mileage of load carried by trucks and combinations intrastate, interstate, and transstate on MAIN RURAL ROADS in each State in the year 1940*

State	Intrastate: Percentage loaded	Intrastate: Carried load: Average weight	Intrastate: Carried load: Ton-miles	Intrastate: Carried load: Percentage of State total	Interstate: Percentage loaded	Interstate: Carried load: Average weight	Interstate: Carried load: Ton-miles	Interstate: Carried load: Percentage of State total	Transstate: Percentage loaded	Transstate: Carried load: Average weight	Transstate: Carried load: Ton-miles	Transstate: Carried load: Percentage of State total	Total ton-miles
		Tons	*Thousands*			*Tons*	*Thousands*			*Tons*	*Thousands*		*Thousands*
Alabama	56. 2	2. 63	338, 939	66. 1	68. 6	3. 71	155, 584	30. 3	70. 4	3. 36	18, 361	3. 6	512, 884
Arizona	55. 4	2. 54	117, 513	36. 6	82. 5	8. 26	164, 674	51. 4	75. 0	6. 52	38, 433	12. 0	320, 620
California	71. 7	5. 25	3, 948, 330	93. 1	87. 0	8. 53	291, 136	6. 8	79. 8	2. 06	1, 791	. 1	4, 241, 257
Colorado	66. 5	2. 39	458, 967	66. 3	76. 0	4. 06	230, 237	33. 3	92. 6	1. 49	3, 019	. 4	692, 223
Florida	47. 6	3. 60	645, 993	74. 3	59. 1	4. 78	220, 928	25. 4	69. 7	3. 75	2, 389	. 3	869, 310
Idaho	58. 3	1. 96	161, 838	72. 1	74. 8	3. 31	57, 930	25. 8	85. 8	1. 80	4, 678	2. 1	224, 446
Illinois	60. 7	3. 04	1, 053, 649	48. 7	76. 2	5. 01	842, 889	39. 0	78. 8	6. 05	266, 809	12. 3	2, 163, 347
Indiana	67. 4	2. 69	910, 169	38. 6	73. 2	5. 57	780, 499	33. 1	85. 8	7. 48	665, 495	28. 3	2, 356, 163
Iowa	66. 9	2. 47	580, 470	56. 5	80. 5	4. 08	311, 165	30. 3	90. 7	6. 39	135, 861	13. 2	1, 027, 496
Kansas	58. 8	3. 10	467, 984	51. 1	65. 5	4. 59	382, 008	41. 7	78. 4	3. 79	66, 354	7. 2	916, 346
Kentucky	62. 5	2. 15	391, 986	48. 9	80. 3	3. 55	229, 122	28. 6	90. 1	5. 56	179, 787	22. 5	800, 895
Louisiana	55. 9	2. 71	351, 726	74. 2	72. 0	3. 08	111, 809	23. 6	71. 5	3. 72	10, 655	2. 2	474, 190
Maryland	65. 0	2. 93	392, 661	35. 8	70. 7	3. 93	481, 734	43. 9	77. 1	5. 82	223, 377	20. 3	1, 097, 772
Massachusetts	70. 4	2. 49	444, 594	51. 5	82. 6	5. 80	386, 528	44. 8	83. 5	5. 93	31, 963	3. 7	863, 085
Michigan	66. 2	3. 08	1, 351, 295	75. 0	88. 3	5. 13	448, 804	24. 9	77. 7	2. 74	650	. 1	1, 800, 749
Minnesota	69. 5	2. 73	692, 452	78. 2	71. 5	3. 96	180, 875	20. 4	77. 9	2. 72	11, 946	1. 4	885, 273
Mississippi	57. 6	2. 21	520, 642	68. 6	71. 3	2. 51	173, 477	22. 9	78. 5	3. 03	64, 612	8. 5	758, 731
Missouri	59. 2	2. 59	764, 324	53. 0	71. 8	4. 71	565, 774	39. 3	67. 5	5. 95	111, 350	7. 7	1, 441, 448
Montana	49. 3	3. 06	238, 177	70. 7	64. 0	6. 06	85, 524	25. 4	85. 0	5. 64	13, 097	3. 9	336, 798
Nebraska	67. 3	2. 37	311, 114	63. 6	71. 7	3. 96	148, 815	30. 4	81. 8	5. 08	29, 578	6. 0	489, 507
Nevada	57. 9	2. 90	62, 094	52. 0	77. 1	4. 27	25, 999	21. 8	92. 0	7. 67	31, 340	26. 2	119, 433
New Hampshire	67. 4	2. 19	84, 050	42. 4	81. 2	3. 07	70, 445	35. 5	87. 4	4. 09	43, 948	22. 1	198, 443
New Mexico	54. 3	2. 43	149, 407	51. 1	72. 8	3. 43	90, 475	30. 9	85. 4	4. 39	52, 737	18. 0	292, 619
North Carolina	62. 9	3. 63	1, 125, 740	64. 6	74. 5	4. 27	441, 285	25. 3	72. 1	5. 46	175, 746	10. 1	1, 742, 771
North Dakota	65. 3	3. 13	166, 154	79. 7	76. 3	3. 44	31, 968	15. 3	91. 1	4. 42	10, 436	5. 0	208, 558
Ohio	57. 4	3. 85	1, 541, 220	47. 9	73. 6	7. 31	1, 255, 221	39. 1	82. 2	8. 73	418, 676	13. 0	3, 215, 117
Oklahoma	57. 3	2. 96	601, 864	62. 3	65. 5	4. 04	322, 818	33. 4	70. 5	4. 39	40, 926	4. 3	965, 608
Pennsylvania	65. 4	2. 75	1, 476, 958	66. 2	71. 0	4. 25	616, 297	27. 6	78. 6	4. 48	138, 545	6. 2	2, 231, 800
Rhode Island	61. 7	1. 80	35, 174	37. 6	70. 9	3. 52	44, 717	47. 8	76. 1	5. 28	13, 641	14. 6	93, 532
South Carolina	62. 9	3. 48	516, 346	53. 3	70. 5	4. 44	280, 528	29. 0	72. 6	4. 89	171, 204	17. 7	968, 078
South Dakota	61. 9	1. 94	127, 808	61. 3	72. 4	3. 19	78, 111	37. 4	78. 5	2. 48	2, 750	1. 3	208, 669
Tennessee	62. 4	2. 39	437, 474	64. 3	71. 2	3. 65	189, 701	27. 9	75. 5	4. 11	53, 425	7. 8	680, 600
Texas	60. 2	2. 22	1, 751, 276	87. 8	67. 8	3. 21	232, 361	11. 7	79. 9	1. 87	10, 672	. 5	1, 994, 309
Utah	62. 0	2. 79	169, 395	81. 0	79. 5	4. 03	36, 222	17. 3	92. 2	2. 68	3, 549	1. 7	209, 166
Virginia	61. 4	2. 69	608, 490	44. 5	73. 8	4. 61	511, 693	37. 5	82. 3	4. 67	246, 377	18. 0	1, 366, 560
Washington	59. 1	3. 31	596, 687	77. 3	74. 7	5. 40	161, 681	20. 9	72. 0	6. 00	13, 542	1. 8	771, 910
West Virginia	54. 5	2. 16	222, 440	55. 7	82. 9	3. 52	139, 194	34. 9	77. 9	4. 35	37, 730	9. 4	399, 364
Wisconsin	71. 7	2. 59	746, 185	65. 5	87. 1	4. 00	269, 594	23. 6	93. 1	9. 34	124, 282	10. 9	1, 140, 061
Wyoming	52. 9	3. 78	128, 230	50. 8	67. 1	4. 67	87, 445	34. 7	63. 2	4. 22	36, 667	14. 5	252, 342
Subtotal	62. 5	3. 00	24, 689, 815	62. 8	73. 6	4. 61	11, 135, 267	28. 3	80. 0	5. 70	3, 506, 398	8. 9	39, 331, 480
Other States [1]	62. 4	2. 81	4, 024, 558	54. 7	71. 4	4. 38	2, 628, 930	35. 8	75. 6	4. 72	700, 753	9. 5	7, 354, 241
Totals and averages	62. 5	2. 97	28, 714, 373	61. 5	73. 1	4. 57	13, 764, 197	29. 5	79. 1	5. 51	4, 207, 151	9. 0	46, 685, 721

[1] Includes Arkansas, Connecticut, Delaware, Georgia, Maine, New Jersey, New York, Oregon, and Vermont.

TABLE 16.—*Percentage loaded, average weight of load, and ton-mileage of load carried by trucks and combinations intrastate, interstate, and transstate on LOCAL RURAL ROADS in each State in the year 1940*

State	Intrastate				Interstate				Transstate				Total ton-miles
	Percentage loaded	Carried load			Percentage loaded	Carried load			Percentage loaded	Carried load			
		Average weight	Ton-miles	Percentage of State total		Average weight	Ton-miles	Percentage of State total		Average weight	Ton-miles	Percentage of State total	
		Tons	*Thousands*			*Tons*	*Thousands*			*Tons*	*Thousands*		*Thousands*
Idaho	59.7	1.60	82,600	87.2	76.6	2.70	11,855	12.5	88.1	1.47	239	0.3	94,694
Indiana	66.6	1.68	423,092	93.4	72.3	3.47	28,446	6.3	84.8	4.67	1,545	.3	453,083
Iowa	69.7	1.63	262,538	93.3	83.8	2.70	17,827	6.3	94.4	4.23	955	.4	281,320
Michigan	67.5	1.50	321,123	94.5	90.1	2.50	18,313	5.4	79.3	1.33	344	.1	339,780
Minnesota	68.7	1.93	299,883	96.4	70.7	2.80	11,017	3.5	77.0	1.92	344	.1	311,244
Nebraska	68.2	1.76	181,859	93.8	72.7	2.95	11,069	5.7	82.9	3.78	983	.5	193,911
Nevada	61.1	2.13	32,296	90.2	80.5	3.13	3,366	9.4	92.8	5.64	141	.4	35,803
New Hampshire	71.3	2.06	59,525	72.9	85.9	2.89	18,600	22.8	92.5	3.86	3,489	4.3	81,614
New Mexico	60.0	2.07	136,842	95.8	80.5	2.92	5,559	3.9	94.4	3.73	400	.3	142,801
Ohio	58.5	2.85	607,966	92.2	75.0	5.42	47,450	7.2	83.8	6.47	4,084	.6	659,500
South Carolina	65.9	2.14	145,936	94.2	73.8	2.73	8,270	5.3	76.0	3.00	739	.5	154,945
South Dakota	63.8	1.73	108,069	86.9	74.6	2.84	16,144	13.0	80.2	2.21	188	.1	124,401
Tennessee	63.5	1.92	269,910	93.8	72.5	2.93	16,588	5.8	77.0	3.31	1,169	.4	287,667
Utah	63.3	2.00	60,341	95.6	81.1	2.88	2,749	4.4	-----	-----	-----	-----	63,090
West Virginia	58.6	1.81	142,274	85.7	89.1	2.95	22,231	13.4	83.7	3.27	1,574	.9	166,079
Wisconsin	72.9	1.66	358,576	95.1	88.6	2.70	17,473	4.6	94.7	3.34	961	.3	377,010
Wyoming	55.5	2.66	62,550	91.9	70.3	3.28	5,182	7.6	66.3	2.97	353	.5	68,085
Subtotal	65.6	1.89	3,555,380	92.6	79.6	3.16	262,139	6.9	85.3	3.80	17,508	.5	3,835,027
Other States [1]	63.4	2.06	7,938,975	93.0	75.0	3.38	565,409	6.6	78.8	3.72	33,212	.4	8,537,596
Totals and averages	63.9	2.01	11,494,355	92.9	76.4	3.31	827,548	6.7	80.8	3.74	50,720	.4	12,372,623

[1] Includes Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Illinois, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Mississippi, Missouri, Montana, New Jersey, New York, North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Vermont, Virginia, and Washington.

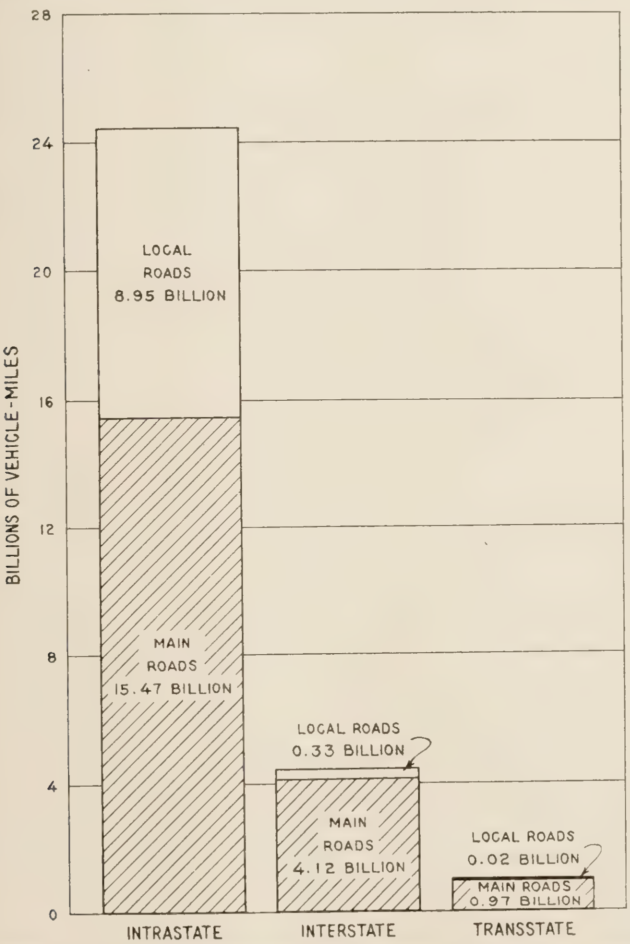


FIGURE 11.—VEHICLE-MILES OF TRUCKS TRAVELING INTRASTATE, INTERSTATE AND TRANSSTATE ON MAIN AND LOCAL RURAL ROADS IN THE YEAR 1940.

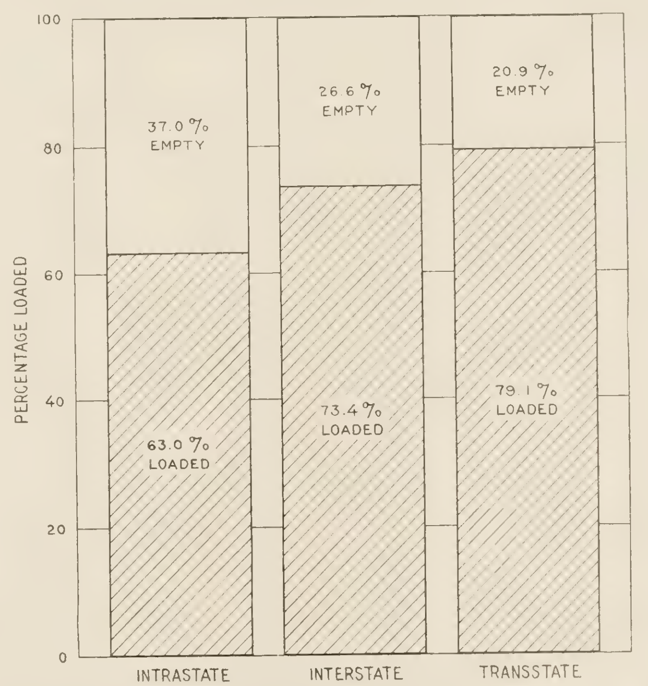


FIGURE 12.—LOADED AND EMPTY TRUCKS AS PERCENTAGES OF TRUCKS TRAVELING INTRASTATE, INTERSTATE, AND TRANSSTATE ON ALL RURAL ROADS IN THE YEAR 1940.

alone. The two classifications combined accounted for 38.5 percent of the ton-miles of hauling on main roads, and for 31.9 percent of that on all rural roads, as shown in tables 15 and 17. A greater proportion of the trucks engaged in hauling between points in different States were loaded and they carried heavier loads, on the average, than those on intrastate trips. This is brought out clearly in figures 12 and 13.

TABLE 17.—*Percentage loaded, average weight of load, and ton-mileage of load carried by trucks and combinations intrastate, interstate, and transstate on ALL RURAL ROADS in each State in the year 1940*

State	Intrastate				Interstate				Transstate				Total ton-miles
	Percentage loaded	Carried load			Percentage loaded	Carried load			Percentage loaded	Carried load			
		Average weight	Ton-miles	Percentage of State total		Average weight	Ton-miles	Percentage of State total		Average weight	Ton-miles	Percentage of State total	
		Tons	*Thousands*			*Tons*	*Thousands*			*Tons*	*Thousands*		*Thousands*
Alabama	57.4	2.38	677,378	77.5	69.0	3.61	177,368	20.3	70.5	3.34	18,926	2.2	873,672
Arizona	57.3	2.41	227,365	50.3	83.2	8.16	185,163	41.0	75.1	6.50	39,223	8.7	451,751
California	71.0	4.23	5,109,097	94.4	86.8	8.14	304,949	5.6	79.8	2.06	1,791	[1] .0	5,415,837
Colorado	66.9	2.30	572,746	70.3			238,487	29.3	92.6	1.49	3,019	.4	814,252
Florida	47.6	3.24	841,859	78.3	59.1	4.68	230,916	21.5	69.7	3.74	2,389	.2	1,075,164
Idaho	58.8	1.82	244,438	76.6	75.1	3.19	69,785	21.9	86.0	1.78	4,917	1.5	319,140
Illinois	61.8	2.72	1,524,689	56.8	76.5	4.47	889,975	33.2	78.8	6.03	269,368	10.0	2,684,032
Indiana	67.1	2.26	1,333,261	47.5	73.2	5.46	808,945	28.8	85.8	7.47	667,040	23.7	2,809,246
Iowa	68.0	2.13	843,008	64.4	80.7	3.97	328,992	25.1	90.7	6.36	136,816	10.5	1,308,816
Kansas	59.8	2.37	732,275	60.6	65.7	4.36	407,922	33.8	78.4	3.75	67,267	5.6	1,207,464
Kentucky	64.0	2.15	586,379	57.9	80.6	3.55	244,125	24.1	90.1	5.56	182,048	18.0	1,012,552
Louisiana	56.8	2.41	530,969	80.2	72.3	3.00	120,204	18.2	71.5	3.72	10,655	1.6	661,828
Maryland	65.7	2.89	517,975	41.8	70.8	3.92	495,980	40.1	77.1	5.81	224,656	18.1	1,238,611
Massachusetts	71.6	2.31	932,559	66.1	83.0	5.69	445,055	31.5	83.6	5.89	33,402	2.4	1,411,016
Michigan	66.6	2.56	1,672,418	78.1	88.5	4.92	467,117	21.8	78.4	2.01	994	.1	2,140,529
Minnesota	69.2	2.43	992,335	82.9	71.5	3.97	191,892	16.1	77.8	2.69	12,290	1.0	1,196,517
Mississippi	58.6	1.97	737,579	74.8	71.6	2.45	183,580	18.6	78.6	3.01	65,453	6.6	986,612
Missouri	59.4	2.45	976,372	58.3	71.8	4.67	586,810	35.0	67.5	5.94	111,934	6.7	1,675,116
Montana	49.7	2.77	374,828	77.9	64.1	5.91	93,425	19.4	84.9	5.64	13,097	2.7	481,350
Nebraska	67.7	2.10	492,973	72.1	71.8	3.87	159,884	23.4	81.8	5.03	30,561	4.5	683,418
Nevada	59.2	2.58	94,390	60.8	77.6	4.10	29,365	18.9	92.1	7.66	31,481	20.3	155,236
New Hampshire	69.0	2.13	143,575	51.3	82.2	3.03	89,045	31.8	87.8	4.07	47,437	16.9	280,057
New Mexico	57.1	2.24	286,249	65.7	75.9	3.28	96,034	22.1	85.5	4.39	53,137	12.2	435,420
North Carolina	63.1	3.27	1,333,095	67.7	74.6	4.20	452,302	23.0	72.1	5.36	183,322	9.3	1,968,719
North Dakota	65.5	2.84	234,960	84.0	76.3	3.37	34,050	12.2	91.1	4.40	10,574	3.8	279,584
Ohio	57.8	3.50	2,149,186	55.5	73.6	7.22	1,302,671	33.6	82.2	8.70	422,760	10.9	3,874,617
Oklahoma	56.9	2.54	796,551	67.8	65.4	3.93	336,811	28.7	70.4	4.36	41,299	3.5	1,174,661
Pennsylvania	65.7	2.55	1,953,180	71.4	71.1	4.19	644,448	23.5	58.7	4.47	139,511	5.1	2,737,139
Rhode Island	62.4	1.78	46,727	43.4	71.0	3.51	46,411	43.1	76.3	5.27	14,548	13.5	107,686
South Carolina	63.8	3.06	662,282	59.0	70.6	4.36	288,798	25.7	72.6	4.87	171,943	15.3	1,123,023
South Dakota	62.8	1.84	235,877	70.8	72.8	3.12	94,255	28.3	78.6	2.46	2,938	.9	333,070
Tennessee	63.0	2.19	707,384	73.1	71.3	3.58	206,289	21.3	75.6	4.09	54,594	5.6	968,267
Texas	60.1	2.02	2,254,332	89.9	67.8	3.15	243,151	9.7	79.9	1.87	10,672	.4	2,508,155
Utah	62.4	2.53	229,736	84.4	79.7	3.92	38,971	14.3	92.1	2.68	3,549	1.3	272,256
Virginia	62.6	2.51	830,867	51.5	74.0	4.56	533,850	33.1	82.3	4.66	248,010	15.4	1,612,727
Washington	59.3	2.96	785,652	81.1	74.8	5.28	169,636	17.5	72.0	6.00	13,542	1.4	968,830
West Virginia	56.2	2.01	364,714	64.5	83.9	3.43	161,425	28.5	78.2	4.29	39,304	7.0	565,443
Wisconsin	72.2	2.19	1,104,761	72.8	87.3	3.88	287,067	18.9	93.1	9.21	125,243	8.3	1,517,071
Wyoming	53.9	3.32	190,780	59.5	67.3	4.56	92,627	28.9	63.2	5.20	37,020	11.6	320,427
Subtotal	63.0	2.64	34,324,801	69.1	58.5	5.69	11,777,780	23.7	78.6	5.67	3,546,730	7.2	49,649,311
Other States [2]	63.2	2.49	5,883,927	62.5	71.7	4.31	2,813,965	29.9	81.2	4.71	711,141	7.6	9,409,033
Totals and averages	63.0	2.61	40,208,728	68.1	73.4	4.47	14,591,745	24.7	79.1	5.48	4,257,871	7.2	59,058,344

[1] Less than 0.05 percent.
[2] Includes Arkansas, Connecticut, Delaware, Georgia, Maine, New Jersey, New York, Oregon, and Vermont.

EXTENT OF TRIPS INDICATED BY NUMBER OF COUNTIES

In 17 States, studies were made on the basis of the number of counties into which a trip extended, and table 18 is based on these studies. County size varies considerably in different sections of the country and to aid in interpreting the table in terms of trip length, the average county area is shown for each of the States. In Nevada, in which counties average 6,458 square miles in area, or about 80 miles square, a trip within one county might be long compared to a trip within a county in Indiana where counties average only 394 square miles, or about 20 miles square. However, towns and railroads are so much farther apart in the west that longer distances must be traveled to get to town, or to a railroad station, and the average trip within a county would still be classed as relatively short in States like Nevada.

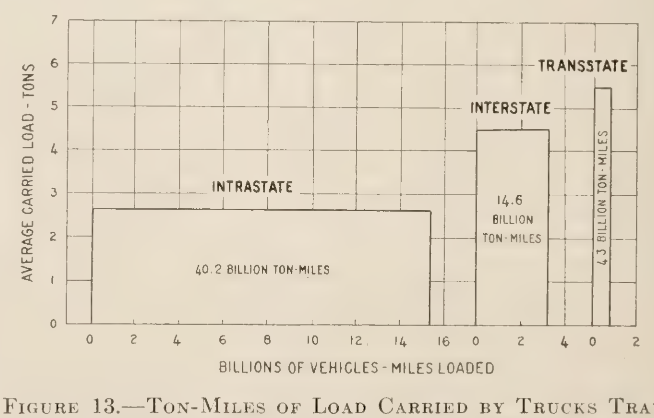


FIGURE 13.—TON-MILES OF LOAD CARRIED BY TRUCKS TRAVELING INTRASTATE, INTERSTATE, AND TRANSSTATE ON ALL RURAL ROADS IN THE YEAR 1940.

Table 18.—*Vehicle-mileage traveled by trucks and combinations making trips extending into one county only, two counties, and three or more counties on MAIN AND ON LOCAL RURAL ROADS in each of 17 States*

State	Total truck travel	Trips requiring travel in— One county		Two counties		Three or more counties		Average area of a county
	Thousands of vehicle-miles	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*	*Percent*	*Thousands of vehicle-miles*	*Square miles*
MAIN RURAL ROADS								
Idaho	168, 295	46. 6	78, 425	22. 7	38, 203	30. 7	51, 667	1, 882
Indiana	797, 144	20. 6	164, 212	20. 9	166, 603	58. 5	466, 329	394
Iowa	469, 331	24. 6	115, 456	21. 7	101, 845	53. 7	252, 030	566
Michigan	763, 041	28. 6	218, 230	38. 6	294, 534	32. 8	250, 277	687
Minnesota	433, 872	42. 0	182, 227	29. 2	126, 690	28. 8	124, 955	920
Nebraska	254, 168	20. 9	53, 223	17. 8	45, 166	61. 3	155, 779	824
Nevada	49, 341	52. 9	26, 101	30. 0	14, 802	17. 1	8, 438	6, 458
New Hampshire	97, 620	32. 2	31, 434	22. 4	21, 867	45. 4	44, 319	902
New Mexico	163, 318	44. 6	72, 840	16. 7	27, 274	38. 7	63, 204	3, 920
Ohio	989, 042	22. 7	224, 513	21. 7	214, 622	55. 6	549, 907	467
Oregon	235, 643	48. 6	114, 522	28. 7	67, 630	22. 7	53, 491	2, 676
South Carolina	373, 895	23. 0	85, 996	32. 9	123, 011	44. 1	164, 888	665
South Dakota	141, 482	31. 0	43, 859	23. 5	33, 249	45. 5	64, 374	1, 109
Tennessee	382, 650	25. 1	96, 045	24. 8	94, 897	50. 1	191, 708	763
Utah	110, 714	36. 5	40, 411	27. 4	30, 335	36. 1	39, 968	2, 840
West Virginia	247, 328	37. 6	92, 995	28. 6	70, 736	33. 8	83, 597	438
Wisconsin	492, 893	31. 6	155, 656	23. 5	115, 780	44. 9	221, 457	771
Totals and averages	6, 169, 777	29. 1	1, 796, 145	25. 7	1, 587, 244	45. 2	2, 786, 388	1, 071
LOCAL RURAL ROADS								
Idaho	92, 570	76. 3	70, 631	16. 9	15, 644	6. 8	6, 295	1, 882
Indiana	390, 438	65. 6	256, 127	27. 2	106, 200	7. 2	28, 111	394
Iowa	238, 765	65. 3	155, 913	23. 9	57, 065	10. 8	25, 787	566
Michigan	325, 750	68. 1	221, 836	24. 4	79, 483	7. 5	24, 431	687
Minnesota	232, 199	72. 9	169, 273	23. 4	54, 334	3. 7	8, 592	920
Nebraska	156, 639	68. 5	107, 376	19. 9	31, 171	11. 6	18, 092	824
Nevada	26, 156	88. 6	23, 174	7. 8	2, 040	3. 6	942	6, 458
New Hampshire	48, 881	65. 0	31, 773	20. 6	10, 069	14. 4	7, 039	902
New Mexico	112, 848	81. 6	92, 084	16. 2	18, 281	2. 2	2, 483	3, 920
Ohio	376, 670	64. 5	242, 952	26. 8	100, 948	8. 7	32, 770	467
Oregon	93, 886	79. 9	75, 015	17. 1	16, 054	3. 0	2, 817	2, 676
South Carolina	108, 065	72. 8	78, 671	22. 1	23, 883	5. 1	5, 511	665
South Dakota	105, 838	67. 3	71, 229	20. 1	21, 273	12. 6	13, 336	1, 109
Tennessee	229, 554	68. 7	157, 704	21. 7	49, 813	9. 6	22, 037	763
Utah	48, 939	80. 6	39, 445	14. 6	7, 145	4. 8	2, 349	2, 840
West Virginia	143, 503	72. 0	103, 322	21. 8	31, 283	6. 2	8, 898	438
Wisconsin	304, 493	69. 7	212, 232	24. 4	74, 296	5. 9	17, 965	771
Totals and averages	3, 035, 194	69. 5	2, 108, 757	23. 0	698, 982	7. 5	227, 455	1, 071
ALL RURAL ROADS								
Idaho	260, 865	57. 1	149, 056	20. 7	53, 847	22. 2	57, 962	1, 882
Indiana	1, 187, 582	35. 4	420, 339	23. 0	272, 803	41. 6	494, 440	394
Iowa	708, 096	38. 3	271, 369	22. 5	158, 910	39. 2	277, 817	566
Michigan	1, 088, 791	40. 4	440, 066	34. 4	374, 017	25. 2	274, 708	687
Minnesota	666, 071	52. 8	351, 500	27. 2	181, 024	20. 0	133, 547	920
Nebraska	410, 807	39. 1	160, 599	18. 6	76, 337	42. 3	173, 871	824
Nevada	75, 497	65. 3	49, 275	22. 3	16, 842	12. 4	9, 380	6, 458
New Hampshire	146, 501	43. 1	63, 207	21. 9	31, 936	35. 0	51, 358	902
New Mexico	276, 166	59. 7	164, 924	16. 5	45, 555	23. 8	65, 687	3, 920
Ohio	1, 365, 712	34. 2	467, 465	23. 1	315, 570	42. 7	582, 677	467
Oregon	329, 529	57. 5	189, 537	25. 4	83, 684	17. 1	56, 308	2, 676
South Carolina	481, 960	34. 2	164, 667	30. 5	146, 894	35. 3	170, 399	665
South Dakota	247, 320	46. 5	115, 088	22. 1	54, 522	31. 4	77, 710	1, 109
Tennessee	612, 204	41. 5	253, 749	23. 6	144, 710	34. 9	213, 745	763
Utah	159, 653	50. 0	79, 856	23. 5	37, 480	26. 5	42, 317	2, 840
West Virginia	390, 831	50. 2	196, 317	26. 1	102, 019	23. 7	92, 495	438
Wisconsin	797, 386	46. 2	367, 888	23. 8	190, 076	30. 0	239, 422	771
Totals and averages	9, 204, 971	42. 4	3, 904, 902	24. 8	2, 286, 226	32. 8	3, 013, 843	1, 071

It is difficult to interpret data on trips requiring travel in two counties in terms of trip length because they may be very short trips from farms in one county to a town just across the county line, or they may extend almost across the two counties. The most that can be said about them is that they cannot be longer than the distance across two counties. Most of the trips requiring travel in three or more counties are probably relatively long, though there are exceptional cases where short trips cut across a corner or narrow neck of a county to a third county.

Interpreting figure 14 in such terms, it may be said that, on all rural roads in the 17 States in which a study was made of trip extent in terms of numbers of counties traversed, about 42 percent of the truck-mileage was on short trips, about 33 percent was on long trips, and the remaining 25 percent was in part on short trips and in part on moderately long trips. On main roads, corresponding percentages would be 29 percent, 45 percent, and 26 percent for the short, long, and short or moderately long classifications, respectively. Such interpretations are perhaps more en-

TABLE 19.—*Percentage of vehicles loaded, average weight of load, and ton-mileage of load carried by trucks and combinations on trips requiring travel in one county only, two counties, and three or more counties on MAIN RURAL ROADS in each of 16 States*

State	Trips requiring travel in—												Total ton-miles
	One county				Two counties				Three or more counties				
	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Carried load: Percentage of State total	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Carried load: Percentage of State total	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Carried load: Percentage of State total	
		Tons	*Thousands*			*Tons*	*Thousands*			*Tons*	*Thousands*		*Thousands*
Idaho	53.8	1.32	55,834	24.9	63.5	2.50	60,664	27.0	70.5	2.96	107,948	48.1	224,446
Indiana	66.0	1.40	152,307	6.5	67.7	2.82	317,948	13.5	74.3	5.44	1,885,908	80.0	2,356,163
Iowa	62.2	1.99	142,990	13.9	66.8	2.44	165,860	16.2	76.5	3.73	718,646	69.9	1,027,496
Michigan	51.6	1.59	179,450	10.0	68.6	3.06	618,026	34.3	84.7	4.73	1,003,273	55.7	1,800,749
Minnesota	69.0	2.14	269,364	30.4	70.1	3.21	284,621	32.2	71.3	3.72	331,288	37.4	885,273
Nebraska	66.1	1.80	63,130	12.9	67.0	2.22	67,084	13.7	70.0	3.29	359,293	73.4	489,507
Nevada	53.3	2.79	38,796	32.5	72.5	3.44	36,942	30.9	82.7	6.26	43,695	36.6	119,433
New Hampshire	63.0	2.04	40,491	20.4	73.1	2.37	37,919	19.1	82.1	3.30	120,033	60.5	198,443
New Mexico	49.9	2.21	80,234	27.4	61.6	2.73	45,913	15.7	73.8	3.57	166,472	56.9	292,619
Ohio	50.0	2.16	242,649	7.5	57.8	3.83	474,902	14.8	69.7	6.51	2,497,566	77.7	3,215,117
South Carolina	59.5	3.01	154,126	15.9	66.3	3.93	320,352	33.1	69.1	4.33	493,600	51.0	968,078
South Dakota	58.3	1.22	31,165	14.9	63.7	2.23	47,194	22.6	69.3	2.92	130,310	62.5	208,669
Tennessee	58.5	1.71	97,931	14.4	62.6	2.38	141,546	20.8	69.0	3.34	441,123	64.8	680,600
Utah	55.0	1.99	44,164	21.1	64.1	2.91	56,613	27.1	73.6	3.69	108,389	51.8	209,166
West Virginia	40.4	1.57	59,032	14.8	66.3	2.46	115,273	28.8	79.6	3.38	225,059	56.4	399,364
Wisconsin	63.7	1.82	180,481	15.8	72.6	2.56	215,561	18.9	83.7	4.02	744,019	65.3	1,140,061
Totals and averages	57.7	1.89	1,832,144	12.9	66.2	2.99	3,006,418	21.1	74.3	4.62	9,376,622	66.0	14,215,184

TABLE 20.—*Percentage of vehicles loaded, average weight of load, and ton-mileage of load carried by trucks and combinations on trips requiring travel in one county only, two counties, and three or more counties on LOCAL RURAL ROADS in each of 16 States*

State	Trips requiring travel in—												Total ton-miles
	One county				Two counties				Three or more counties				
	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Carried load: Percentage of State total	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Carried load: Percentage of State total	Percentage loaded	Carried load: Average weight	Carried load: Ton-miles	Carried load: Percentage of State total	
		Tons	*Thousands*			*Tons*	*Thousands*			*Tons*	*Thousands*		*Thousands*
Idaho	58.2	1.40	57,559	60.8	67.2	2.42	25,442	26.9	73.5	2.53	11,693	12.3	94,694
Indiana	65.0	1.38	230,426	50.9	69.6	2.25	166,053	36.6	71.8	2.80	56,594	12.5	453,083
Iowa	67.3	1.41	147,539	52.5	74.3	2.03	85,857	30.5	78.1	2.38	47,924	17.0	281,320
Michigan	60.6	1.18	158,650	46.7	82.5	1.97	128,932	37.9	89.0	2.40	52,198	15.4	339,780
Minnesota	68.4	1.70	196,441	63.1	69.6	2.59	97,878	31.5	70.3	2.80	16,925	5.4	311,244
Nebraska	67.8	1.54	111,962	57.7	69.2	2.27	48,890	25.2	70.7	2.58	33,059	17.1	193,911
Nevada	60.2	2.08	28,955	80.9	76.9	2.83	4,435	12.4	80.9	3.17	2,413	6.7	35,803
New Hampshire	69.0	1.96	42,883	52.5	80.9	2.50	20,359	25.0	86.6	3.01	18,372	22.5	81,614
New Mexico	59.9	1.97	108,566	76.0	63.4	2.58	29,898	20.9	62.2	2.81	4,337	3.1	142,801
Ohio	54.1	2.11	277,900	42.1	65.6	3.96	265,605	40.4	72.0	4.87	114,995	17.5	659,500
South Carolina	64.6	2.03	103,383	65.7	70.0	2.46	41,068	26.5	72.0	2.64	10,494	6.8	154,945
South Dakota	61.5	1.38	60,734	48.8	69.9	2.48	36,878	29.7	73.0	2.75	26,789	21.5	124,401
Tennessee	61.3	1.66	160,213	55.7	68.6	2.45	83,823	29.1	71.3	2.78	43,631	15.2	287,667
Utah	60.5	1.83	43,719	69.3	76.4	2.61	14,224	22.5	79.0	2.77	5,147	8.2	63,090
West Virginia	51.7	1.53	81,459	49.0	81.7	2.44	62,446	37.6	87.8	2.84	22,174	13.4	166,079
Wisconsin	70.1	1.54	229,088	60.8	80.0	1.92	114,185	30.3	84.3	2.22	33,737	8.9	377,010
Totals and averages	62.7	1.60	2,039,477	54.1	72.7	2.47	1,225,983	32.6	75.5	2.91	500,482	13.3	3,765,942

lightening when made on a State-by-State rather than on a national basis. The estimates for individual States are shown in table 18.

Separate values for percentage of trucks loaded and average carried load, classed according to number of counties in which the travel occurred were not directly available, because such basis of classifications was not used at the stations at which trucks were weighed. However, tables 15, 16, and 17 show that both the percentage of trucks loaded and the average carried load were greatest for transstate trips, next greatest for interstate trips, and least for intrastate trips. It is reasonable to assume that, within each of these classifications, the percentage of trucks loaded and the average carried load increased as the extent of trip, in terms of the number of counties in which the travel occurred, increased. Values shown in tables 19, 20, and 21 were estimated from curves plotted on the basis of such an assumption, as explained in the appendix. Figure 15 shows the percentage distribution of ton-mileage according to number of counties in which the travel occurred for main and local roads, separately and combined. Naturally the long-haul classification contains a higher percentage of the ton-mileage than of the vehicle-mileage, because a greater percentage of the trucks traveling long distances are loaded and they weigh more, on the average, than those traveling short distances.

TABLE 21.—*Percentage of vehicles loaded, average weight of load, and ton-mileage of load carried by trucks and combinations on trips requiring travel in one county only, two counties, and three or more counties on ALL RURAL ROADS in each of 16 States*

State	Trips requiring travel in— One county: Percentage loaded	One county: Carried load: Average weight	One county: Carried load: Ton-miles	One county: Carried load: Percentage of State total	Two counties: Percentage loaded	Two counties: Carried load: Average weight	Two counties: Carried load: Ton-miles	Two counties: Carried load: Percentage of State total	Three or more counties: Percentage loaded	Three or more counties: Carried load: Average weight	Three or more counties: Carried load: Ton-miles	Three or more counties: Carried load: Percentage of State total	Total ton-miles
		Tons	*Thousands*			*Tons*	*Thousands*			*Tons*	*Thousands*		*Thousands*
Idaho	55.9	1.36	113,393	35.5	64.6	2.48	86,106	27.0	70.8	2.91	119,641	37.5	319,140
Indiana	65.4	1.39	382,733	13.6	68.4	2.59	484,011	17.2	74.2	5.30	1,942,502	69.2	2,809,246
Iowa	65.1	1.64	290,529	22.2	69.5	2.28	251,717	19.2	76.6	3.60	766,570	58.6	1,308,816
Michigan	56.2	1.37	338,100	15.8	71.6	2.79	746,958	34.9	85.1	4.51	1,055,471	49.3	2,140,529
Minnesota	68.7	1.93	465,805	38.9	69.9	3.02	382,499	32.0	71.2	3.66	348,213	29.1	1,196,517
Nebraska	67.2	1.62	175,092	25.6	67.9	2.24	115,974	17.0	70.1	3.22	392,352	57.4	683,418
Nevada	56.5	2.43	67,751	43.6	73.0	3.36	41,377	26.7	82.5	5.96	46,108	29.7	155,236
New Hampshire	66.0	2.00	83,374	29.8	75.5	2.42	58,278	20.8	82.7	3.26	138,405	49.4	280,057
New Mexico	55.4	2.06	188,800	43.4	62.3	2.66	75,811	17.4	73.4	3.54	170,809	39.2	435,420
Ohio	52.1	2.14	520,549	13.4	60.7	3.87	741,507	19.7	69.9	6.42	2,612,561	67.4	3,874,617
South Carolina	61.9	2.53	257,509	22.9	66.9	3.67	361,420	32.2	69.2	4.27	504,094	44.9	1,123,023
South Dakota	60.3	1.33	91,899	27.6	66.1	2.33	84,072	25.2	70.0	2.89	157,099	47.2	333,070
Tennessee	60.2	1.69	258,144	26.7	64.7	2.41	225,369	23.3	69.2	3.28	484,754	50.0	968,267
Utah	57.7	1.91	87,883	32.3	66.4	2.85	70,837	26.0	73.8	3.63	113,536	41.7	272,256
West Virginia	46.4	1.54	140,491	24.9	71.0	2.45	177,719	31.4	80.4	3.33	247,233	43.7	565,443
Wisconsin	67.3	1.65	409,569	27.0	75.5	2.30	329,746	21.7	83.7	3.88	777,756	51.3	1,517,071
Totals and averages	60.4	1.72	3,871,621	21.5	68.2	2.82	4,233,401	23.6	74.5	4.48	9,877,104	54.9	17,982,126

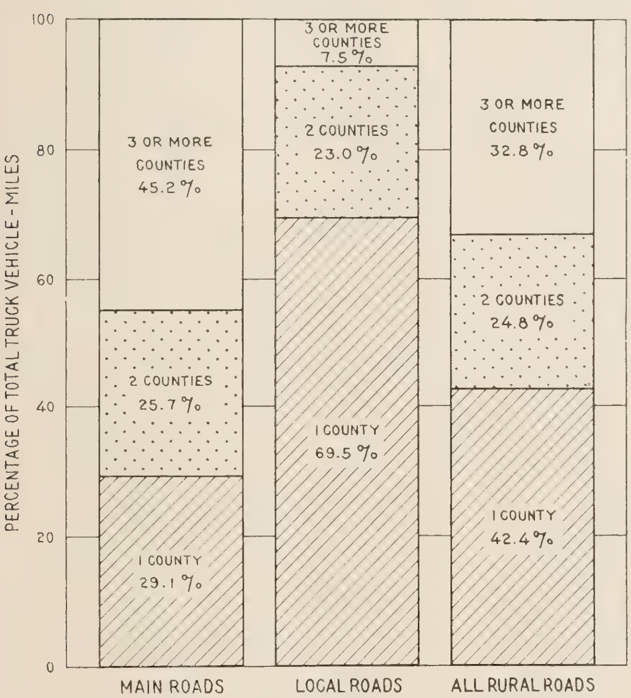


FIGURE 14.—PERCENTAGE DISTRIBUTION OF VEHICLE-MILES OF TRUCKS ON THE BASIS OF TRIP EXTENT IN TERMS OF NUMBER OF COUNTIES INVOLVED ON MAIN AND LOCAL RURAL ROADS IN 17 STATES IN THE YEAR 1940.

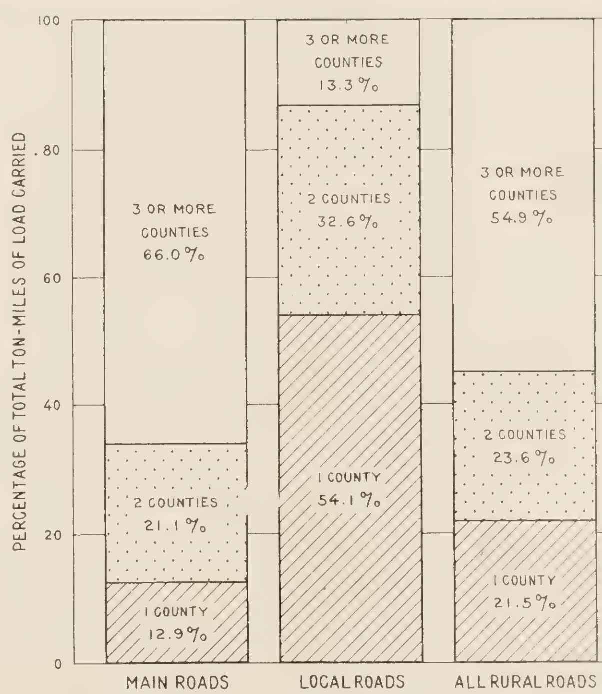


FIGURE 15.—PERCENTAGE DISTRIBUTION OF TON-MILES OF LOAD CARRIED BY TRUCKS ON THE BASIS OF TRIP EXTENT IN TERMS OF NUMBER OF COUNTIES, ON MAIN AND LOCAL ROADS IN 16 STATES IN THE YEAR 1940.

WARTIME TRENDS ESTIMATED

The estimates so far presented have related entirely to the year 1940. Since our entrance into the war, a number of things have happened that have had important effects upon the amount and characteristics of trucking on rural roads. Restrictions have been placed on the purchase of automobiles, tires, and gasoline; legal restrictions on sizes and weights of vehicles have been lifted or relaxed in some States; and regulations have been issued by the Office of Defense Transportation. Changes from a peacetime economy to a wartime economy have involved changes in the kind of materials hauled and in their origins and destinations. Hauling to cantonments and war plants during and after construction has increased to large proportions, while hauling in many other categories has decreased. All of these things have resulted in changes in traffic volumes, in the percentage relations between vehicle types and in the average weight of the load carried.

TABLE 22.—*Estimates by census regions, of 1936, 1940, and 1942 vehicle-mileage by all vehicles, truck vehicle-mileage, percentage loaded, average carried load, and ton-mileage of load hauled on MAIN RURAL ROADS*

Census region	Year	Travel by all vehicles	Percentage of all vehicles	Travel by trucks and combinations	Percentage loaded	Carried load: Average weight	Carried load: Amount	Single-unit trucks: Percentage of all trucks	Travel by single units	Percentage loaded	Carried load: Average weight	Carried load: Amount	Truck combinations: Percentage of all trucks	Travel by combinations	Percentage loaded	Carried load: Average weight	Carried load: Amount
		Thousands of vehicle-miles		*Thousands of vehicle-miles*		*Tons*	*Thousands of ton-miles*		*Thousands of ton-miles*		*Tons*	*Thousands of ton-miles*		*Thousands of ton-miles*		*Tons*	*Thousands of ton-miles*
New England	1936	5, 252, 578	12. 7	665, 157	68. 0	2. 91	1, 314, 315	88. 8	590, 803	66. 6	2. 21	869, 145	11. 2	74, 354	79. 4	7. 54	445, 170
	1940	6, 310, 944	14. 7	926, 387	71. 7	3. 30	2, 194, 376	86. 9	805, 330	70. 6	2. 49	1, 412, 240	13. 1	121, 057	79. 4	8. 14	782, 136
	1942	4, 246, 210	17. 6	746, 171	60. 7	4. 44	2, 010, 824	75. 6	563, 960	55. 2	2. 70	839, 631	24. 4	182, 211	77. 8	8. 26	1, 171, 193
Ratio 1942 to 1940	----	0. 67	1. 20	0. 81	0. 85	1. 35	0. 92	0. 87	0. 70	0. 78	1. 08	0. 59	1. 86	1. 50	0. 98	1. 01	1. 50
Middle Atlantic	1936	13, 090, 754	14. 1	1, 841, 884	62. 6	2. 87	3, 312, 557	84. 4	1, 553, 959	61. 2	1. 99	1, 895, 803	15. 6	287, 925	70. 2	7. 00	1, 416, 754
	1940	15, 809, 923	16. 1	2, 540, 395	65. 9	3. 29	5, 504, 412	81. 9	2, 081, 515	64. 9	2. 27	3, 064, 582	18. 1	458, 880	70. 2	7. 57	2, 439, 830
	1942	12, 053, 622	17. 6	2, 122, 683	53. 0	4. 55	5, 118, 594	73. 9	1, 568, 321	50. 3	2. 83	2, 233, 468	26. 1	554, 362	60. 5	8. 60	2, 885, 126
Ratio 1942 to 1940	----	0. 76	1. 09	0. 84	0. 80	1. 38	0. 93	0. 90	0. 75	0. 78	1. 25	0. 73	1. 44	1. 21	0. 86	1. 14	1. 18
South Atlantic	1936	12, 475, 419	19. 6	2, 449, 370	61. 2	3. 23	4, 836, 079	81. 1	1, 986, 540	59. 2	2. 18	2, 558, 069	18. 9	462, 830	69. 8	7. 05	2, 278, 010
	1940	16, 536, 492	21. 5	3, 563, 118	64. 3	3. 67	8, 416, 522	77. 7	2, 766, 916	62. 8	2. 40	4, 172, 832	22. 3	796, 202	69. 8	7. 64	4, 243, 690
	1942	13, 124, 142	24. 7	3, 241, 733	59. 2	4. 45	8, 547, 979	71. 4	2, 316, 192	56. 7	2. 33	3, 058, 287	28. 6	925, 541	65. 5	9. 06	5, 489, 692
Ratio 1942 to 1940		0. 79	1. 15	0. 91	0. 92	1. 21	1. 02	0. 92	0. 84	0. 90	0. 97	0. 73	1. 28	1. 16	0. 94	1. 19	1. 29
East North Central	1936	17, 943, 461	15. 8	2, 836, 513	64. 9	3. 53	6, 491, 337	72. 6	2, 060, 097	61. 3	1. 95	2, 467, 071	27. 4	776, 416	74. 4	6. 97	4, 024, 266
	1940	22, 155, 069	17. 6	3, 890, 392	67. 9	4. 04	10, 675, 437	68. 4	2, 660, 707	65. 0	2. 19	3, 790, 553	31. 6	1, 229, 685	74. 2	7. 55	6, 884, 884
	1942	19, 112, 499	17. 6	3, 361, 540	60. 4	4. 94	10, 012, 855	61. 7	2, 069, 375	54. 2	2. 40	2, 667, 904	38. 3	1, 292, 165	70. 3	8. 06	7, 344, 951
Ratio 1942 to 1940	----	0. 86	1. 00	0. 86	0. 89	1. 22	0. 94	0. 90	0. 78	0. 83	1. 09	0. 70	1. 21	1. 05	0. 95	1. 07	1. 07
East South Central	1936	5, 699, 938	20. 5	1, 168, 149	60. 2	2. 46	1, 730, 235	91. 5	1, 068, 311	59. 4	2. 14	1, 357, 462	8. 5	99, 838	68. 7	5. 44	372, 773
	1940	7, 241, 058	22. 4	1, 621, 392	63. 5	2. 68	2, 753, 110	90. 0	1, 458, 710	62. 9	2. 28	2, 095, 985	10. 0	162, 682	68. 6	5. 89	657, 125
	1942	6, 607, 466	22. 1	1, 458, 587	48. 4	3. 41	2, 404, 214	85. 3	1, 244, 842	45. 4	2. 41	1, 359, 976	14. 7	213, 745	65. 7	7. 44	1, 044, 238
Ratio 1942 to 1940		0. 91	0. 99	0. 90	0. 76	1. 27	0. 87	0. 95	0. 85	0. 72	1. 06	0. 65	1. 47	1. 31	0. 96	1. 26	1. 59
West North Central	1936	10, 751, 485	18. 1	1, 948, 109	61. 9	2. 81	3, 394, 974	83. 7	1, 629, 707	60. 2	2. 00	1, 955, 831	16. 3	318, 402	71. 0	6. 37	1, 439, 143
	1940	12, 604, 672	19. 8	2, 494, 536	66. 2	3. 13	5, 177, 297	81. 4	2, 029, 965	65. 1	2. 22	2, 930, 359	18. 6	464, 571	71. 2	6. 80	2, 246, 938
	1942	11, 376, 164	19. 9	2, 258, 967	59. 7	3. 47	4, 684, 886	78. 6	1, 776, 127	56. 9	2. 19	2, 192, 422	21. 4	482, 840	70. 0	7. 37	2, 492, 464
Ratio 1942 to 1940	----	0. 90	1. 01	0. 91	0. 90	1. 11	0. 90	0. 97	0. 87	0. 87	0. 99	0. 75	1. 15	1. 04	0. 98	1. 08	1. 11
West South Central	1936	9, 857, 964	19. 1	1, 879, 481	57. 4	2. 28	2, 456, 025	82. 0	1, 541, 603	55. 4	1. 67	1, 426, 580	18. 0	337, 878	66. 9	4. 56	1, 029, 445
	1940	12, 043, 568	21. 5	2, 587, 225	60. 4	2. 58	3, 964, 048	79. 2	2, 048, 629	58. 7	1. 82	2, 188, 694	20. 8	538, 596	66. 9	4. 93	1, 775, 354
	1942	11, 312, 422	20. 6	2, 334, 281	49. 6	3. 45	3, 994, 521	74. 7	1, 744, 700	44. 9	1. 95	1, 523, 190	25. 3	589, 581	63. 6	6. 59	2, 471, 331
Ratio 1942 to 1940	----	0. 94	0. 96	0. 90	0. 83	1. 34	1. 01	0. 94	0. 85	0. 76	1. 07	0. 70	1. 22	1. 09	0. 95	1. 34	1. 39
Mountain	1936	4, 792, 625	19. 5	933, 147	58. 9	2. 70	1, 485, 818	90. 6	845, 217	57. 8	2. 19	1, 070, 646	9. 4	87, 930	69. 4	6. 80	415, 172
	1940	6, 151, 752	20. 5	1, 260, 844	62. 2	3. 12	2, 447, 647	88. 5	1, 115, 824	61. 2	2. 48	1, 691, 767	11. 5	145, 020	69. 7	7. 48	755, 880
	1942	5, 521, 263	20. 3	1, 123, 391	51. 4	4. 20	2, 423, 339	81. 1	910, 569	47. 5	2. 58	1, 115, 530	18. 9	212, 822	68. 1	9. 03	1, 307, 809
Ratio 1942 to 1940	----	0. 90	0. 99	0. 89	0. 83	1. 35	0. 99	0. 92	0. 82	0. 78	1. 04	0. 66	1. 64	1. 47	0. 98	1. 21	1. 73
Pacific	1936	8, 823, 900	14. 4	1, 272, 187	64. 9	4. 29	3, 544, 040	79. 6	1, 012, 878	61. 5	2. 07	1, 287, 756	20. 4	259, 309	78. 0	11. 16	2, 256, 284
	1940	10, 776, 142	15. 5	1, 674, 017	68. 1	4. 87	5, 552, 872	76. 5	1, 280, 211	65. 1	2. 23	1, 859, 789	23. 5	393, 806	77. 9	12. 05	3, 693, 083
	1942	9, 821, 024	16. 3	1, 601, 787	67. 9	6. 22	6, 762, 354	73. 7	1, 181, 114	64. 0	2. 33	1, 756, 838	26. 3	420, 673	79. 0	15. 05	5, 005, 516
Ratio 1942 to 1940	----	0. 91	1. 05	0. 96	1. 00	1. 28	1. 22	0. 96	0. 92	0. 98	1. 04	0. 94	1. 12	1. 07	1. 01	1. 25	1. 36
Total	1936	88, 688, 124	16. 9	14, 993, 997	62. 1	3. 06	28, 565, 380	82. 0	12, 289, 115	59. 9	2. 02	14, 888, 363	18. 0	2, 704, 882	71. 9	7. 03	13, 677, 017
	1940	109, 629, 620	18. 8	20, 558, 306	65. 4	3. 47	46, 685, 721	79. 0	16, 247, 807	63. 7	2. 24	23, 206, 801	21. 0	4, 310, 499	71. 8	7. 58	23, 478, 920
	1942	93, 175, 112	19. 6	18, 249, 140	57. 0	4. 42	45, 959, 566	73. 3	13, 375, 200	52. 9	2. 37	16, 747, 246	26. 7	4, 873, 940	68. 2	8. 79	29, 212, 320
Ratio 1942 to 1940		0. 85	1. 04	0. 89	0. 87	1. 27	0. 98	0. 93	0. 82	0. 83	1. 06	0. 72	1. 27	1. 13	0. 95	1. 16	1. 24

Wartime changes in traffic volume, composition, and weights on main rural roads are shown in table 22 which gives estimates for the years 1936, 1940, and 1942 for each of the census regions of the United States shown in figure 16. The method of preparing the 1940 estimates has been previously described and, in cases where the original survey was made in a year other than 1936, the 1936 estimates were prepared in a similar manner, projecting backwards to 1936 the trends indicated by the best available data for each item. Since the original survey was made in either 1936 or 1937 in all but a few States, only slight adjustments, if any, were generally required to prepare 1936 estimates from the survey year data.

The 1942 estimates are based in part on data from the regular continuing survey operations and in part on the results of a special short survey made in July and August 1942, by 46 State highway departments in cooperation with the Public Roads Administration. The vehicle-mileage by all vehicles was computed on the basis of trends established by 466 automatic traffic recorders operated continuously throughout 1940 and 1942. The truck-mileage was determined on the basis of the trends found to exist in the mid-summer survey, but classification counts in 16 States made at the same 122 stations in all seasons of 1940 and 1942 checked the trend in the United States total almost exactly. These seasonal classification counts were well distributed geographically, but did not give sufficient coverage in any one region to justify a check by regions. The 1942 estimates for the percentage distribution between single-unit trucks and combinations, percentage loaded, and average weight, are based entirely on trends established by comparing data on over 50,000 trucks taken at 486 stations in the 1942 survey with corresponding data taken at the identical locations in a comparable period in the same season of a previous year.

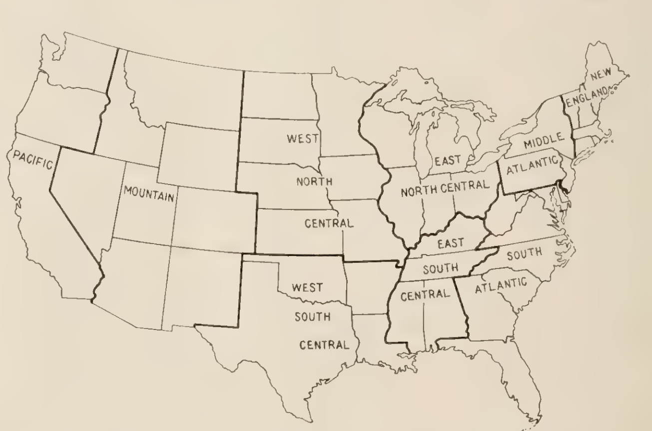


FIGURE 16.—CENSUS REGIONS OF THE UNITED STATES.

Table 22 was limited to data on main roads because of the lack of figures on truck loading on local roads in 1942. However, gasoline consumption figures, automatic traffic recorder data, and classification counts were sufficient to permit the preparation of approximate esti-

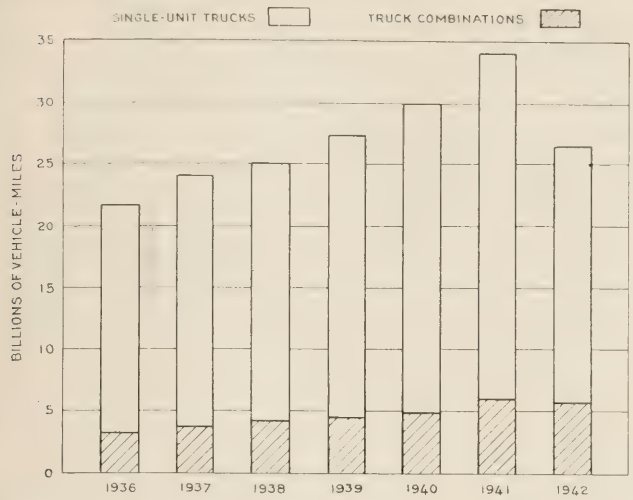


Figure 17.—Estimated Vehicle-Miles of Single-Unit Trucks and of Combinations on All Rural Roads in the United States in Each Year From 1936 to 1942, Inclusive.

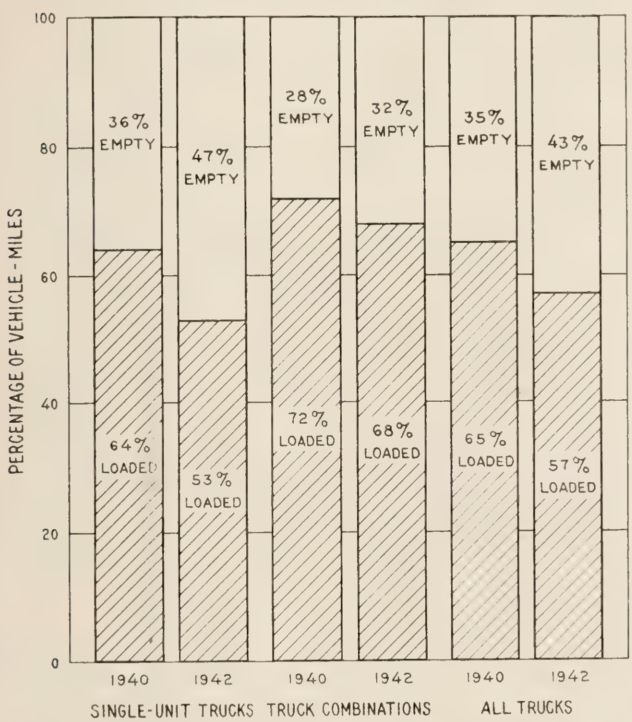


Figure 18.—Comparison of Percentage of Vehicle-Miles Loaded in 1942 With That in 1940, For Single-Unit Trucks and Combinations on Main Rural Roads Throughout the United States.

mates of the mileage traveled by single-unit trucks and by combinations on all rural roads in each year from 1936 to 1942, inclusive. These estimates are presented in figure 17, which is the only figure showing wartime trends which apply to all rural roads. It shows that the mileage of truck travel of all kinds increased steadily from 1936 to 1941, but dropped sharply in 1942, while the mileage of combinations increased steadily from 1936 to 1942 with a slight peak above the trend line in 1941. Throughout this period, the tendency was toward an increased use of combinations, particularly tractor-truck and semitrailer combinations, such as are shown in figure 1, and this tendency increased considerably under war conditions. Table 22 shows that, on main roads, combinations were 18.0 percent

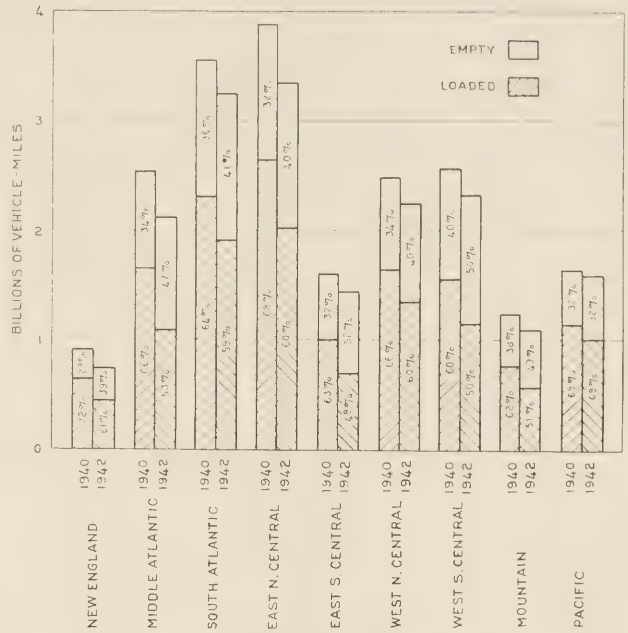


Figure 19.—Comparison of Estimated Vehicle-Miles of Empty Trucks and of Loaded Trucks on Main Rural Roads in 1942 With Those in 1940, in Each Census Region.

of all trucks in 1936, 21.0 percent in 1940, and 26. 7 percent in 1942.

TRAFFIC BY EMPTY TRUCKS INCREASED WHILE THAT BY LOADED TRUCKS DECREASED

One of the surprising facts discovered in the 1942 survey was that the percentages of both single-unit trucks and combinations running empty were higher in 1942 than in previous years, in spite of the efforts of the Office of Defense Transportation to bring about fuller utilization of truck capacity. Figure 18 shows that the percentage of empty single-unit trucks increased to a considerable extent, while the percentage of empty combinations increased to a lesser extent. The number of loaded single-unit trucks using the main rural roads in 1942 was not much greater than the number of empty trucks of this type.

One reason for this relative increase in empty trucks is that trucks hauling materials to construction jobs, or supplies to cantonments, generally cannot obtain return loads. Hauling in these categories increased, while the hauling of goods between cities, a type of hauling in which two-way loads are relatively easy to obtain, decreased. This does not fully explain the very high percentage of empty single-unit trucks, however, which was 50 percent or more in a number of States. It seems probable that there was a considerable use of light trucks to transport people, caused by restrictions on the purchase of new automobiles, tires, and gasoline. Apparently, many farmers and other persons owning both trucks and passenger cars put away their passenger cars and used their trucks for all purposes.

Figure 19 shows the mileage traveled by loaded and empty trucks of all kinds in each census region in 1940 and in 1942. Figures in the bars indicate the percentage of vehicles loaded and the percentage empty, in each case. In all regions, total truck traffic and movement of loaded trucks were less in 1942 than in 1940. In all except the Pacific region, mileage of empty trucks increased, while that of loaded trucks decreased. In the East South Central States the mileage of empty

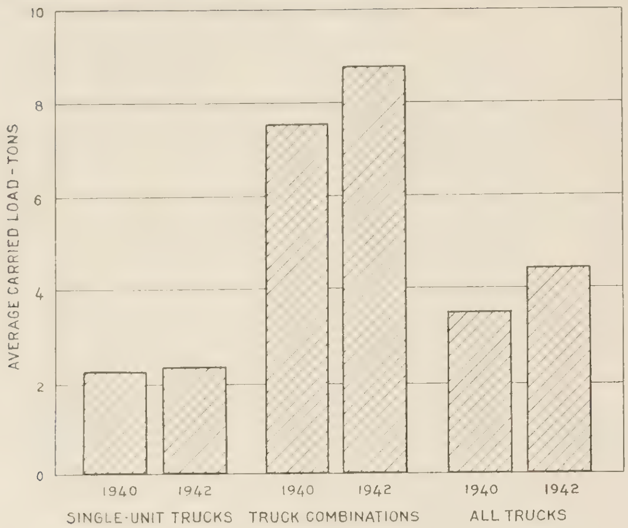


Figure 20.—Comparison of Estimated Average Carried Load of Loaded Single-Unit Trucks and Combinations in 1942 With That in 1940, on Main Rural Roads Throughout the United States.

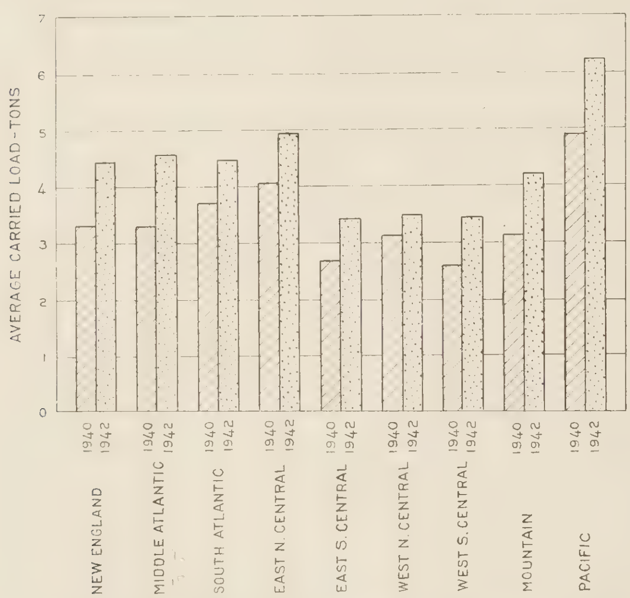


Figure 21.—Comparison of Estimated Average Carried Load of Loaded Trucks in 1942 With That in 1940, on Main Rural Roads in Each Census Region.

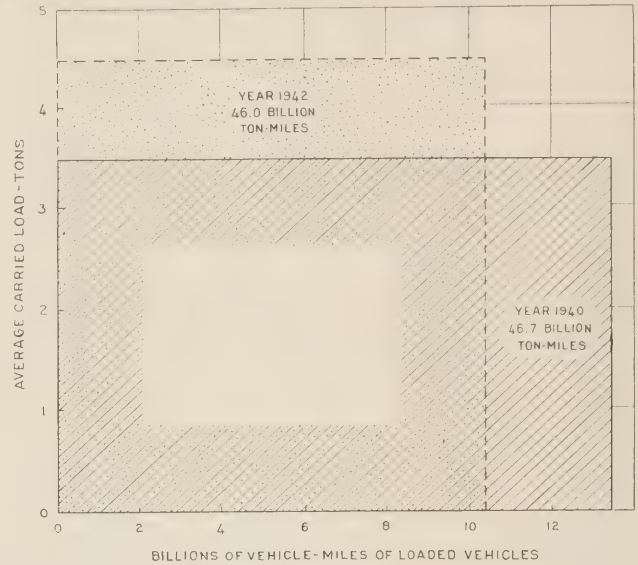


Figure 22.—Comparison of Estimated Ton-Miles in 1942 With Those in 1940, on Main Rural Roads in the United States.

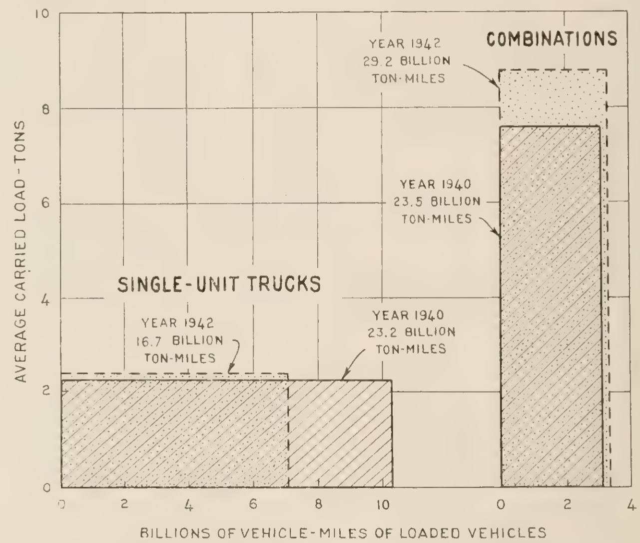


Figure 23.—Comparison of Estimated Ton-Miles Carried by Single-Unit Trucks and By Combinations in 1942 With Those in 1940, on Main Rural Roads in the United States.

trucks actually exceeded that of loaded trucks in 1942, and in the West South Central States the truck traffic was divided equally between empty and loaded vehicles.

SMALLER VEHICLE-MILEAGE OFFSET BY HEAVIER LOADS

Figure 20 shows that the average load carried by loaded vehicles was greater in 1942 than in 1940 for both single-unit trucks and for combinations. Because of the increased proportion of combinations, the average load of loaded vehicles of both types combined increased by a greater percentage than that of either type. This increase in average load took place in all regions, as shown by figure 21.

For main roads in the United States as a whole, the decrease in mileage of loaded vehicles was nearly offset by the increase in carried load so that the ton-mileage was almost as great in 1942 as in 1940. Figure 22 is drawn with the vehicle-mileages of loaded vehicles as abscissas and the average carried loads as ordinates so that ton-mileages are represented by rectangular areas. The rectangle for 1942 is shorter than that for 1940, but is higher by an amount that makes it almost equal in area.

A study of these relations by vehicle type emphasizes the increasing importance of combinations in trucking on main rural roads. Figure 23 is constructed in the same manner as figure 22, but separate ton-mile rectangles are shown for single-unit trucks and for combinations. From 1940 to 1942, the mileage of loaded single-unit trucks decreased considerably and the average carried load increased only slightly with a resultant large loss in ton-mileage by vehicles of this type. On the other hand, both the mileage of loaded vehicles and the average of loads carried by combinations increased and the ton-mileage increased correspondingly. In 1940, the ton-mileage by combinations was about the same as that by single-unit trucks, while in 1942 the

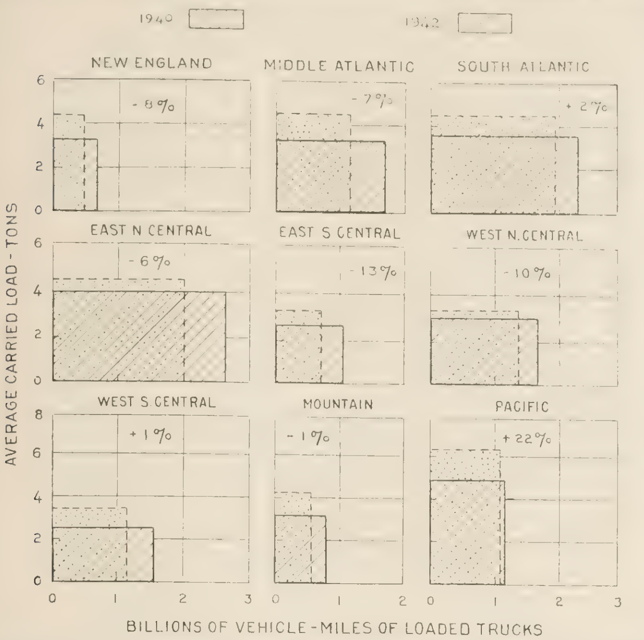


FIGURE 24.—COMPARISON OF ESTIMATED TON-MILES IN 1942 WITH THOSE IN 1940, ON MAIN RURAL ROADS IN EACH CENSUS REGION.

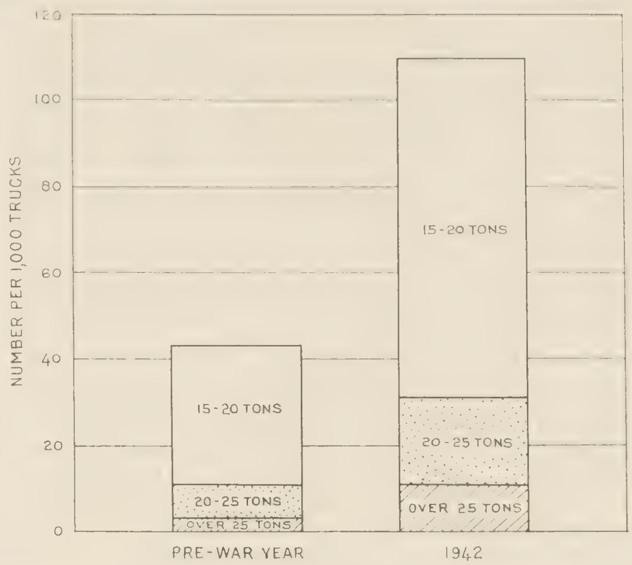


FIGURE 25.—NUMBER OF HEAVY GROSS LOADS PER 1,000 LOADED AND EMPTY TRUCKS IN THE SUMMER OF 1942 AND IN A CORRESPONDING PERIOD OF A PRE-WAR YEAR BETWEEN 1936 AND 1940, ON MAIN RURAL ROADS THROUGHOUT THE UNITED STATES.

combinations carried about 74 percent more than the single-unit trucks.

Figure 24 shows, by means of rectangles, the ton-mileage by all trucks, including combinations, on main rural roads in each census region, in 1940 and 1942. The figures above the rectangles indicate the percentage increase or decrease in ton-mileage from 1940 to 1942. Only in the Pacific region was there a substantial increase. In two of the other regions there was a negligible increase, and in the other six regions there was a decrease.

There is considerable evidence to indicate that the tonnages hauled by large truckers were much greater in 1942 than in 1940. Reports to the Interstate Commerce Commission and to the American Trucking Associations, Inc., tell of increases of this kind. This is not necessarily inconsistent with the conclusion that the ton-mileage by all trucks did not increase from 1940 to 1942. As has already been brought out, the large truckers making periodic reports constitute a very small percentage of the total. It is entirely possible that much of their increased tonnage was diverted from truck owners who preferred to ship by common carrier rather than use their own trucks because of the difficulty in obtaining new vehicles and parts. The fact that both vehicle-mileage and ton-mileage increased for combinations and decreased for single-unit trucks tends to support such a conclusion.

Another fact to be borne in mind is that increased tonnages do not necessarily mean increased ton-mileages, as the average length of haul might be reduced. Shipments normally sent all of the way from origin to destination by truck might, under war conditions, go by truck only to or from the nearest railroad station. Also, some trucks which formerly made long trips between cities may have been diverted to shorter trips between rail or water terminals or sources of supply and construction jobs, cantonments, and war plants.

HEAVY GROSS LOADS AND AXLE LOADS INCREASED IN FREQUENCY

From the point of view of the highway engineer, the frequencies of heavy gross loads, axle loads, and load concentrations are more important than averages, because these are the frequencies of severe stressing of road surfaces and bridges and are the basis for design. It has already been shown that averages of loads carried increased materially between 1940 and 1942, and it is reasonable to assume that the frequency of heavy gross weights increased correspondingly during this period. Available trend data were not sufficient to justify estimates of the frequencies of heavy gross weights and axle loads for the year 1940, so the 1942 frequencies were compared with pre-war averages, determined by averaging data taken in the original survey regardless of the survey year. This combining of data taken in different years in different States, of course, gives only an indication of average conditions existing in the 1936 to 1940 period, with the earlier years of the period given more weight than the latter years since the original survey was in 1936 or 1937 in most States. Though the pre-war average is therefore somewhat vague as to meaning, it is nevertheless a useful figure as a basis for determining the wartime changes in the frequencies of heavy axle loads in different parts of the country.

Figure 25 shows that heavy gross loads were much more frequent in 1942 than in the pre-war period. For each 1,000 trucks found on main roads, an average of 110 weighed over 15 tons in 1942 compared to an average of 43 weighing over 15 tons in the 1936-1940 period. Trucks weighing over 25 tons averaged 11 per thousand in 1942 compared to only 3 per thousand in the pre-war period.

This increase in the frequency of heavy gross loads took place in all regions, as is shown by figure 26. In 1942, gross loads over 15 tons were most frequent in the East North Central region, but nearly all of these were between 15 and 20 tons or between 20 and 25 tons.

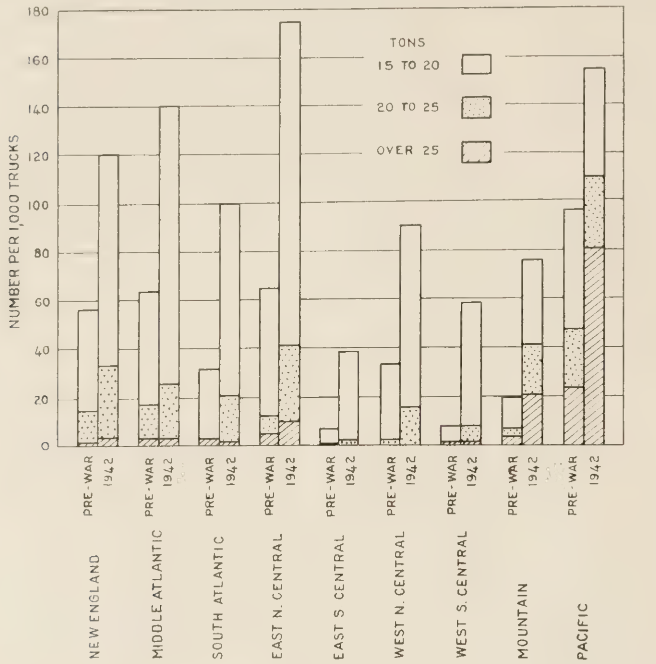


Figure 26.—Number of Heavy Gross Loads Per 1,000 Loaded and Empty Trucks in the Summer of 1942 and in a Corresponding Period of a Pre-War Year Between 1936 and 1940, on Main Rural Roads in Each Census Region.

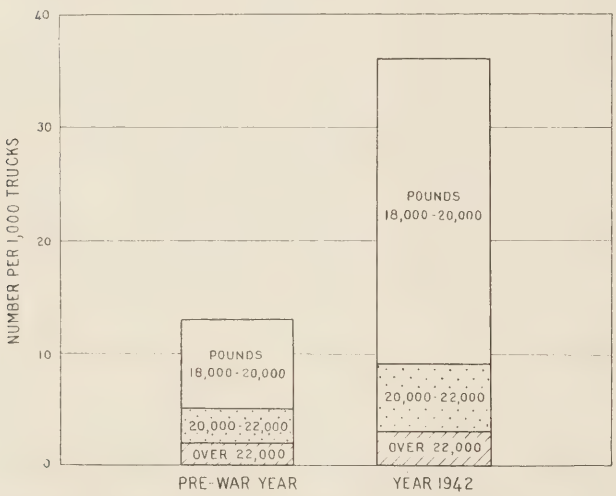


Figure 27.—Number of Heavy Axle Loads Per 1,000 Loaded and Empty Trucks in the Summer of 1942 and in a Corresponding Period of a Pre-War Year Between 1936 and 1940, on Main Rural Roads Throughout the United States.

The frequency of gross loads over 25 tons was by far the greatest in the Pacific region, due to the use in this region of large combinations, frequently consisting of a tractor-truck, a semitrailer, and a trailer (fig. 1D). Most of the combinations in the East North Central States were of the type shown in figure 1A.

The increase in frequency of heavy gross weights does not necessarily mean an increase in the frequency of heavy axle loads, since the larger vehicles generally have more axles than the smaller ones. However, heavy axle loads were much more frequent in 1942 than in the pre-war period, as is shown by figure 27. For

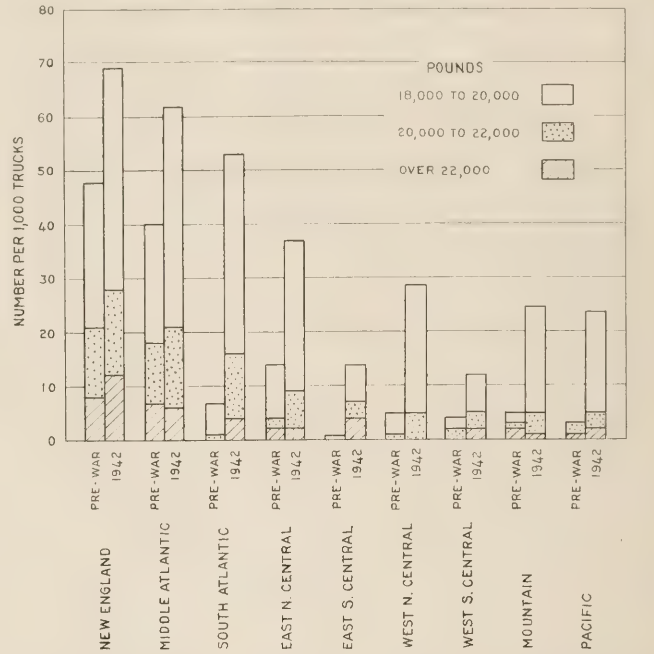


Figure 28.—Number of Heavy Axle Loads Per 1,000 Loaded and Empty Trucks in the Summer of 1942, and in a Corresponding Period of a Pre-War Year Between 1936 and 1940, on Main Rural Roads in Each Census Region.

each 1,000 trucks passing over the main roads there were, on the average, 36 axles weighing over 18,000 pounds in 1942 compared to 13 in the pre-war period. There were similar increases in the frequency of axle loads over 20,000 pounds and over 22,000 pounds.

All regions had a greater frequency of heavy axle loads in 1942 than in the pre-war period. Figure 28 shows that the increase was very great in some regions such as, for example, in the South Atlantic States, where axle loads over 18,000 pounds increased from 7 per thousand trucks in the pre-war period to 53 per thousand trucks in 1942. It is rather surprising to find from this figure that the New England States had the greatest frequency of heavy axle loads in 1942, since figure 26 showed that the frequency of heavy gross loads in the New England region was little, if any, above the national average. On the other hand, the Pacific region, which had such a high frequency of gross loads over 25 tons, was well below the national average in frequency of heavy axle loads. The explanation lies in the fact that the large combinations, which are confined mainly to the west, have their loads well distributed on a number of axles. For example, the three-axle tractor-truck with triple-axle semitrailer, shown in figure 1C, weighed 64,430 pounds, but no axle load was more than 12,020 pounds. The tractor-truck, semitrailer, and trailer combination shown in figure 1D weighed 72,255 pounds, but no axle load was more than 14,010 pounds. In contrast to this, the single-unit truck shown in figure 3A has most of its weight on one axle, and the one shown in figure 3B, while better proportioned, still had about two-thirds of its weight on the rear axle. The cab-over-engine truck in figure 3C and the truck with dual rear axles in figure 3D have better weight distribution. The laws in different States have much to do with the extent of usage of vehicles of different types.

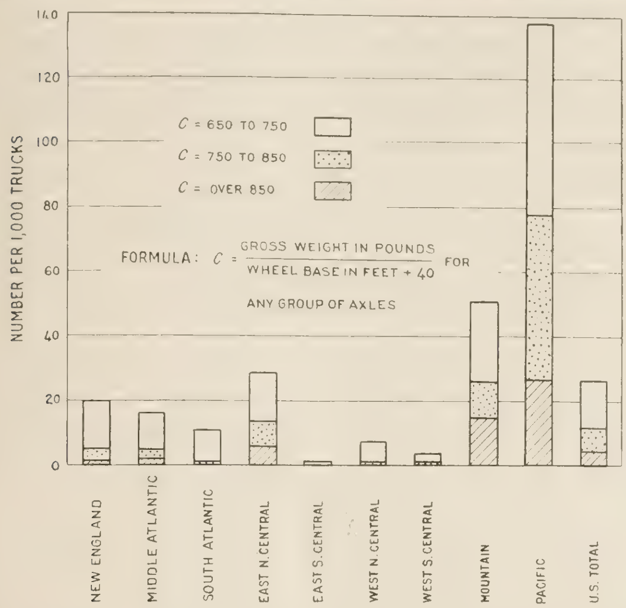


Figure 29.—Number of Trucks Per 1,000 Loaded and Empty Trucks With High Values of C in the Gross-Weight Formula, in the Summer of 1942, on Main Rural Roads in Each Census Region.

HEAVIEST LOAD CONCENTRATIONS GENERALLY PRODUCED BY INTERIOR GROUPS OF AXLES

While the large combinations prevalent on the Pacific coast do not impose heavy axle loads, they do have heavy load concentrations on two or more axles that produce high bridge stresses.

The gross load formula $C=W \div (L+40)$ has been designed to give an indication of the degree of load concentration, which might be more important from the point of view of bridge stresses than either the gross load or the axle load. In this formula L is the distance in feet between the first and last axle of the vehicle, or of any interior group of axles; W is the total weight of the vehicle or the weight transmitted by the interior group of axles; and C is a measure of the load concentration. Numerous States have laws limiting the maximum permissible value of C for any load to a specific value. The value is different in different States, and sometimes depends upon axle spacing but ordinarily is 750, 700, or 650.

Since complete information on axle spacing was not obtained in the original survey, it was not possible to establish trends in values of C, but figure 29 shows the frequencies of various values as found in the summer of 1942. It will be noted that values in excess of 750 were very frequent in the Mountain and Pacific regions and occurred to a lesser extent in other regions.

It is not the over-all wheel base, but some interior group of axles that generally has the highest value of C for a truck with more than two axles. This fact is especially significant, since the laws of some States provide that only the over-all wheel base shall be considered in calculating C.

Table 23, based on 1942 observations, shows that, of the 542 vehicles with a value of C greater than 750, only 15 were so designed and loaded that the highest value of C was derived from consideration of over-all wheel base. In 468 cases, or 86 percent of the total, consideration of all axles other than the front axle yielded the highest value.

Table 23.—*Number of trucks observed in the summer of 1942, having values of C in the gross weight formula greater than 750, classified in accordance with the axle group having the highest value of C* [1]

Type of vehicle	Axle group with highest value of C: Over-all wheel base	Second to last axle	Other group	Total
Single-unit (2-axle)	1			1
Single-unit (3-axle)	1	31		32
Combinations	13	437	59	509
Total	15	468	59	542

[1] The gross weight formula is $C=\frac{W}{L+40}$ in which L is the distance in feet between the first and the last axle of the vehicle or of any interior group of axles, and W is the total weight of the vehicle or of the interior group of axles.

APPENDIX.—SOURCES OF DATA AND METHODS OF COMPUTATION

For the benefit of those who may wish to carry the estimates further, and prepare comparable estimates of some of the items for other years, or to determine the extent to which the various items are based on ample data, the sources of the data and the methods of arriving at the figures will be described in some detail.

HIGHWAY PLANNING SURVEYS DESCRIBED

The estimates are founded primarily on the numerous tables of various series prepared as a part of the highway planning surveys conducted by all States in cooperation with the Public Roads Administration within the past few years. The original field surveys were made in most States in 1936 or 1937, but surveys were not made until 1938, 1939, or 1940 in some States, and in a few States they have not yet been completed. These surveys were very extensive and had many ramifications that are not pertinent to the estimates. Only the collection of information having an important bearing on the amount and characteristics of trucking on rural roads, will be briefly described.

In the rural road inventory, all roads outside of municipalities, or closely built-up urban communities, which were open to unrestricted public use, were driven over and measured with automobile odometers. The mileage figures thus determined were used in the calculation of vehicle-miles.

Traffic was counted at about 350,000 points on rural roads of all classes. At some of these points the count was for 8 hours only; at others there were from four 8-hour counts to twelve 24-hour counts, seasonally spaced. At about 8,000 important road intersections there were from eighteen to twenty-one 8-hour counts distributed throughout the seasons of the year, the days of the week, and the hours of the day in such manner as to permit the determination of average daily traffic for the approximately 28,000 road sections radiating from the intersections, and the development of traffic patterns to aid in the expansion of the shorter counts to daily averages. Automatic traffic recorders of fixed and portable types aided further in the determination of traffic patterns. From this combined information, it was possible to estimate average daily traffic throughout the year on every mile of public road, and to calculate vehicle-miles by multiplying by the mileage obtained in the inventory. In all of the traffic counts except those made by automatic recorders a separate classification was made of single-unit trucks, tractor-trucks with semitrailers, and truck and trailer combinations so that, in general, it was possible to calculate the vehicle-miles of trucks and combinations on main and local roads on the basis of ample data.

In the so-called "road-use" survey, which was a part of the highway planning surveys, representative motor-vehicle owners were questioned concerning the amount of driving done on roads of different classes during the preceding year. Approximately 185,000 truck owners in 44 States were interviewed. From their answers it was possible to calculate the truck-miles driven on rural roads. These calculations served to check the calculations based on the traffic survey, and to supply vehicle-mile figures for a few States that had not completed the traffic tables.

At about 3,000 of the traffic-count stations, trucks were weighed on portable scales known as "loadometers," and their drivers were questioned. The loadometer schedules called for operation in all seasons, on all days of the week, and at all hours of the day and night. Included in the information obtained was the following: The vehicle type and capacity, whether the vehicle was loaded or empty; the total weight of the vehicle; the weight of the carried load or the empty weight of loaded vehicles, if obtainable; and the origin and destination of the trip. This information was obtained for over 2,500,000 trucks, mostly on main roads, though, in some cases, vehicles traveling on local roads intersecting a main road at a loadometer station were sampled. Except for those States that had not completed loadometer tables, the weight data were fully adequate for computing ton-miles hauled on main roads in the survey year, in the aggregate, and in each of a number of origin and destination categories.

In a number of States the origin and destination data obtained on main roads at loadometer stations were supplemented by data obtained at traffic-count stations on local roads, either by interviewing drivers, or by handing them questionnaires to be filled out and returned later. Eighteen States have prepared origin and destination tables for local roads, and the total local-road truck sample for these States was about 850,000.

SURVEYS TO ESTABLISH TRENDS

Since the original field surveys were completed, continuing operations have supplied data on trends for some phases of the survey. Changes in road mileages are reported annually. Through the continuous operation of over 650 automatic traffic recorders at permanent locations, the operation on schedule of about 2,000 portable recorders, and manual counts in which vehicles are classified by types, traffic trends are fairly well established, especially on main roads.

Unfortunately, few States undertook repeat weighing operations in the 1936–40 period which could be used in making the estimates for 1940. In order to determine wartime trends, however, 486 loadometer stations were operated in the summer of 1942 on main roads in 46 States. About 120,000 trucks were counted and classified, and about 53,000 were weighed in this survey.

In most States, 10 stations were selected so that the combined data would be representative of traffic on main rural roads and were operated for 8 hours each, either from 6 a. m. to 2 p. m. or from 2 p. m. to 10 p. m. on a weekday. To insure comparability with earlier data, and to permit determination of trends, stations operated in the original highway planning survey were selected, and the hours of operation at each station were the same as those for a weekday operation in the original survey within a few weeks of the same time of year. Stations were not operated on Saturday, Sunday, and at night (10 p. m. to 6 a. m.).

BASIC VEHICLE-MILEAGE AND TON-MILEAGE TABLES

Sources of data.—All available data pertinent to each portion of the estimate were examined, and an effort was made to explain discrepancies before the final figures were decided upon. The principal series of tables and other data examined were as follows:

1. Road-inventory tables (RI series).
2. Annual highway-mileage tables (SM and LM series).
3. Traffic-inventory tables (T series).
4. Origin-destination tables (OD series).
5. Loadometer tables (L series).
6. Pit-scale tables (P series).
7. Road-use tables (RU series).
8. Analysis of motor-fuel usage (Public Roads Administration table G–21 for different years).
9. Numerous special tables submitted by individual States such as: Michigan blanket-count tables for local roads (B series); Iowa traffic survey table T–101 for different years; Iowa 1940 loadometer series; annual traffic tabulations for Virginia, New Mexico, and other States; et cetera.
10. Highway planning survey reports published by numerous States.
11. Special tabulations entitled "Rural Road Usage by Traffic Types," based in part on the traffic survey and in part on the road-use survey.
12. Special tabulations entitled "Percentage distribution of rural vehicle-miles classified by vehicle type and by local and foreign registration."
13. Automatic traffic-recorder-station classification-count data, submitted to the Public Roads Administration periodically.
14. Letters from a number of States written in reply to specific inquiries.
15. Replies to telegrams of May 19, 1942, making inquiry concerning wartime changes in truck-traffic volumes and weights. While most of these replies treat with a period subsequent to 1940, some of them give data which aid in establishing trends prior to 1940.
16. Tables made as a part of the special 1942 survey to determine wartime trends (W series).

For many States, information on total vehicle-miles and on the percentage of trucks and combinations was available both from the traffic survey and the road-use survey. In such cases the traffic-survey figures were used because they include traffic by foreign vehicles, which is not included in the road-use figures. The figures from the two sources were compared, however, and were found to be reasonably consistent in all cases. Where only road-use figures were available, they were used after adjustment for travel by foreign vehicles.

Highway systems.—Since trucking characteristics on local roads differ materially from those on main roads, it was thought advisable to prepare separate estimates for the two classes of roads. The main roads in each State were well covered by loadometer stations, but relatively few loadometer data were obtained for local roads. Likewise, some of the trend information is applicable to the main roads only. It follows that the estimates for the main roads should be fairly accurate, while those for the local roads are only approximate. Since the local roads have less than 30 percent of the total vehicle-mileage and only about 20 percent of the total ton-mileage, an error of considerable proportions in the estimates for local roads would result in only a small percentage of error in the estimates for all rural roads.

In selecting the road mileage to be classed as "main" and that to be classed as "local," an effort was made to confine the main road mileage to that well covered by the loadometer survey. In most States this meant classifying the roads of the State system, or the primary State system, as main roads and all others as local roads. In Louisiana the classification was made on the basis of traffic volume rather than administrative system because a special study provided the basis for such a classification and indicated it to be preferable to the administrative classification. It will be noted that the term "local roads" as used in this analysis includes important county roads, secondary State roads, and other groups of roads not ordinarily called local.

Table 1 shows the characteristics of the two road systems as selected in each State. For the country as a whole, the main roads constituted 11.6 percent of the total rural mileage, carried 71.6 percent of the total rural vehicle-mileage, and had an average traffic density of 883 vehicles per day. The local roads constituted 88.4 percent of the mileage, carried 28.4 percent of the vehicle-mileage, and had an average traffic density of 46 vehicles per day. Table 1 serves to define the two systems and was included principally for this purpose.

Vehicle-mileage of all vehicles.—The figures for vehicle-miles of all vehicles in the survey year came from tables based on the traffic survey, with the following exceptions:

1. Figures for travel on the secondary systems in Arkansas and Illinois are from the road-use survey.
2. Figures for travel on both systems in Montana, Washington, and Wyoming, are in part from the traffic survey and in part from the road-use survey, as combined by the State.
3. Travel on the secondary system in Mississippi was estimated as explained in the next paragraph.
4. Delaware, Georgia, Maine, New Jersey, and New York have not submitted traffic or road-use tables showing vehicle-miles. Each has submitted either measured or estimated road-mileage figures. Average daily traffic figures were estimated for each road system in each of these States on the basis of corresponding figures for other States, similarly situated. Vehicle-miles were computed by multiplying the mileage by the average daily traffic so estimated. Data are not shown separately in the estimates for these States, with the exception of Georgia, but were grouped in an "Other States" classification. Data for Georgia were shown separately, because the availability of weight data made it possible to extend further the estimates for that State.

The vehicle-mile figures for 1940 were estimated from those for the survey year on the assumption that traffic on both systems increased in the same ratio as did the consumption of gasoline on highways in each State. The gasoline-consumption figures were obtained from Public Roads Administration table G–21. Where the survey year was made up of parts of two calendar years, the number of months in each calendar year was multiplied by one-twelfth of the gasoline consumption for that year and the two products were added to obtain the approximate gasoline consumption for the survey year.

Trucks and combinations as a percentage of all vehicles.—The vehicle-mileage of trucks and combinations expressed as a percentage of the vehicle-mileage of all vehicles on main roads in the survey year was submitted by 40 States in tables based on the traffic survey, or on a combination of the traffic and road-use surveys. Only a figure based on the road-use survey was available for Connecticut and this was multiplied by 0.91 which was the average ratio of the traffic-survey figure to the road-use figure for main roads in the 34 States for which both sets of figures were available. Since almost all trucks and combinations carry a license plate for the State in which they are operating and were therefore classed as local, the road-use survey, which includes only traffic by local vehicles, naturally shows a higher percentage for trucks and combinations than the traffic survey which includes foreign traffic, nearly all of which consists of passenger cars.

No information on the percentage for trucks and combinations on the primary system was submitted by Delaware, Georgia, Maine, Massachusetts, New Jersey, New York, or Rhode Island, and percentages were estimated for these seven States on the basis of corresponding percentages for other States similarly situated.

For local roads, 38 States submitted percentages for trucks and combinations based on the traffic survey, or a combination of the traffic and road-use surveys. Road-use figures for Connecticut and Vermont were multiplied by 0.97 to correct for foreign traffic, the correction factor being determined in the same manner as that for main roads. The factor is nearer unity for local roads than for main roads, because there are relatively fewer foreign vehicles on local roads. No percentages for trucks and combinations on local roads were submitted by Delaware, Georgia, Maine, Massachusetts, Mississippi, New Jersey, New York, and Rhode Island and percentages were estimated for these eight States on the basis of corresponding percentages for other States similarly situated.

Data permitting a computation of the trend in percentage for trucks and combinations on main roads between 1936 and 1940 were submitted by Arizona, Arkansas, California, Iowa, Missouri, Oklahoma, Oregon, South Dakota, and Wyoming. According to these data, the percentage declined very slightly between 1936 and 1940 in Arizona and Wyoming, and increased substantially in the other seven States. For the nine States, the percentage increased an average of 0.52 per year. Long-range trend data in Virginia and Nevada going back to 1926, show a steady increase averaging about 0.30 per year in Virginia and 0.55 in Nevada. Automatic traffic-recorder classification counts on primary roads throughout the United States show an increase of 0.7 from 1939 to 1940.

The only trend data available for local roads are from Arkansas, Missouri, Oklahoma, and Oregon. These data show an average increase in the percentage for trucks and combinations of 0.38 per year during the 1936–1940 period.

Considering all of the above data, the percentage for trucks and combinations on both systems was increased by 0.50 for each year intervening between the latest year for which a figure was available and 1940 to obtain the 1940 estimates. For example, if the percentage was 16.0 in 1936, it was considered to be 18.0 in 1940. The adjustment was made by adding an increment to the percentage, instead of multiplying the percentage by a factor as in the other adjustments, because this procedure appeared to be more consistent with the available data.

Combinations as a percentage of all trucks.—Data from the traffic surveys on the percentages for single-unit trucks and combinations, respectively, on main roads were submitted by 31 States. These figures are considered to be more accurate than those of the loadometer survey because the samples are much larger and are better distributed. Only the distribution from the loadometer sample was available for Georgia, Massachusetts, Minnesota, New Mexico, North Carolina, North Dakota, Ohio, Rhode Island, Texas, Utah, Vermont, and Wisconsin.

Twenty-eight States submitted data from traffic density surveys on local roads showing the percentage distribution between single-unit trucks and combinations. For these States combined, the percentage for combinations on local roads was about 0.3 the percentage on main roads. The percentages for main roads were therefore multiplied by 0.3 to estimate percentages for local roads in the 15 States for which main-road percentages only were known. These States were as follows: Georgia, Massachusetts, Minnesota, Mississippi, New Mexico, North Carolina, North Dakota, Ohio, Rhode Island, South Carolina, Texas, Utah, Vermont, Virginia, and Wisconsin.

Data showing the trend in the percentage for combinations between 1936 and 1940 were submitted by Arizona, Iowa, Missouri, and Virginia. All of these data indicate that the proportion of combinations in total truck traffic increased over this period. The average rate of increase in the four States was 4 percent per year. Classification counts made at automatic traffic-recorder stations on primary roads throughout the country showed an increase in the percentage for combinations, averaging 6 percent a year from 1939 to 1941, though there was a slight dip in the 1940 percentage. Replies to telegrams of May 19, 1942, relative to wartime traffic trends, indicated a sharp increase in the percentage for combinations in 10 of the 11 States submitting information on this point, but in only 3 States did the data go back of 1940. At one point in Connecticut the increase from 1939 to 1942 was 12.7 percent a year; at one point in Maryland the increase from 1937 to 1942 was 11.7 percent a year; and at four points in Colorado the average increase from 1937 to 1942 was 2.4 percent a year. It is probable that much of the increase in Connecticut and Maryland took place between 1940 and 1942, since data from other States indicate that the use of combinations was increasing rapidly during that period.

Considering the data in the preceding paragraph, an increase in percentage for combinations of 4 percent a year was decided upon as conservative. In other words, percentages for 1939, 1938, 1937, and 1936 were multiplied by 1.04, 1.08, 1.12, and 1.16, respectively, to obtain the 1940 estimates.

Percentage of loaded trucks.—Information on loaded vehicles as a percentage of all vehicles was obtained only at weight stations and these percentages were used exclusively in making the estimates. A special study of trucking on local roads in Michigan showed the ratio between percentages of loaded trucks and combinations on local roads and on main roads to be 0.97. The difference in percentages was regarded as too small to be significant. In the absence of other information bearing on this relation, the percentage of loaded vehicles as determined from the loadometer sample for each type of vehicle, was regarded as being applicable to local as well as main roads. When vehicles of all types were combined, this resulted in a percentage of loaded vehicles on local roads 98.5 percent of that on main roads.

Extensive loadometer resurveys were conducted in Kansas and Iowa in 1940, and these surveys showed an increase in percentage of loaded vehicles over that shown by the 1936 survey, averaging 2.4 percent per year for the two States. Kentucky estimated a decline in percentage of loaded vehicles of 1.4 percent per year from 1937 to 1941, and an 8-hour operation at a station on U S 1 in Maryland showed an increase of 2.0 percent per year from 1937 to 1942. Only the Iowa and Maryland data showed combinations separate from single-unit trucks, and in both cases all of the increase in percentage of loaded vehicles took place in single-unit trucks with a slight decrease, in fact, in the percentage of loaded combinations. The Iowa and Kansas data, being based on extensive surveys, should be much more reliable than the other data, but because of possibilities of sectional variations, the increase shown in those two States was reduced from 2.4 percent to 1.3 percent per year by averaging with the Kentucky and Maryland data. This is equivalent to 1.5 percent increase for single-unit trucks alone, and this figure was used in making estimates for these vehicles. It was assumed that there was no change in the figure for combinations. In other words, if the survey was made in 1936, the percentage of loaded single-unit trucks was multiplied by 1.06 to obtain the 1940 estimate, while the 1936 figure for percentage of loaded combinations was used without change in making the 1940 estimates.

Average carried load.—Loadometer tables L–71, L–72, and L–73 show the average carried load (average load of loaded vehicles) for single-unit trucks, tractor-trucks and semitrailers, and trailers, respectively. The sample in these tables is necessarily limited to loaded vehicles for which the empty weight is known, or those for which the weight of the load carried is known by the driver or can be estimated accurately. In some States (such as Ohio) the empty weight of practically all vehicles is known because the law requires it to be stenciled on the side of the vehicle or shown on the registration card. The loadometer tables from such States include nearly all of the loaded trucks weighed. In some States, estimates of carried load were freely made, while in others carried loads were computed only in case the empty vehicle had previously been weighed and a sticker indicating the weight attached. For some reason the vehicles with known empty weight were heavier, on the average, than those with unknown empty weight. This is proved by the fact that in most States, the average total weight of loaded vehicles for which empty weight is known, taken from tables L–71, L–72, and L–73, is materially greater than the average total weight for all loaded vehicles taken from tables L–23, L–25, and L–27. This may be because more of the heavier vehicles are apt to pass a loadometer station both when empty and when loaded, or it may be because drivers were more likely to know the weight of heavier loads. Whatever the reason, the figures themselves show that the loaded vehicles included in tables L–71, L–72, and L–73 were heavier than the average and it may reasonably be assumed that their carried loads were also heavier.

In preparing the estimates, it was assumed that the empty weights shown in tables L–71, L–72, and L–73 were applicable only to the portion of the loaded vehicles shown in those tables, and that the empty weights of empty vehicles shown in tables L–24, L–26, and L–28 were applicable to the remainder of the loaded vehicles. An average empty weight was calculated for each type of vehicle by weighting in this manner, and was subtracted from the average weight of loaded vehicle of the same type, shown in tables L–23, L–25, or L–27, to determine the average carried load. This method of calculation gives a lower value for average carried load than that shown in tables L–71, L–72, and L–73 and it also gives a lower value than would be obtained by subtracting the average empty weight of all empty vehicles from the average total weight of all loaded vehicles. It is believed to be more accurate than either of the other methods.

The Michigan blanket-count tables for local roads show the average load carried by single-unit trucks on local roads to be 17.5 percent smaller than the figure for main roads as shown in loadometer tables. The average load carried by combinations was 21.8 percent smaller on local roads than on main roads. This difference in carried load is in addition to that which results from the smaller relative frequency of combinations on local roads. The survey in which the data on local roads were obtained was conducted from May to October 1936, and all weights were based on estimates made by the vehicle operators. Therefore the data are not strictly comparable with those for main roads in the regular loadometer tables, but the relations indicated are believed to be significant and approximately correct for Michigan conditions, at least. In other States the average load carried by single-unit trucks and that carried by combinations on local roads was assumed to be 80 percent of that carried by vehicles of the same type on primary roads.

As previously stated, Iowa and Kansas conducted extensive loadometer surveys in 1940, and data from these surveys, together with data from the original loadometer surveys of 1936, give the means of establishing the trends in weights in those States from 1936 to 1940. Because of the difficulties in computing carried load discussed above, and the relative smallness of the sample of vehicles with known carried load, it is possible that apparent trends in carried load may be due in part to differences in field and office procedures. Trends in total weight can be established from the data with much greater assurance of accuracy, and it is reasonable to assume that percentage increases in carried load have been at least as great as those in total weight.

In both Iowa and Kansas, the total weights of loaded single-unit trucks and of loaded combinations increased during the 1936–1940 period. The average increase per year for the two States was 5.4 percent for single-unit trucks and 1.0 percent for combinations. Results of an 8-hour operation at a station on U S 1 in Maryland in 1937 and again in 1942, indicated an average annual increase in total weight for the period of 2.8 percent for single-unit trucks, and also for combinations. Similar operations at a station on U S 5 in Connecticut in 1939 and 1942, indicated an average annual increase in total weight for the period of 0.5 percent for single-unit trucks and 2.3 percent for combinations. Data from 11 stations in Connecticut operated in 1934 and in 1940 showed a much larger rate of increase, but there is considerable question, in this case, concerning comparability. While the Iowa and Kansas data should be much more accurate than the others, they might be subject to sectional variation and for this reason were modified on the basis of the indications in Maryland and Delaware. The annual rates of increase in carried load during the 1936–39 period were therefore assumed to be 3.5 percent for single-unit trucks and 2.0 percent for combinations.

RURAL AND URBAN ORIGIN AND DESTINATION TABLES

Sources of data on vehicle-mileage.—Highway planning survey table OD–4 shows for rural roads the truck-miles and percentages with rural origin and rural destination, with rural origin and urban destination or vice versa, and with urban origin and urban destination, in the survey year. This information is shown for a primary system, for a secondary system, and in some cases for a tertiary system also.

Usable OD–4 tables were received from the following 18 States: Idaho, Indiana, Iowa, Michigan, Minnesota, Nebraska, Nevada, New Hampshire, New Mexico, Ohio, Oregon, South Carolina, South Dakota, Tennessee, Utah, West Virginia, Wisconsin, and Wyoming (secondary system only). For all of these States except Oregon, the mileage classed as "primary" in the OD tables was the same as that classed as "main" in the ton-mileage tables, and that classed as "secondary" and "tertiary" (if any) was the same as that classed as "local" in the ton-mileage tables. In the case of Oregon, the small mileage classed as secondary was included with that of main roads in the ton-mile tables because its characteristics appeared to resemble those of main roads more nearly than those of local roads.

Information on origin and destination was obtained in the loadometer survey and these data were utilized in preparing the OD tables. In fact the information in the OD tables for trucks on the primary system was obtained in large part from the loadometer data and percentages from loadometer table L–4 therefore agree very closely with percentages for the primary system from table OD–4. In addition to the 17 States submitting usable OD tables for the primary system, the following 23 States submitted loadometer table L–4, permitting the calculation of origin and destination percentages for main roads: Alabama, Arizona, California, Colorado, Florida, Illinois, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, Missouri, Montana, North Carolina, North Dakota, Oklahoma, Pennsylvania, Rhode Island, Texas, Virginia, Washington, and Wyoming. Origin and destination data were therefore available for main roads in 40 States and for local roads in 18 States.

Calculation of vehicle-mileage.—For the 18 States for which local road data were available, there was found to be an approximate relation between average traffic density on local roads (table 1 of the ton-mileage series) and the percentage distribution of vehicle-mileage according to origin-destination classification. This is not surprising, since a high average traffic density and a high proportion of travel with urban origin or destination are both caused by the presence of numerous cities of considerable size in a State. In figure 30, the average daily traffic density on local roads was plotted as abscissas, and the percentages with origin and destination both urban as ordinates for one curve, and the percentages with either an urban origin or destination or both as ordinates for a second curve. Lines were located through the two groups of points by the method of least squares. For 20 of the 22 States supplying origin and destination data for main roads, but not for local roads, the percentages applying to local roads were read from the curves. The average daily traffic density on local roads for the State was obtained from table 1, and a vertical line was drawn through this average density in figure 30. From the point where this vertical line intersected the lower curve, a horizontal line was drawn to the left, and the percentage with origin and destination both urban was read from the vertical scale at the left; and from the point where the vertical line intersected the upper curve, a horizontal line was drawn to the right and the percentage with origin and destination both rural was read from the vertical scale at the right. The difference between the sum of these two percentages and 100 was the percentage of urban-rural or rural-urban movement. The average daily traffic on local roads in Massachusetts and Rhode Island fell well outside of the limits of figure 30, and the percentages were estimated on the basis of corresponding percentages in other States similarly situated as regards the distribution of urban and rural population.

The percentages in table 6 relating to main roads were taken from table OD–4 when available from the State, and otherwise from table L–4. The percentages in table 7 relating to local roads were taken from table OD–4 when available from the State, and otherwise from the curves of figure 30 as explained above. In the case of the eight States for which no origin and destination data were available, the percentages were estimated on the basis of corresponding percentages in other States similarly situated as regards the distribution of urban and rural population. These eight States are not shown separately in the tables, however, but are classified as "Other States" in a single group. The truck-mileages for each system were taken from table 2 and were multiplied by the percentages to obtain the vehicle-mileage with origin and destination both rural, one rural and the other urban, and both urban. Table 8 for all rural roads was calculated by combining the figures in table 7 with those in table 6.

In the calculation described above the assumption is inherent that the proportions of the travel in the various origin-destination classifications did not change between the survey year and 1940. While there is no evidence on this point, it seems reasonable to assume that these relations remain stable, or change very slowly, except under very abnormal conditions such as have come about subsequent to 1940.

Calculation of ton-mileage.—The proportion of loaded vehicles in total truck traffic with origin and destination both urban, with one urban and the other rural, and with both rural, can be calculated on a percentage basis from loadometer table L–4, and an average carried load for vehicles in each of these three origin-destination categories can be calculated from table L–7. These tables were submitted by 39 States, these being the States named above as having submitted origin and destination vehicle-mileage data with the exception of Oregon. The data by States are shown in tables 6, 7, and 8.

For each State, the percentage loaded of trucks in each origin-destination category (urban-urban, rural-urban and urban-rural, and rural-rural) was calculated from table L–4, and a percentage of loaded vehicles in

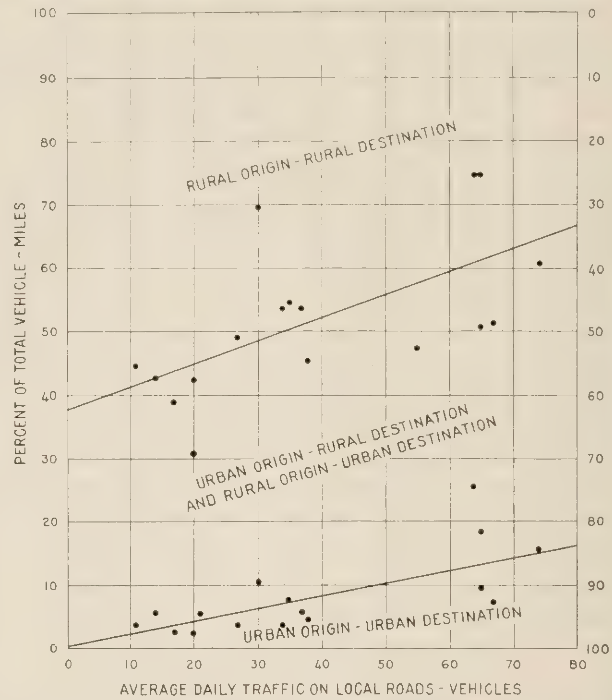


FIGURE 30.—PERCENTAGE OF TOTAL VEHICLE-MILES WITH ORIGIN AND DESTINATION BOTH URBAN, ONE URBAN AND THE OTHER RURAL, AND BOTH RURAL IN RELATION TO AVERAGE DAILY TRAFFIC ON LOCAL RURAL ROADS.

all categories combined was calculated separately for main roads and for local roads by weighting in accordance with the proportion of the vehicle-mileage in each origin and destination category on each system as shown in tables 6 and 7. The percentage of loaded vehicles on main roads was then adjusted to agree with that shown for the year 1940 in table 3, and the percentages in each origin-destination category were adjusted proportionately. The percentage of loaded vehicles on local roads was similarly adjusted to agree with the 1940 percentage shown in table 4. The average carried load for each origin-destination category was calculated from table L–7 and adjusted to the average carried load shown in tables 3 and 4 in the same manner that the percentage of loaded vehicles was adjusted.

The calculations described in the preceding paragraph involve assumptions, as follows:

1. That the relations of the percentage of loaded vehicles in the three origin-destination categories are the same for local roads as for main roads.
2. That the relations of the averages for carried load for the three origin-destination categories are the same for local roads as for main roads.
3. That the relations of the percentages of loaded vehicles for the three origin-destination categories did not change on either system (main or local) between the survey year and 1940.
4. That the relations of the averages for carried load for the three origin-destination categories did not change on either system between the survey year and 1940.

It should be noted that the above assumptions apply only to relations of values for the three origin-destination categories and not to the values themselves. Thus, different proportions of urban-urban, rural-urban and urban-rural, and rural-rural travel on the two systems result in different values for percentage of loaded vehicles and for average carried load, even before adjustment to agree with tables 3 and 4. Likewise, changes in both percentage of loaded vehicles and average carried load between the survey year and 1940 on both systems are recognized, but the changes are assumed to have taken place to the same degree in each of the three origin-destination categories.

The ton-mileages shown in tables 9 and 10 for each system and for each origin-destination category were calculated by multiplying the corresponding vehicle-mileages shown in tables 6 and 7 by the percentage of loaded vehicles, and then by the average carried load. Table 11, for all rural roads, was calculated by combining the figures in table 10 with those in table 9.

TABLES SHOWING EXTENT OF TRIPS CLASSIFIED AS INTRASTATE, INTERSTATE, AND TRANSSTATE, AND CLASSIFIED ACCORDING TO NUMBER OF COUNTIES TRAVERSED

Sources of data on vehicle-mileage.—Highway planning survey table OD–2 shows the truck-mileage and percentages for intrastate, interstate, and transstate trips, on rural roads, subdivided into either two or three road system classifications, in the survey year. Table OD–3 shows the same information concerning trips involving travel in one county only, two counties, and three or more counties. These OD tables were available for the following 17 States: Idaho, Indiana, Iowa, Michigan, Minnesota, Nebraska, Nevada, New Hampshire, New Mexico, Ohio, Oregon, South Carolina, South Dakota, Tennessee, Utah, West Virginia, and Wisconsin. In addition, Wyoming tables for the secondary system were available. For all of these States except Oregon, the "primary" system classification in the OD tables was the same as the "main" road classification in the ton-mileage tables, and the "secondary" classification, plus the "tertiary" classification, if any mileage was so classified, was the same as the "local road" classification in the ton-mileage tables. In Oregon, the small mileage classed as secondary was included with the main road mileage in the ton-mileage tables because its characteristics appeared to resemble the main road mileage more nearly than the local road mileage.

Information as to origin and destination obtained in the loadometer survey was used in preparing table OD–2. Most of the information in this table for trucks on the primary system was, in fact, obtained from the loadometer data, and percentages from loadometer table L–5 therefore agree very closely with percentages relating to the primary system from table OD–2. In addition to the 17 States submitting OD tables for the primary system, the following 24 States submitted loadometer table L–5, permitting the calculation of origin-destination percentages for main roads: Alabama, Arizona, California, Colorado, Florida, Illinois, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, Missouri, Montana, North Carolina, North Dakota, Oklahoma, Pennsylvania, Rhode Island, Texas, Vermont, Virginia, Washington, and Wyoming. Data concerning the intrastate, interstate, and transstate classifications were therefore available for main roads in 41 States and for local roads in 18 States. Information concerning the extent of trips by the number of counties traversed was available for local roads in 18 States and for primary roads in 17 States.

Calculation of vehicle-mileage.—The percentage of rural traffic in a State that is of an interstate or transstate nature depends on many factors, among which are the size of the State, the location of urban centers of population, natural or artificial barriers to traffic, and other geographical, social, or economic conditions. In the information submitted from the 17 States, for which origin-destination data were available for both main roads and local roads, only an approximate relation was found between the percentage of trucks classed as interstate or transstate on the main roads and that on the local roads. This approximate relation, however, is satisfactory for estimating the amount of interstate or transstate traffic on local roads in other States since the total truck traffic of the two types seldom exceeds 5 percent of the total traffic on these roads. In these 17 States, the amount of interstate traffic on local roads averaged 3.5 percent of the total traffic and the transstate traffic averaged 0.2 percent. The ratio of the percentage of interstate traffic on local roads to the percentage on main roads was 0.18 while the similar ratio for transstate traffic was 0.04. These relations between the percentages interstate and transstate of traffic on main and on local roads were used in obtaining an estimate of the percentages for these two types of traffic in 23 States which had compiled the loadometer tables but from which OD tables were not available.

The percentages in table 12 relating to main roads were taken from table OD–2 when available for the State and otherwise from table L–5. In the case of the seven States for which origin-destination data were not available, the percentages were estimated on the basis of corresponding percentages in other States similarly situated as regards size, location, and other pertinent factors. These seven States are not shown separately in the table but are classified as "Other States" in a single group.

The percentages for local roads were taken from table OD–2 when available for a State, and otherwise were estimated from the corresponding percentages for main roads, by multiplying by 0.18 in the case of interstate traffic and 0.04 in the case of the transstate traffic, as explained above. In table 13, only those States for which table OD–2 was available were listed separately and the States for which the percentages were estimated were lumped together in the single classification "Other States." The fact that the percentages on the line giving the subtotal for the States listed are the same as those on the line for "Other States" is accidental, in this case, as the method of making the estimates did not involve the assumption that these percentages would be the same.

Table 14 was prepared by combining the vehicle-mileage figures for main roads in each State, shown in table 12, with those for local roads, shown in table 13 or estimated as described. The reason the estimated figures for local roads were used State by State in table 14 for all rural roads, but not in table 13 for local roads, is that an error of high percentage in a local road figure would introduce only an error of low percentage in the corresponding figure for all rural roads.

The figures for total truck mileage in tables 12, 13, and 14, were taken from table 2. Vehicle-mileages of intrastate, interstate, and transstate truck traffic were calculated by multiplying the total truck mileages by the percentages.

The percentages of truck-miles on rural roads for trips which had an extent of one county only, of two counties, and of three or more counties, were taken from the OD-3 tables submitted by 17 States. Percentages for main rural roads and for local rural roads were obtained separately from the data for primary, secondary, and tertiary (if any) roads as described above. These percentages were applied to the truck-mileage figures for main roads and for local roads, given in table 2, to obtain the vehicle-mileages of trips requiring travel in one county, in two counties, and in three or more counties which are listed in table 18. In the last portion of table 18 the vehicle-miles of travel are combined for all rural roads and a percentage breakdown obtained from these total figures. Data were not available concerning the extent of trip, in terms of counties traversed, on either main or local roads, for the 31 States not submitting OD tables. Estimates were not made as there was no satisfactory basis for them.

The average area of counties, shown for each State in the last column of table 18, was computed from 1940 census figures, by dividing the land area of the State by the number of counties in the State. The purpose of this information is to aid in interpreting the data in terms of trip length.

In the calculations described above the assumption is made that the proportion of the travel that is intrastate, interstate, or transstate, or within one, two, or three or more counties, did not change between the survey year and 1940. While there is no evidence on this point, it seems reasonable to assume that these relations remain stable, or change very slowly, except under very abnormal conditions such as have come about subsequent to 1940.

Vehicle-mileage of loaded vehicles.—Figures for loaded vehicles, as a percentage of all vehicles engaged in rural intrastate, interstate, and transstate traffic were calculated from the data in loadometer table L-5. Such figures are hereafter referred to as "percentage of loaded vehicles." Table L-5 was submitted by 39 States, these being all of the States which are named above as having submitted some type of origin and destination information except Oregon and Vermont. The percentage of loaded vehicles for each of these categories was estimated for the remaining States, on the basis of the percentages in States similarly situated, and the estimated vehicle-mileage of loaded vehicles was obtained by multiplying the vehicle-mileage of all trucks by the percentage of those loaded for each category being considered. These latter vehicle-mileage figures (for loaded vehicles only) were then adjusted to agree with the total vehicle-mileage of loaded vehicles for 1940 in each State which previously had been established for each of the two systems of rural roads. The adjusted percentages of loaded vehicles by States are given in table 15 for main roads in 39 States and in table 16 for local roads in 17 States. The estimates of vehicle-mileage of loaded vehicles on main and on local roads were combined for 39 States and the percentages of vehicles loaded on all rural roads are tabulated in table 17. The data for States not tabulated separately are combined in each table.

The calculations described in the preceding paragraph involve two assumptions: First, that the relations of the percentage of loaded vehicles in the three origin-destination categories are the same for local roads as for main roads; second, that the relations of the percentage of loaded vehicles for the three origin-destination categories did not change on either system (main or local) between the survey year and 1940.

These assumptions pertain only to the relations of values for the three categories being considered and not to the values themselves. Thus different proportions of intrastate, interstate, or transstate traffic on the two systems result in different values for percentage of loaded vehicles even before adjustment to agree with previously established total values. Likewise, changes in percentage of loaded vehicles between the survey year and 1940 on both systems are recognized, but the changes are assumed to have taken place to the same degree in each of the three origin and destination categories.

Since the loadometer tables do not give any information concerning trip extent on the basis of the number of counties traversed, there is no direct means of determining separately the percentage of loaded vehicles making trips in one county, two counties, and in three or more counties. These percentages were estimated by assuming that they varied with the length of the trip and by utilizing the loadometer data concerning intrastate, interstate, and transstate trucking.

It was found from the loadometer data that the highest percentage of loaded vehicles was for the transstate trucks, the next highest for the interstate, and the lowest for the intrastate trucks. It was assumed that within each of these categories, the percentage of loaded vehicles increased as the number of counties traversed increased. For example, vehicles in the one-State-one-county, the one-State-two-counties, and the one-State-three-or-more-counties classifications shown in table OD-2 were assumed to have percentages of loaded vehicles in ascending order, with the total of these percentages the same as that shown in loadometer table L-5 for the intrastate classification.

The curve in figure 31, for main roads in the State of Iowa, illustrates the manner in which these estimates of percentage of loaded vehicles were made. The percentage of the total vehicle-miles classified as intrastate shown in table 12 is 74.8, and a vertical line was drawn at 74.8 percent, through D in the chart; the percentage classified as interstate is 20.2 and a vertical line was drawn at 95.0 percent (74.8 plus 20.2), through G on the chart. The remaining 5.0 percent is transstate traffic. The two vertical lines divide the chart into three sections representing intrastate, interstate, and transstate traffic, respectively. The percentage of loaded vehicles in each of the three classifications, shown in table 15, was then plotted at the center of the section, and sloping lines were drawn through these three points to form the curve shown in the figure. The slopes of these lines are, of course, indeterminate but when one is assumed, the other two are determinable. The slope of the line in the interstate field of the chart was generally the one assumed. Two penciled lines were first drawn lightly through the plotted point in this field, one passing through the plotted point in the intrastate field, and the other passing through the one in the transstate field. The line for the interstate field was then drawn so that it approximately bisected the angle between the other two lines.

The intrastate traffic is, of course, one-State traffic and is shown in table OD-3 as one-State-one-county, one-State-two-counties, and one-State-three-or-more-counties traffic. The intrastate field on the chart (fig. 31) was divided into one-county, two-counties, and three-or-more-counties fields, in accordance with the percentages shown for each in table OD–3, by vertical lines drawn through B and C in the chart.

The two-States-two-counties and the two-States-three-or-more-counties traffic is interstate, and vertical lines were drawn through E and F in the chart, in accordance with the percentages shown for these two classifications in table OD–3. The remaining percentage of the traffic is three-or-more-States-three-or-more-counties, and a portion of this is interstate and a portion is transstate. It is for this reason that the vertical line through F lies to the left of the vertical line through G in the chart.

The weighted averages of the percentages of loaded vehicles for one-county, two-counties, and three-or-more-counties traffic were then calculated from the chart as follows:

$$\text{One-county} = \frac{IA+JB}{2}$$

$$\text{Two-counties} = \left(\frac{JB+KC}{2}\times JK + \frac{LD+ME}{2}\times LM\right) \div (JK+LM)$$

$$\text{Three-or-more-counties} = \left(\frac{KC+LD}{2}\times KL + \frac{ME+OG}{2}\times MO + \frac{OG+PH}{2}\times OP\right) \div (KL+MO+OP)$$

Where necessary, small adjustments were made in the values thus computed to make them consistent with the percentage of loaded vehicles for the system as a whole, shown in tables 3 and 4. While some assumptions are involved in the method described above, it is believed that the resulting percentages are reasonably close approximations. The adjusted percentages of loaded vehicles in each of the three categories (one-county, two-counties, and three-or-more-counties) are shown for main roads in table 19. Values estimated similarly for local roads are shown in table 20. The vehicle-mileage data were combined for the two systems and the percentages of loaded vehicles derived for all rural roads are shown in table 21.

Ton-mile calculations.—The average load of loaded vehicles engaged in intrastate, interstate, and transstate traffic can be calculated from table L–9. These tables were submitted by 39 States, these being all of the States listed above as submitting data on percentage of loaded vehicles (table L–5). The average carried load for each origin and destination category was calculated from the table mentioned and these figures were adjusted to the total ton-miles of carried load shown in tables 3 and 4 in the same manner that the percentage of loaded vehicles was adjusted. The average carried loads and the ton-mileages carried on main roads are shown for 39 States and in a separate group for "Other States" in table 15. The same information for local roads is shown for 17 States in table 16. Vehicle-mileages of loaded vehicles and ton-mileage estimates for main roads and local roads were combined and average carried load and ton-mileage figures calculated for all rural roads, and these are shown in table 17.

The calculations described in the preceding paragraph involved certain assumptions, similar to those made concerning average percentage of loaded vehicles which

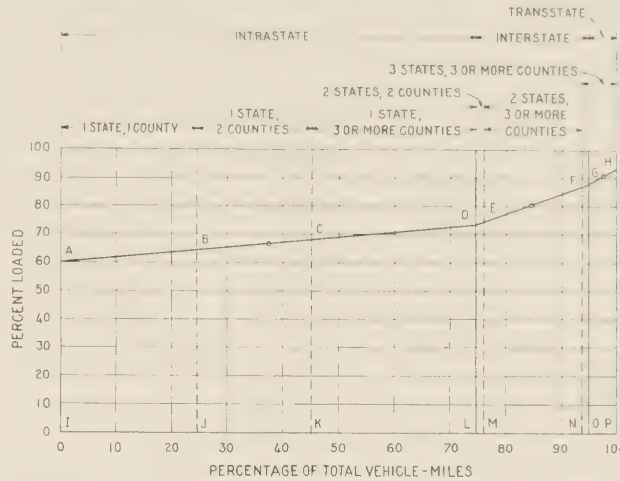


FIGURE 31.—CHART FOR IOWA MAIN ROADS, ILLUSTRATING METHOD OF ESTIMATING THE PERCENTAGE OF LOADED TRUCKS FOR ONE-COUNTY, TWO-COUNTY, AND THREE-OR-MORE-COUNTY TRUCK TRAFFIC.

were discussed above, and which are as follows: First, that the relation of the average carried loads for the three origin-destination categories is the same for local roads as for main roads; second, that the relation of the average carried loads for the three origin-destination categories did not change on either system between the survey year and 1940. As pointed out in the section concerning percentage of loaded vehicles, these assumptions have only to do with the relations of values for the three categories and not with the values themselves.

The average load carried by trucks making trips having an extent of one county only, two counties, and three or more counties was calculated using the same plan as that used in calculating the percentage of loaded vehicles of traffic in these three categories. A graph was drawn for average carried load similar to the one for percentage of loaded vehicles in figure 31, using the average carried load in tons for intrastate, interstate, and transstate traffic. In this case, however, the horizontal scale represented loaded vehicle-mileage instead of total vehicle-mileage. Such adjustments were made as were necessary to make the average carried load for each system agree with figures previously determined and shown in tables 3 and 4 of the ton-mileage series. The averages for carried load and for ton-mileage of carried load on main roads are shown for the 16 States from which the complete information was available in table 19 and for local roads in table 20. The loaded vehicle-mileage data used in calculating tables 19 and 20 and the ton-mileage figures tabulated in these tables were added together and these figures used in calculating the average carried load in tons for all rural roads, shown in table 21.

WARTIME CHANGES

All of the States except North Carolina undertook weighing operations in 1942, and submitted tables of the "W" series showing wartime trends. In New York the survey was postponed until fall because the only earlier weight data that could be used for comparisons were collected in the fall of 1939. Although the New York tables of the "W" series have now been received, they were not available when the tables and charts were prepared in final form. Since the trends shown by the New York tables are very similar to the trends calculated for the region on the basis of data from Pennsylvania and New Jersey, the tables and charts were not revised to include New York. They are based on data from all States except New York and North Carolina.

The general procedure used in calculating the figures for 1942 in table 22 involved the following steps:

a. The calculation, for each State, of trends from the original survey year to 1942 on the basis of data taken at the same stations in comparable periods in the two years. For example, it may have been found that, at the ten stations operated in a State in the 1942 survey, 27.5 percent of all vehicles counted were trucks while, at the same stations, in a comparable summer period in 1937, only 19.1 percent were trucks. The 1942:1937 trend ratio for this item would then be $27.5 \div 19.1 = 1.44$.

b. The calculation of trends from 1940 to 1942 by dividing the trends from the survey year to 1942 by the trends from the survey year to 1940. Thus, continuing the above example, assume that the 1940:1937 trend ratio for this item, used in computing table 2, was 1.08. The 1942:1940 trend ratio would then be $1.44 \div 1.08 = 1.33$.

c. The calculation of values for each item for the full year 1942 by multiplying the 1940 value shown in table 2 or 3 by the 1942:1940 trend ratio for the item. In the example, assume that table 2 shows that, for the State in question, 21.3 percent of the annual vehicle-mileage in 1940 was by trucks and truck combinations. The corresponding value for 1942 would be $21.3 \times 1.33 = 28.3$ percent.

The following items were calculated for 1942 by means of trend ratios as above described:

1. Traffic by all vehicles.
2. Trucks as a percentage of all vehicles.
3. Combinations as a percentage of all trucks.
4. Percentage of combinations loaded.
5. Average carried load for combinations.
6. Single-unit trucks as a percentage of all trucks.
7. Percentage of single-unit trucks loaded.
8. Average carried load for single-unit trucks.

These items were calculated for each State separately, and combined by regions for inclusion in table 22. Some reservations must be made with respect to items 5 and 8. In the 1942 survey those vehicles weighed while empty were not the same vehicles as those weighed while loaded. Since the percentage of travel while empty is greater for certain types of vehicles than for others, the sample of empty vehicles was not strictly comparable with the sample of loaded vehicles. In this short survey, it was not possible to weigh the same vehicle empty on one occasion and loaded on another, and therefore trends in carried load could not be computed directly. These trends were estimated on the assumption that fluctuations in carried load were proportional to fluctuations in gross load. This assumption did not tend to exaggerate changes, and may have tended to minimize them to some extent.

As regards item 1, ratios for traffic by all vehicles established by the summer counts were not believed to be representative of the entire year. In normal years there is a large tourist traffic in the summer. War restrictions have been aimed particularly at recreational driving and have checked it to a much greater extent than the more essential driving which is characterized by less seasonal fluctuation. Subsequent to the initial compilation of the table, data became available from automatic traffic recorders operated continuously throughout 1940 and 1942 at 466 stations in 46 States. As had been expected, these data showed that the 1942 vehicle-mileage computed on the basis of the midsummer trends was too low, and the column showing vehicle-miles by all vehicles was revised on the basis of the trends shown by the automatic traffic recorder data. The vehicle-miles were computed for each State separately and then combined to obtain the regional and United States totals shown. For the two States without complete automatic traffic recorder data (Delaware and New Jersey) 1942:1940 ratios were estimated on the basis of ratios in nearby States with similar traffic conditions.

Truck traffic is not subject to the same seasonal fluctuations as passenger-car traffic, and the truck-mileage trends determined from the midsummer counts might therefore be expected to be much more nearly representative of the ratios for the entire year than those for passenger vehicles. The truck-mileages calculated from the data of the special survey were therefore left unchanged in table 22 and the percentage relations between truck miles and vehicle-miles by all vehicles were recalculated. The relations were then checked against relations established from continuing survey classification counts.

Classification counts were made in 1940 and 1942, either monthly or at least once in each season, at 122 stations (identical for all counts) in the following 16 States: California, Florida, Illinois, Kentucky, Louisiana, Montana, Nebraska, Nevada, Oklahoma, Pennsylvania, South Dakota, Texas, Utah, Washington, West Virginia, and Wisconsin. Generally the counts were made only on weekdays. It would be expected that trucks would constitute a higher percentage of total traffic than would be found if Sunday counts were included. The percentage was 22.5 in 1942 compared to 21.6 in 1940, the 1942:1940 ratio being 1.04, which is exactly the same as the ratio shown in table 22. If the percentages are applied to the vehicle-mileage by all vehicles, the 1942:1940 truck-mileage ratio from the continuing classification count data is 0.885 compared to 0.89 shown in table 22. This very close check based on data for a full year from 16 States, well distributed geographically, indicates that the ratios based on the data from the special midsummer survey are representative of the ratios for the entire year, so far as trucks are concerned.

SOME PROBLEMS OF ROAD CONSTRUCTION AND MAINTENANCE IN ALASKA

By STEPHEN TABER, Professor of Geology and Mineralogy, University of South Carolina

ALASKA has an area of 586,400 square miles, approximately one-fifth that of the United States, but in 1939 it had fewer than 2,500 miles of highway and only 1,600 miles of sled roads. This lack of appreciable road mileage is due chiefly to the sparseness of population though difficulties of road construction and maintenance are factors also. The population of Alaska, according to the 1940 census, was 72,524, including 32,458 Indians and Eskimos. Normally the population is augmented during the summer by several thousand laborers in gold mines and fish canneries. In the last 2 years an unreported number of defense workers and men of the armed forces have moved into the territory.

For several years the longest continuous road in Alaska has been the Richardson Highway from Valdez to Fairbanks with its extension, the Steese Highway, from Fairbanks to Circle, a total of 522 miles (fig. 1). The Richardson Highway has been kept open for traffic for about four-and-a-half months of the year, roughly from the first of June through September. Just prior to the present war a road was begun to connect Anchorage with the Richardson Highway. Except in towns, none of the roads in Alaska has been hard surfaced.

Alaska possesses a very wide range in topography, climate, and soil. Therefore the factors affecting road conditions vary greatly in different localities. The problems of highway construction and maintenance commonly encountered in the United States are found in Alaska together with additional problems which are unfamiliar to the majority of American engineers. Most of these new problems result from the freezing and thawing of water under conditions peculiar to subpolar regions.

Nearly 30 years ago the writer began an experimental investigation of the freezing of soils.[1] The experiments were later carried on with the financial cooperation of the Public Roads Administration, formerly the Bureau of Public Roads.[2] In 1935 the author, under the sponsorship of the Geological Survey, made a field study of problems connected with perennially frozen ground in Alaska.[3] This experience enabled him better to understand and appreciate the difficulties with which road engineers in a subpolar country have had to contend.

THE PERENNIALLY FROZEN GROUND

Throughout most of Alaska, except for a broad coastal zone in the south and southeast (fig. 1), the subsoil is perennially frozen to depths which sometimes exceed 300 feet. The surface soil is subjected to seasonal thawing and refreezing to a depth of a few inches or a few feet depending upon climate, type of soil, amount of water content, exposure to sun, and amount of insulation by snow and vegetal cover.

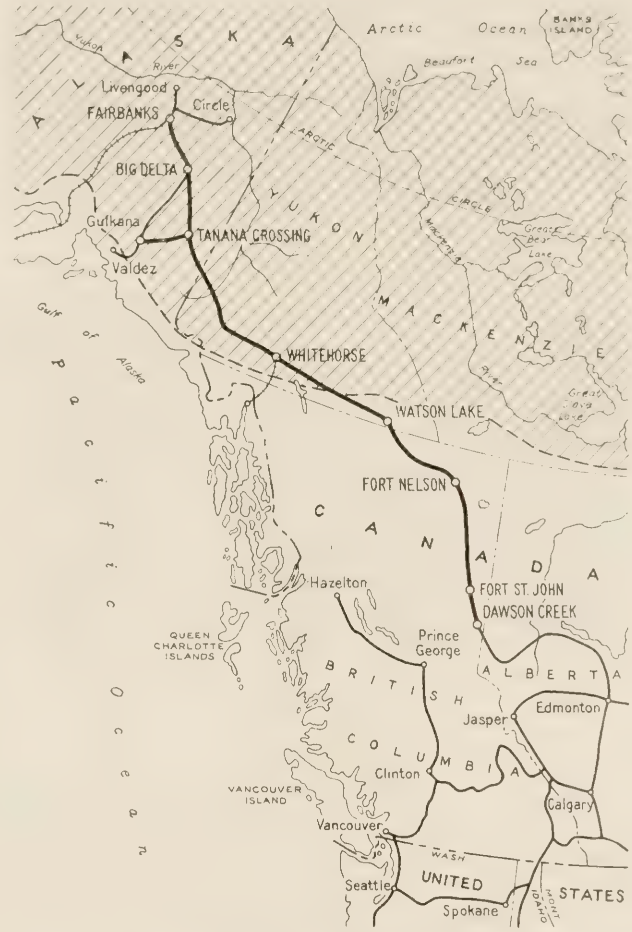


FIGURE 1.—LOCATION OF ALASKA HIGHWAY AND CONNECTING ROADS. AREA OF PERENNIALLY FROZEN GROUND IS SHOWN BY HATCHING.

In many localities the frozen ground contains masses of relatively pure ice occurring partly in almost horizontal layers or lenses, and partly in the form of nearly vertical wedge-shaped veins which, in places, merge into overlying ice layers (fig. 2). Layers vary from a few inches to 12 feet or more in thickness, and veins are as much as 8 feet in width. In some areas ice amounts to 80 percent of the volume of frozen ground.

The deep freezing occurred in early Pleistocene time, perhaps a million years ago. Since then, part of the ground has been deeply thawed and refrozen at least once but most of it has remained continuously frozen to the present time. There is considerable evidence that during the last few thousand years the climate, on the average, has become warmer and that the area of perennially frozen ground has been decreasing.

Over large areas the surface of Alaska is covered with a dense growth of mosses, grasses and other small plants which grade downward into a peaty layer. This plant

[1] The Growth of Crystals Under External Pressure, The American Journal of Science, vol. XLI, June 1916; Ice Forming in Clay Soils Will Lift Surface Weights, Engineering News-Record, vol. 80, No. 6, February 7, 1918; Surface Heaving Caused by Segregation of WaterForming Ice Crystals, *ibid.*, vol. 81, No. 15, October 10, 1918.

[2] Frost Heaving, The Journal of Geology, vol. XXXVII, No. 5, July–August, 1929; The Mechanics of Frost Heaving, *ibid.*, vol. XXXVIII, No. 4, May–June 1930; Freezing and Thawing of Soils as Factors in the Destruction of Road Pavements, PUBLIC ROADS, vol. 11, No. 6, August 1930.

[3] Perennially Frozen Ground in Alaska, Its Origin and History, by Stephen Taber, will be published shortly by the Geological Society of America.

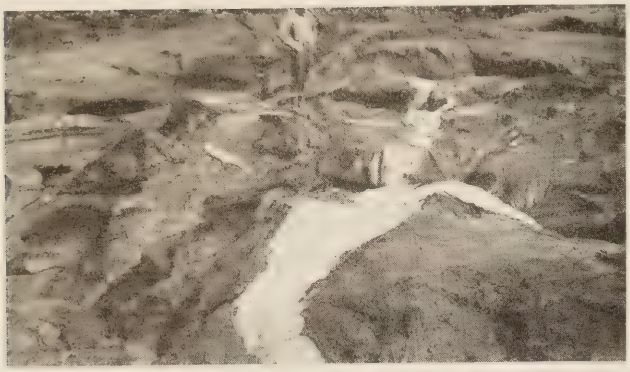


FIGURE 2.—ICE VEINS IN SILT EXPOSED DURING STRIPPING OPERATIONS ON ENGINEER CREEK, NEAR FAIRBANKS.

By Courtesy of Alaska Road Commission.

FIGURE 4.—FLUID MUD FLOW ON GULKANA-CHISANA ROAD.

FIGURE 3.—WIDENING THE FAIRBANKS-LIVENGOOD ROAD. REMOVAL OF DENSE COVER OF VEGETATION AND PEAT HAS RESULTED IN DEEPER SUMMER THAWING OF PERENNIALLY FROZEN GROUND.

By Courtesy of Alaska Road Commission.

FIGURE 5.—ICE ON STEESE HIGHWAY AT FOX GULCH, MARCH 14, 1933. TELEPHONE WIRES ARE STRUNG ON TRIPODS TO AVOID HEAVING. LITTLE SNOW ACCUMULATED DURING THE WINTER.

material is like a sponge in its absorption of water and thus prevents rapid run-off. It also acts as an insulating blanket so that slow thawing through the summer helps to keep the soil wet. Most of the precipitation in central Alaska occurs in the form of light showers during summer and early fall. Since water does not percolate downward through the frozen subsoil, and surface drainage is slow, the soil is usually saturated close to the surface when seasonal freezing occurs. Removal of the vegetal cover in the construction of roads results in deeper thawing.

SEGREGATION OF WATER IN THE FORM OF ICE DURING THE FREEZING OF SOILS

Miniature ice layers and ice veins, similar in every respect except size to those found in Alaska, have been produced by the writer in laboratory experiments.

When soils saturated with water are cooled from the surface downward, as happens normally in the ground, the water immediately below the zone of freezing is usually free to move either upward to feed the growing ice crystals or downward away from them. In other words, the freezing occurs in an open rather than in a closed system, and any surface heaving, or other pressure effect observed, results from the growth of ice crystals rather than from the increase in volume that accompanies the freezing of water.

If freezing takes place in coarse-grained material, such as gravel and clean sand, ice forms in the relatively large interstitial spaces, the excess water being expelled downward so that little or no heaving of the surface occurs. But if freezing takes place in fine-grained soils, water is fed to the growing ice crystals which build up masses of relatively pure ground ice. The pressure developed by a growing ice crystal is in the direction of growth, which is usually normal to the cooling surface. Surface heaving results from the formation of masses of ice crystals and is approximately proportional to the size of these masses. Therefore, under favorable conditions, the uplift may greatly exceed that which could be brought about by a change in volume of the water when frozen. In some instances the surface uplift is equal to 80 percent or more of the depth of freezing.

Over large areas in central and northern Alaska the prevailing soil is a fine-grained silt containing little or no clay. This soil is, therefore, quite permeable and, when slowly cooled, it is a medium highly conducive to the formation of segregated ice. The silt ranges in thickness from shallow deposits to more than 200 feet in some of the valleys; and it is in these thick deposits that most of the very large masses of ground ice are found. The fine-grained silts are most abundant in the large areas of central and northern Alaska which were not covered by the continental ice caps of Pleistocene time, as were large areas farther south.

DIFFERENTIAL FROST HEAVING

Frost heaving is especially intense over perennially frozen ground because the fine-grained soil is usually saturated with water close to the surface when freezing occurs. As a result of repeated cycles of freezing and thawing, posts and similar objects work up out of the ground to an extent that is unknown in the northern parts of the United States. Partly for this reason, and partly because of the difficulty of digging deep holes in frozen ground, telegraph and telephone wires are commonly strung on tripods (figs. 5 and 7).

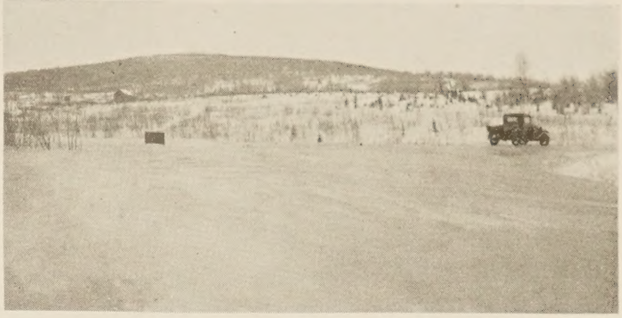
Uniform heaving has little direct effect on highways; but differential heaving of the surface may damage highways and even interrupt traffic. The principal causes of differential heaving of the surface are local differences in soil texture, the water supply, and the rate of freezing.

The most striking instance that has come to the writer's attention of the differential heaving of a roadway occurred in the early winter of 1934 on the Steese Highway at mile post 24, northeast of Fairbanks. The locality was examined the following summer by the writer in company with Mr. Frank Nash of the Alaska Road Commission, who described the heaving in detail. The road, which passes along the lower part of a steep hill slope having a southerly exposure, was locally heaved up with the formation of a hummock about 20 feet across and 7 to 8 feet high. A crack about 1 foot wide formed along the crest of the hummock.

The soil at the place where the hummock formed is a fine, micaceous silt, containing angular fragments of the mica schist from which it was derived by processes of disintegration, chiefly frost action. The surface is covered with a dense growth of mosses and grasses which grade downward into a foot or more of peaty material. This vegetal blanket had been removed locally in grading the road. A shallow ditch along the upper side of the road collected seepage water draining down the slope and conducted it to a culvert passing under the gravel-surfaced road.

Freezing, and therefore heaving, began first under the road which was not protected by the insulating blanket of vegetal material. The culvert, if not already blocked, was soon rendered useless by the heaving. For some time after heaving began, water continued to percolate down the slope under the protection of the vegetal mat which had been warmed by long exposure to the sun. Rupturing of the surface crust along the top of the growing hummock exposed the underlying soil to more rapid cooling. Such excessive differential heaving is, of course, very unusual. It may be prevented by a drainage system that will not allow water to accumulate under the road.

On slopes with southerly exposures summer thawing normally penetrates to a greater depth than on other slopes, and this helps to explain why frost troubles are somewhat more common where roads are located along the bases of slopes facing the south. When refreezing occurs in the fall and early winter the thaw-water, under favorable conditions, may continue for some time to percolate down the slope between the downward freezing surface layer and the deeply frozen ground below. If the percolating water becomes trapped between the frozen layers, so that it cannot readily escape, hydrostatic pressure may be developed. This condition tends to accentuate heaving. Occasionally the heaving ground is ruptured with a loud report like the sound of a cannon, and fragments of ice and frozen soil may be flung considerable distances. Such explosive effects are due to the sudden relief of stresses in elastic material. The stresses are set up by the slow growth of masses of ground ice or by the hydrostatic pressure of confined water or by both of these factors. Such occurrences are rather rare in Alaska, and they should not be confused with the relatively common tension cracks that form suddenly as a result of contraction of frozen ground in very cold weather. Cracks of this type are seldom more than one-half inch in width, and they tend to close as the temperature rises.



By Courtesy of Alaska Road Commission.

FIGURE 6.—THICK ICE BURYING HIGHWAY IN FAIRBANKS DISTRICT, MARCH 14, 1933. LITTLE SNOW ACCUMULATED DURING THE WINTER.

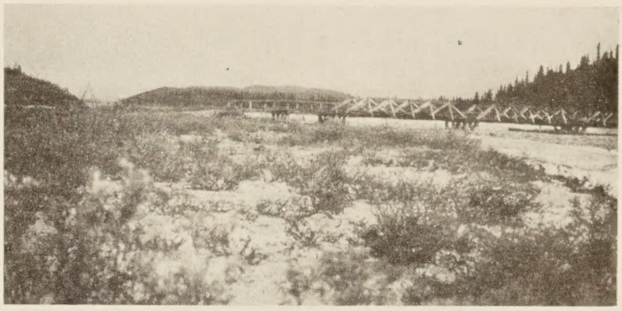


FIGURE 7.—FOUR-SPAN BRIDGE OVER STREAM ON RICHARDSON HIGHWAY, SUMMER OF 1935. BRIDGE WAS BURIED UNDER ICE DURING THE PREVIOUS WINTER.

DOWN-SLOPE CREEP

As freezing progresses inward from a sloping surface, each ice crystal formed grows by additions of molecules to its base and pushes outward in the direction of heat conduction, or normal to the surface. The soil particles are moved outward in the same direction, those at the surface being displaced the most, and those near the bottom of the zone of freezing the least. On thawing, the soil settles vertically downward under the influence of gravity. Each freezing cycle, therefore, results in a small down-slope displacement of the surface. Thaw-water escaping through the expanded soil displaces some soil particles, and thus hastens downward creep. Because of the abnormally high water table on steep slopes where ground is perennially frozen, soil creep is relatively rapid. In Mount McKinley National Park, down-slope displacement of the road is reported by the road engineers to be especially rapid where it passes along the south-facing slope between the Savage and Sanctuary rivers.

PROBLEMS RESULTING FROM THAWING

Thawing penetrates to greater depth under a bare roadway than under an insulating blanket of peat and vegetation. A road constructed on perennially frozen ground containing a high percentage of ice may be passable for cars and trucks when newly graded, but become impassable later as a result of deep thawing. Where the slopes are steep, mud flows and slumps occur; where the ground is low and flat, the roadway becomes deep mud. The road from Fairbanks to Livengood, north of the Chatanika River, was graded in 1933, but some parts were in such bad condition in the summer of 1935 that the road was not open to

Photo by Mrs. H. E. Revelle.

FIGURE 8.—BRIDGE BURIED UNDER ICE, RICHARDSON HIGHWAY, SPRING OF 1935.

Photo by Mrs. H. E. Revelle.

FIGURE 9.—REMOVING ICE FROM BRIDGE ON RICHARDSON HIGHWAY. BOILER FURNISHES STEAM FOR THAWING. LITTLE SNOW ON VALLEY SLOPES.

traffic. In broadening the road the grading machine exposed a mass of ground ice at the point shown in figure 3.

Where drainage is good, so that thaw-water can escape, a road becomes stabilized in time but on flat, poorly drained surfaces it is often preferable to leave the insulating turf in place and build the road on top of it, or on top of a corduroy laid on the turf, so as to prevent thawing under the roadbed.

More water can be introduced into a soil in situ by freezing and thawing than in any other way. Introduction of water by percolation is limited by a soil's porosity but the volume of segregated ice formed in fine-grained soils may be several times the volume of the voids present before freezing because additional water has been drawn up from below. The thin layer of thawed soil resting on perennially frozen subsoil is commonly saturated with water when seasonal refreezing takes place. Freezing tends to concentrate the water in the upper part of the surface layer at the expense of water in the lower part and, where this water is replaced by down-slope percolation from a higher elevation, the total water content may be greatly increased locally as in the case of excessive heaving previously described. Rapid thawing of surface soils by warm rains in early summer often results in shallow mud flows of high fluidity as shown in figure 4. Interstitial water adds to the weight of the soil mass and also acts as a lubricant. Compaction due to settling or shearing of saturated silts that have been expanded by freezing causes them to behave like a liquid.

BURIAL OF HIGHWAYS UNDER ICE

Springs and seepages of ground water that continue to flow after most of the surface soil has frozen build up large deposits of ice (figs. 5 and 6) locally called "glaciers" which may cover an area of thousands of square yards and attain a thickness of more than 25 feet. This happens chiefly near the bases of steep slopes with southerly exposures. Similar accumulations of ice formed by streams that freeze to their beds and overflow are also erroneously called "glaciers." The ice tends to accumulate below points where streams emerge from under protective screens of vegetation or from under glaciers and where streams spreading out over gravelly beds become shallow.

In winter, the road in Mount McKinley National Park becomes buried at several places under such heavy deposits of ice that it is necessary to thaw and remove the ice to open the road for early summer traffic. The worst condition in recent years developed at a point where a corrugated, galvanized iron culvert conducted the water of a small stream under the road. The water, trickling down under the protection of a dense growth of vegetation, continued to flow after freezing began along the exposed roadbed. Rapid conduction of heat by the metal culvert hastened freezing and, when the culvert became blocked, water overflowed to freeze on the road and bury it under ice. Perhaps the trouble might have been prevented by substituting for the metal culvert a wooden culvert with steep slope and extending it well up into the vegetation so as to protect the water from rapid cooling while flowing quickly under the road. Wood may be used for culverts in Alaska because it decays very slowly under the climatic conditions prevailing in areas of perennially frozen ground.

Where the Richardson Highway passes through the valley of the Delta River, a four-span, wooden bridge (fig. 7) over a glacial stream was almost completely buried under ice during the winter of 1934–35. The stream continued to flow from under the protecting glacier during cold weather, but a short distance below, near the bridge, the water spreading out over its broad gravelly bed became cold enough to freeze. Ice forming on the bed of the stream caused the water to overflow. When the stream froze over, water broke through cracks to overflow and form ice farther down. Repetition of these processes resulted in the burial of the bridge as shown in figure 8.

The bridge was cleared for traffic in the spring by melting and breaking out blocks of ice which could be hauled away by a tractor (figs. 9 and 10). Steam from a boiler was used for the thawing. Trouble such as this can be prevented in some places by wise selection of a road's location or by the building of a relatively high bridge.

FLOODS

The annual precipitation over most of the area of perennially frozen ground in Alaska is less than 15 inches. At Fairbanks it is 11.03 inches. Surprisingly little snow accumulates in the winter in central Alaska since more than half of the precipitation is in the form of light rains, chiefly during July, August, and September. Under these conditions large floods in the rivers are rare except during the spring "break-up" when ice jams are common.

Flash floods occur on some of the small mountain streams, especially when warm summer rains cause rapid melting of glacial ice. Such floods are most troublesome in the valley of the Delta River where the

Richardson Highway crosses several alluvial cones. These cones have been built up by small streams during floods which bring down heavy loads of boulders, pebbles, and sand. Deposition of the material is caused by the sudden change in grade as the streams enter the broad valley of the Delta River. The road is commonly downgrade in both directions from the bridge over a stream that is building a cone.

When floods occur, small bridges are frequently washed out. Sometimes a stream takes a new course down a cone, leaving the bridge spanning a dry channel. In the summer of 1931 a small bridge was completely buried under a deposit of boulders brought down by Gunnysack Creek, making necessary the building of a new bridge (fig. 11).

THE ALASKA HIGHWAY

The new road to Alaska, in passing northward from Dawson Creek, probably does not pass over perennially frozen ground until it crosses into Yukon Territory. In Alberta and British Columbia perennially frozen ground is found only locally and at high altitudes, but it is reported to extend over nearly all of Yukon Territory.[4] Muskegs, (sphagnum bogs with tussocks) are troublesome south of the region of perennially frozen ground where they thaw completely in summer, but the road has been so located as to avoid most of them.

Much of the country traversed by the Alaska highway was subjected to Pleistocene glaciation, and thick deposits of fine silts containing large amounts of ground ice are not common in the glaciated areas. The highway joins the Richardson Highway near the junction of the Delta and Tanana rivers and just north of the glacier section where maintenance has been so difficult. Glaciers are not found in the immediate vicinity of the new road. Along its route precipitation in the form of both rain and snow is relatively light.

[4] Frozen Ground in the Glaciated Parts of Northern Canada, by W. A. Johnston, F. R. S. C., Transactions of the Royal Society of Canada, section IV, series III, vol. XXIV, May 1930.

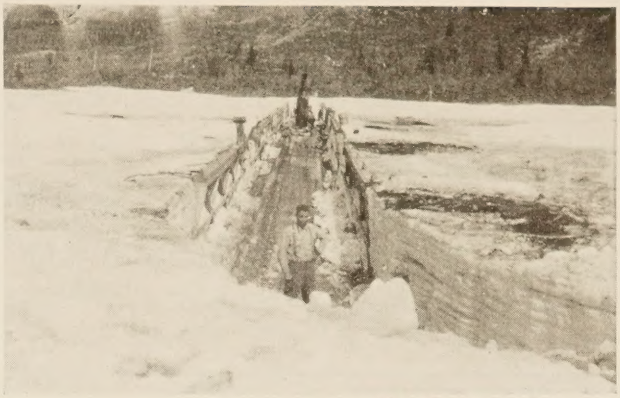


Photo by Mrs. H. E. Revelle.

FIGURE 10.—REMOVING ICE FROM BRIDGE ON RICHARDSON HIGHWAY, SPRING OF 1935.

FIGURE 11.—BRIDGE OVER GUNNYSACK CREEK ON RICHARDSON HIGHWAY. AN EARLIER BRIDGE IS BURIED UNDER BOULDERS AT THE POINT WHERE MAN IS STANDING.