

Highway Ton-Miles

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Highway ton-mile estimates are used as a measure of highway use and service provided for goods movements by highway transportation. Comparisons are made between highway systems, with other modes of transportation, with previous years to determine trends, and between segments of the motor carrier industry. This paper describes the procedures for estimating highway ton-miles, discusses problems involved in analysis, and compares highway ton-miles with similar values for other modes of transportation. Additional information on truck travel obtained during 1963 is also presented for study in resolving some of the problems.

•ESTIMATES OF ton-miles of goods hauled on rural highways have been made by the U.S. Bureau of Public Roads since 1929. Until 1936, however, the estimates were limited to all rural roads and were made from a very small statistical sample with practically no information to indicate urban travel or the proportion on local rural roads separately from main rural roads. The initiation of the statewide highway planning studies in 1936 and the subsequent annual programs provided the necessary information to make separate estimates for main and local rural roads. It was not until 1957 that adequate information on urban streets was obtained for estimating ton-miles in urban as well as rural areas.

Since 1939 the Interstate Commerce Commission (ICC) has been making estimates of intercity ton-miles of truck travel as part of its responsibility of obtaining information concerning that segment of highway transportation in interstate commerce.

The need to determine the components of the highway cargo movement so that intercity ton-mile trends could be checked, compared with other modes, and carried forward with greater confidence was recognized by the U.S. Bureau of Public Roads, ICC, the Bureau of the Budget and other agencies involved in estimating and using data for annual ton-miles. The U.S. Bureau of Public Roads obtained additional special information as part of its responsibility for estimating highway ton-miles. The data were obtained during the 1963 annual truck weight study conducted in cooperation with state highway departments.

PROCEDURES FOR ESTIMATING HIGHWAY TON-MILES

The annual highway ton-mile estimates published by the U.S. Bureau of Public Roads (1) and ICC (2) are both based primarily on truck weight data obtained from roadside sample surveys conducted by the state highway departments as part of their highway planning programs. This roadside weighing of trucks involves the sampling of a statistical population of vehicle-miles of truck travel. For other modes, where practically all carriers are in the "regulated" category, intercity ton-mile estimates are based on samples from a statistical population of shipments.

The ton-mile estimates are based on three categories of data. Total vehicle-miles for all vehicle types combined are the first basic element. Vehicle type classification counts are next used in apportioning the total vehicle-miles to each vehicle type.

Finally, the truck weight data are used to estimate the ton-miles hauled by each vehicle type. Since all three of these elements are interdependent, adjustment procedures have been developed to assure consistent relationships. The estimates of total vehicle-miles for all vehicle types are based on annual trends in highway traffic at over 2,000 locations on all classes of roads and streets at which traffic is counted continuously, highway motor fuel consumption determined from tax records, and motor vehicle registration data for each state. Vehicle type classification data are obtained by manual counts conducted at locations on rural roads and urban streets. Classification counts are conducted each year as a part of the annual truck weight operations, but in most states these counts represent only a small part of the classification count program. The scale weights of loaded and empty vehicles of each type are obtained at the roadside during the annual truck weight studies.

The ton-miles of cargo hauled by each vehicle type are estimated using the procedure indicated by the equation,

$$TM_v = VM_v \times P_l \times (\bar{W}_l - \bar{W}_e) \quad (1)$$

where

- TM_v = ton-miles of cargo hauled by vehicle type;
- VM_v = total vehicle-miles of travel by vehicle type;
- P_l = percentage of trucks of type loaded;
- \bar{W}_l = mean (average) weight of loaded vehicles for vehicle type (tons); and
- \bar{W}_e = mean weight of empty vehicles for vehicle type (tons).

The term $(\bar{W}_l - \bar{W}_e)$ is the average carried load. This factor, when multiplied by the percent loaded (P_l), is referred to as the loading factor $P_l (\bar{W}_l - \bar{W}_e)$ since multiplying this factor times vehicle-miles results in estimated ton-miles hauled.

The ICC estimates are based on the Public Roads main rural road ton-miles values adjusted to remove that portion resulting from entirely rural movements and to add the estimated ton-miles resulting from that portion of the intercity movement occurring within urban areas.

ANALYSIS AND PROBLEMS IN ANALYSIS

Tables 1 and 2 show 1962 data for truck vehicle-miles, percent loaded, average carried load, loading factor, and carried load in ton-miles by vehicle type for each census division. Similar estimates have been made each year in preparing ton-mile figures for all rural roads and all roads and streets since 1957. The United States total and census division values are first estimated from the individual state truck weight reports. Slight adjustments are sometimes necessary to bring the estimates of truck vehicle-miles into agreement with travel estimates of all vehicle types and with fuel consumption by vehicle types. The state volumes are then adjusted if necessary by a factor for each census division relating the sum of the state values to the estimated census division value. Because of this adjustment and since both loading and vehicle-mile estimates for a few states are based on rather limited data, individual state estimates are not considered statistically reliable and, hence, are not published.

The Public Roads ton-mile estimates for main rural roads since 1939 and for total rural and urban since 1957 are compared by years with the ICC intercity ton-mile values in Table 3 and Figure 1. The similarity in pattern between these estimates is evident. It is also significant that the intercity volume amounts to approximately 90 percent of the total rural and urban ton-miles since 1957 when the reliable urban estimates were first available.

Since 1957 when information was first available on haulage in urban areas, the urban proportion has approximated 25 percent of all highway freight transportation.

TABLE 1
TRAVEL, LOADING CHARACTERISTICS, AND TON-MILES HAULED ON MAIN RURAL ROADS, 1962^a

Vehicle Classification	New England	Middle Atlantic	South Atlantic (North)	South Atlantic (South)	East North Central	West North Central	East South Central	West South Central	Mountain	Pacific	All Divisions	
											Avg.	Total ^b
(a) Travel, Loaded and Empty (veh-mi, millions)												
Single units:												
Panel and pickups	619	2,056	1,620	3,304	3,095	2,593	2,458	4,587	2,423	3,003	-	25,758
2 axle - 4 tire	191	520	286	199	406	160	293	37	200	92	-	2,384
2 axle - 6 tire	681	1,736	1,247	1,764	2,517	1,483	1,593	1,607	814	871	-	14,313
3 axle	107	299	237	253	320	216	133	214	112	207	-	2,098
Total	1,598	4,611	3,390	5,520	6,338	4,452	4,477	6,445	3,549	4,173	-	44,553
Semitrailer combinations:												
2S1 - 3 axle	212	579	158	368	1,049	274	251	421	193	183	-	3,688
2S2 - 4 axle	352	2,096	910	1,832	2,428	761	1,103	982	227	141	-	10,832
2S3 - 5 axle	47	76	113	83	953	822	214	1,248	947	748	-	5,251
Total	611	2,751	1,181	2,283	4,430	1,857	1,568	2,651	1,367	1,072	-	19,771
(b) Vehicles Carrying Loads (%)												
Single units:												
Panel and pickups	46.2	49.2	35.0	40.0	61.3	48.2	53.0	38.4	52.9	43.0	46.5	-
2 axle - 4 tire	62.3	64.0	62.0	64.9	72.0	65.3	71.2	61.8	56.8	67.5	65.5	-
2 axle - 6 tire	57.6	57.5	65.5	59.1	71.1	67.2	63.7	62.9	70.0	63.1	64.2	-
3 axle	54.8	56.6	52.9	54.1	64.5	60.8	58.5	66.8	56.1	46.9	57.6	-
Total	53.6	54.5	49.7	47.6	66.0	55.7	58.2	45.6	57.2	47.9	53.7	-
Semitrailer combinations:												
2S1 - 3 axle	61.7	65.6	69.8	62.9	60.4	66.4	68.5	60.0	73.1	78.2	64.4	-
2S2 - 4 axle	67.6	62.7	70.4	61.7	69.4	63.9	67.5	64.4	63.5	70.8	65.7	-
3S2 - 5 axle	58.2	63.7	50.3	58.3	69.1	72.4	69.5	71.1	75.8	72.5	71.1	-
Total	64.8	63.3	68.4	61.8	67.2	68.0	67.9	66.9	73.4	73.2	66.9	-
(c) Avg. Carried Load (tons)												
Single units:												
Panel and pickups	0.74	0.40	0.55	0.63	0.65	0.84	0.92	1.18	0.95	0.99	0.82	-
2 axle - 4 tire	1.41	0.84	0.61	0.93	0.91	1.01	0.96	2.22	1.46	1.02	0.98	-
2 axle - 6 tire	3.04	2.96	4.20	3.94	3.77	3.73	4.58	5.88	3.91	4.65	4.09	-
3 axle	8.53	10.79	12.04	12.66	12.10	11.23	13.97	12.59	11.58	10.46	11.72	-
Total	2.42	2.18	3.18	2.58	2.57	2.56	2.74	3.36	2.14	2.45	2.64	-
Semitrailer combinations:												
2S1 - 3 axle	6.10	5.76	6.92	6.12	6.68	6.34	6.72	6.32	6.67	5.80	6.34	-
2S2 - 4 axle	11.40	12.20	13.44	12.56	12.78	12.12	13.22	12.15	11.17	9.31	12.51	-
3S2 - 5 axle	16.50	11.38	15.04	15.08	19.08	16.77	16.42	14.39	15.21	17.40	16.27	-
Total	10.01	10.77	12.66	11.59	12.88	13.48	12.62	12.44	13.43	14.26	12.46	-
(d) Loading Factors (% vehicles carrying loads × avg. carried load)												
Single units:												
Panel and pickups	0.342	0.197	0.193	0.252	0.398	0.405	0.488	0.453	0.503	0.426	0.381	-
2 axle - 4 tire	0.878	0.538	0.378	0.604	0.655	0.660	0.684	1.372	0.829	0.689	0.642	-
2 axle - 6 tire	1.751	1.702	2.751	2.329	2.680	2.507	2.917	3.699	2.737	2.934	2.626	-
3 axle	4.674	6.107	6.369	6.849	7.805	6.828	8.172	8.410	6.496	4.906	6.751	-
Total	1.297	1.188	1.580	1.228	1.696	1.426	1.595	1.532	1.224	1.174	1.418	-
Semitrailer combinations:												
2S1 - 3 axle	3.764	3.779	4.830	3.849	4.035	4.210	4.603	3.792	4.876	4.536	4.083	-
2S2 - 4 axle	7.706	7.649	9.462	7.750	8.869	7.745	8.924	7.825	7.093	6.591	8.219	-
3S2 - 5 axle	9.603	7.249	7.565	8.792	13.184	12.141	11.412	10.231	11.529	12.615	11.568	-
Total	6.486	6.817	8.659	7.163	8.655	9.166	8.569	8.322	9.858	10.438	8.336	-
(e) Carried Load (ton-mi, millions)												
Single units:												
Panel and pickups	213	405	311	828	1,240	1,049	1,194	2,071	1,218	1,279	-	9,808
2 axle - 4 tire	169	278	108	120	265	106	201	50	165	64	-	1,526
2 axle - 6 tire	1,194	2,953	3,436	4,108	6,742	3,718	4,652	5,945	2,231	2,555	-	37,534
3 axle	501	1,829	1,511	1,733	2,498	1,473	1,081	1,800	730	1,013	-	14,169
Total	2,077	5,465	5,366	6,789	10,745	6,346	7,128	9,866	4,344	4,911	-	63,037
Semitrailer combinations:												
2S1 - 3 axle	796	2,187	761	1,415	4,239	1,152	1,156	1,596	941	829	-	15,072
2S2 - 4 axle	2,718	16,025	8,610	14,210	21,536	5,890	9,841	7,686	1,609	932	-	89,057
3S2 - 5 axle	451	551	854	730	12,572	9,976	2,442	12,771	10,918	9,432	-	60,697
Total	3,965	18,763	10,225	16,355	38,347	17,018	13,439	22,053	13,468	11,193	-	164,826

^aMain rural roads consist of approximately 500,000 miles of roads of primary importance in the state highway system.

^bFor 48 states.

In rural areas where the information has been available over a longer period of time, there has been some change in the proportion of haulage over local and main rural roads. Before World War II, haulage on main rural roads amounted to about 80 percent of all rural road ton-mileage. By 1957 when extensive data were obtained for the Highway Cost Allocation Study, this had increased to about 88 percent. This reflects the increased proportion of intercity freight hauled by highway in the larger hauling units, the semitrailer, and full trailer combination, which largely operate on the main intercity routes. In terms of absolute volumes, ton-mile volumes on main and local

TABLE 2
TRAVEL, LOADING CHARACTERISTICS, AND TON-MILES HAULED ON URBAN STREETS, 1962^a

Vehicle Classification	New England	Middle Atlantic	South Atlantic (North)	South Atlantic (South)	East North Central	West North Central	East South Central	West South Central	Mountain	Pacific	All Divisions	
											Avg.	Total ^b
(a) Travel, Loaded and Empty (veh-mi, millions)												
Single units:												
Panel and pickups	1,017	2,004	912	2,211	4,248	1,841	1,570	2,841	1,520	4,380	-	22,544
2 axle - 4 tire	340	566	654	397	941	116	125	139	228	352	-	3,858
2 axle - 6 tire	1,131	1,943	480	807	2,359	1,121	716	536	514	1,452	-	11,059
3 axle	157	267	171	107	220	203	45	35	82	228	-	1,515
Total	2,645	4,780	2,217	3,522	7,768	3,281	2,456	3,551	2,344	6,412	-	38,976
Semitrailer combinations:												
2S1 - 3 axle	185	464	81	84	441	98	105	63	60	151	-	1,732
2S2 - 4 axle	302	1,949	268	398	792	159	440	114	55	92	-	4,569
2S3 - 5 axle	6	130	27	36	270	211	46	173	194	175	-	1,268
Total	493	2,543	376	518	1,503	468	591	350	309	418	-	7,569
(b) Vehicles Carrying Loads (%)												
Single units:												
Panel and pickups	68.7	63.0	36.2	47.5	70.1	50.6	47.3	49.2	50.4	38.6	52.5	-
2 axle - 4 tire	61.9	72.9	56.9	68.7	70.3	65.0	58.7	55.8	61.7	75.3	66.4	-
2 axle - 6 tire	54.2	73.8	50.6	63.3	71.8	68.8	65.3	69.5	70.5	69.5	67.6	-
3 axle	58.1	68.5	41.0	50.0	69.5	63.4	68.5	61.7	55.9	51.0	59.0	-
Total	61.0	68.8	45.8	53.6	70.6	58.1	53.5	52.7	56.1	48.0	58.4	-
Semitrailer combinations:												
2S1 - 3 axle	51.5	66.3	64.3	64.0	65.6	70.1	73.2	64.5	60.5	71.9	65.2	-
2S2 - 4 axle	50.2	66.3	70.3	58.5	74.5	64.2	70.1	61.0	62.7	60.3	66.2	-
2S2 - 5 axle	69.9	66.0	59.3	45.2	60.6	67.1	69.5	67.2	73.2	62.6	65.2	-
Total	50.9	66.3	68.2	58.6	69.4	66.7	70.6	64.7	68.8	65.4	65.8	-
(c) Avg. Carried Load (tons)												
Single units:												
Panel and pickups	0.39	0.31	0.54	0.47	0.55	0.43	0.75	0.58	0.42	0.51	0.50	-
2 axle - 4 tire	0.37	0.58	0.85	0.54	0.75	1.04	0.92	1.98	1.04	0.67	0.74	-
2 axle - 6 tire	2.05	2.25	2.83	1.94	3.37	2.11	2.67	2.59	1.75	2.25	2.49	-
3 axle	7.98	7.53	8.45	6.83	7.75	8.67	8.39	10.22	7.36	6.61	7.80	-
Total	1.45	1.59	1.75	1.06	1.65	1.69	1.63	1.15	1.10	1.33	1.47	-
Semitrailer combinations:												
2S1 - 3 axle	5.53	5.00	5.66	3.42	4.89	5.24	6.78	4.99	5.80	4.09	5.05	-
2S2 - 4 axle	11.39	10.72	11.41	7.87	9.93	9.29	10.95	12.77	11.37	6.58	10.37	-
2S2 - 5 axle	5.88	12.73	14.76	12.98	15.28	13.35	13.69	13.53	13.57	13.70	13.77	-
Total	9.07	9.78	10.44	7.36	9.37	10.23	10.39	11.76	11.88	8.45	9.73	-
(d) Loading Factors (% vehicles carrying loads x avg. carried load)												
Single units:												
Panel and pickup	0.268	0.195	0.195	0.223	0.386	0.218	0.355	0.285	0.212	0.197	0.263	-
2 axle - 4 tire	0.229	0.423	0.484	0.371	0.527	0.676	0.540	1.105	0.642	0.505	0.491	-
2 axle - 6 tire	1.111	1.661	1.432	1.228	2.420	1.452	1.744	1.800	1.234	1.564	1.683	-
3 axle	4.636	5.158	3.465	3.415	5.386	5.497	5.747	6.306	4.114	3.473	4.602	-
Total	0.885	1.094	0.802	0.568	1.165	0.982	0.872	0.606	0.617	0.638	0.858	-
Semitrailer combinations:												
2S1 - 3 axle	2.848	3.315	3.639	2.220	3.208	3.673	4.963	3.219	3.509	2.941	3.293	-
2S2 - 4 axle	5.718	7.107	8.021	4.604	7.398	5.964	7.676	7.790	7.129	3.968	6.865	-
2S3 - 5 axle	4.110	8.402	8.753	5.867	9.260	8.958	9.515	9.092	9.933	8.576	8.978	-
Total	4.617	6.484	7.120	4.313	6.503	6.823	7.335	7.609	8.173	5.526	6.402	-
(e) Carried Load (ton-mi, millions)												
Single units:												
Panel and pickups	270	396	180	490	1,639	401	559	811	324	865	-	5,935
2 axle - 4 tire	78	240	315	147	498	78	68	153	146	177	-	1,900
2 axle - 6 tire	1,254	3,226	697	993	5,705	1,624	1,249	964	635	2,271	-	18,608
3 axle	731	1,378	590	364	1,184	1,115	260	223	339	790	-	6,974
Total	2,333	5,240	1,772	1,994	9,026	3,218	2,136	2,151	1,444	4,103	-	33,417
Semitrailer combinations:												
2S1 - 3 axle	525	1,536	297	185	1,413	361	524	203	212	443	-	5,699
2S2 - 4 axle	1,726	13,839	2,150	1,835	5,853	949	3,379	886	396	365	-	31,378
2S2 - 5 axle	25	1,097	232	214	2,502	1,886	434	1,573	1,922	1,501	-	11,386
Total	2,276	16,472	2,679	2,234	9,768	3,196	4,337	2,662	2,530	2,309	-	48,463

^aUrban streets consist of approximately 470,000 miles of roads of primary importance in the state highway system or 13 percent of the total mileage.

^bFor 48 states.

rural roads have increased nearly 10 times in the last 30 years from an estimated 30 billion in 1933 to about 289 billion in 1963. The average annual increase in the last 10 years has been about 112 billion ton-miles or 6.1 percent. This is nearly twice the rate of increase in the economy of the nation as measured by the gross national product, which has been increasing, when adjusted to real values, about 3 to 4 percent per year.

TABLE 3
COMPARISONS OF HIGHWAY TON-MILE ESTIMATES^a

Year	U.S. Bureau of Public Roads Estimates (ton-mi, millions)			ICC Estimate		
	Main Rural Rd.	All Rural Rd.	Total Rural Rd. and Urban St.	Inter-city (ton-mi, millions)	Percent of Total Rural Ton-Miles	Percent of Total Rural and Urban Ton-Miles
1929	-	26,000	-	-	-	-
1930	-	24,000	-	-	-	-
1931	-	23,000	-	-	-	-
1932	-	26,000	-	-	-	-
1933	-	30,000	-	-	-	-
1934	-	33,000	-	-	-	-
1935	-	34,000	-	-	-	-
1936	28,005	34,863	-	-	-	-
1937	32,444	40,379	-	-	-	-
1938	35,696	44,728	-	-	-	-
1939	40,612	50,697	-	52,821	104.19	-
1940	46,264	57,783	-	62,043	107.37	-
1941	58,853	72,997	-	81,363	111.46	-
1942	45,839	55,722	-	59,896	107.49	-
1943	44,021	53,216	-	56,784	106.70	-
1944	44,838	54,418	-	58,264	107.07	-
1945	50,521	61,442	-	66,948	108.96	-
1946	61,084	73,706	-	81,992	111.24	-
1947	73,865	89,424	-	102,095	114.17	-
1948	83,487	100,508	-	116,045	115.46	-
1949	94,760	113,385	-	126,636	111.69	-
1950	121,091	145,488	-	172,860	118.81	-
1951	126,402	157,691	-	188,012	119.23	-
1952	132,009	163,934	-	194,607	118.71	-
1953	146,810	182,113	-	217,163	119.25	-
1954	143,901	180,270	-	213,225	118.28	-
1955	154,050	190,085	-	223,254	117.45	-
1956	171,249	210,666	-	248,846	118.12	-
1957	187,166	211,497	286,014	254,174	120.18	88.87
1958	187,886	212,904	288,307	255,544	120.03	88.64
1959	211,011	239,333	316,601	288,519	120.55	91.13
1960 ^a	218,574	247,821	333,206	297,662	120.11	89.33
1961	230,455	259,527	344,423	313,141	120.66	90.92
1962	243,818	274,466	364,141	331,319	120.71	90.99
1963 ^b	254,496	293,679	377,533	-	-	-

^aIncludes Alaska and Hawaii for 1960 and subsequent years.

^bPreliminary.

TON-MILEAGE AND MODE OF TRANSPORTATION

Table 4 and Figure 2 compare estimates of ton-miles of goods movements and the percentage of the total carried by each principal mode of transportation. In this table, the highway ton-miles are those for all rural roads excluding movement on urban streets. Since World War II, although railroads have maintained approximately the same absolute volume of ton-miles, the railroad share of total ton-miles has decreased from 67 percent in 1945 to 45 percent in 1961. The highway and pipeline haulage has increased both in ton-miles and share of the total haulage. Waterways have increased total ton-miles hauled and have maintained about the same share of the total. The reliability of these comparisons, although satisfactory for an indication of general trends, is not as precise as might be desired for quantitative

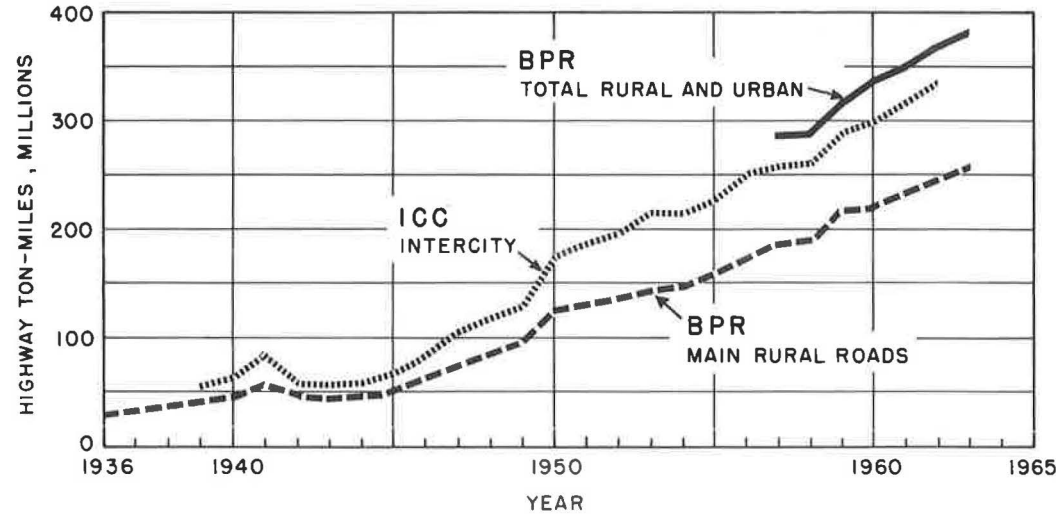


Figure 1. Comparison of trends in ton-miles hauled by highway as published by U.S. Bureau of Public Roads and ICC.

TABLE 4
TRANSPORT SERVICE BY EACH PRINCIPAL MODE OF FREIGHT TRANSPORTATION^a

Year	Railways ^b		Highways ^c		Waterways ^d		Pipelines ^e		Airways ^f		Total (millions)
	Ton-Miles (millions)	Percent of Total	Ton-Miles (millions)	Percent of Total	Ton-Miles (millions)	Percent of Total	Ton-Miles (millions)	Percent of Total	Ton-Miles (millions)	Percent of Total	
1929	450,189	72.9	26,000	4.2	105,982	17.1	35,800	5.8	N.A.	<0.1	617,971
1930	385,815	73.1	24,000	4.5	86,454	16.4	31,800	6.0	0.1	<0.1	528,069
1931	311,073	73.7	23,000	5.4	56,905	13.5	31,200	7.4	0.2	<0.1	422,178
1932	235,309	72.8	26,000	8.1	32,639	10.1	29,200	9.0	0.3	<0.1	323,148
1933	250,651	68.0	30,000	8.1	55,189	15.0	33,000	8.9	0.4	<0.1	368,840
1934	270,292	68.6	33,000	8.4	57,690	14.6	33,132	8.4	0.6	<0.1	394,115
1935	283,637	67.7	34,000	8.1	68,096	16.2	33,517	8.0	1.1	<0.1	419,251
1936	341,182	66.1	34,863	6.8	92,651	18.0	47,013	9.1	1.9	<0.1	515,711
1937	362,815	64.1	40,379	7.1	110,127	19.5	52,462	9.3	2.2	<0.1	565,785
1938	291,866	64.4	44,728	9.9	66,747	14.7	49,950	11.0	2.7	<0.1	453,294
1939	335,375	62.4	50,697	9.4	96,249	17.9	55,602	10.3	3.3	<0.1	537,926
1940	375,369	61.5	57,783	9.5	118,057	19.3	59,277	9.7	4.4	<0.1	610,490
1941	477,576	62.9	72,997	9.6	140,454	18.5	68,428	9.0	6.7	<0.1	759,462
1942	640,992	69.6	55,722	6.1	148,565	16.1	75,087	8.2	14.1	<0.1	920,380
1943	730,132	71.4	53,216	5.2	141,652	13.8	97,867	9.6	18.8	<0.1	1,022,886
1944	740,586	68.7	54,418	5.1	150,155	13.9	132,864	12.3	20.9	<0.1	1,078,044
1945	684,148	67.4	61,442	6.0	142,737	14.1	126,530	12.5	26.6	<0.1	1,014,884
1946	594,943	67.0	73,706	8.3	123,973	13.9	95,727	10.8	44.8	<0.1	888,394
1947	657,878	65.8	89,424	9.0	146,714	14.7	105,161	10.5	71.6	<0.1	999,249
1948	641,104	62.7	100,508	9.8	161,846	15.8	119,597	11.7	108.1	<0.1	1,023,163
1949	529,111	59.0	113,385	12.6	139,396	15.6	114,916	12.8	130.2	<0.1	896,938
1950	591,550	57.5	145,488	14.1	163,344	15.9	129,175	12.5	159.7	<0.1	1,029,717
1951	649,831	56.9	157,691	13.8	182,216	16.0	152,115	13.3	153.5	<0.1	1,142,007
1952	617,942	55.8	163,934	14.8	168,367	15.2	157,502	14.2	172.6	<0.1	1,107,918
1953	608,954	52.3	182,113	15.7	202,439	17.4	169,884	14.6	191.9	<0.1	1,163,582
1954	552,197	50.9	180,270	16.6	173,679	16.0	179,203	16.5	204.8	<0.1	1,085,554
1955	626,893	50.7	190,085	15.4	216,508	17.5	203,244	16.4	247.4	<0.1	1,236,977
1956	651,188	49.6	210,666	16.1	219,978	16.8	229,959	17.5	265.0	<0.1	1,312,060
1957	621,907	48.3	211,497	16.4	231,792	18.0	222,728	17.3	298.5	<0.1	1,288,219
1958	554,534	47.5	212,904	18.2	189,016	16.2	211,289	18.1	319.9	<0.1	1,168,063
1959	578,637	48.6	239,333	19.3	196,559	15.8	226,991	18.3	372.7	<0.1	1,241,893
1960	575,360	45.2	247,821	19.5	220,253	17.3	228,626	18.0	414.4	<0.1	1,272,474
1961	566,295	44.6	259,527	20.5	209,706	16.5	233,172	18.4	482.1	<0.1	1,269,182
1962	595,774	44.7	274,466 ^g	20.6	223,089	16.8	237,723	17.9	581.2	<0.1	1,331,633
1963	625,175	44.5	293,679 ^g	20.9	234,172	16.7	250,319	17.8	629.1	<0.1	1,403,969

^aData for Alaska and Hawaii included beginning 1960.
^bICC, Statistics of Railways in the United States, Class I and II Railroads.
^cU. S. Bureau of Public Roads; estimates include all travel of all kinds and sizes of trucks on rural roads.
^dU. S. Army Board of Engineers for Rivers and Harbors; includes traffic on Great Lakes and inland waterways.
^eData from 1939 to present, ICC; from 1929 through 1938 by H. E. Hale using American Petroleum Institute data.
^fFederal Aviation Agency, Statistical Handbook of Aviation; data include domestic freight, express, and excess baggage.
^gPreliminary.

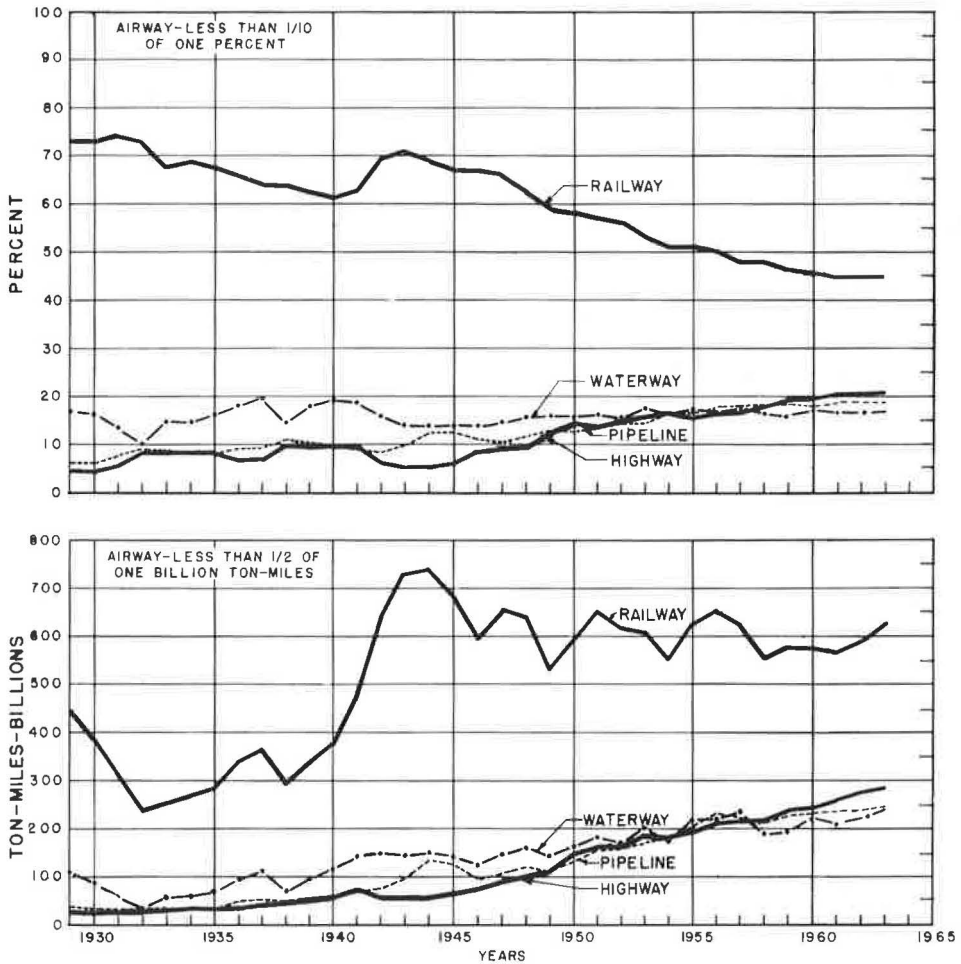


Figure 2. Transport service by mode.

measurement. This is due in part to the different characteristics of operation of each mode and in part to differences in methods used in obtaining source data and in subsequent analysis.

THE 1963 TRUCK WEIGHT SURVEY

In an effort to learn more about the nature of highway transportation—commodities hauled, trip lengths, class of operation, class of origin and destination, type of trip and loading—additional inquiries were made at the weighing of each vehicle and special tabulating cards were prepared by the state highway departments as a part of the annual 1963 truck weight survey (3). Table 5 shows the column arrangement and items of data coded in each card field. Detailed definitions and descriptions of the trip characteristics codes are given in the Appendix. Usage data for more than 217,000 cargo vehicles were obtained at a total of 778 locations in 50 states. Of these, 622 were on rural highways and 156 were in urban locations. Data for these special trip characteristics were subsequently tabulated and analyzed.

To obtain a reliable basis for comparisons, the data were grouped by census divisions and analyzed by vehicle type. Since the roadside weighing procedure involved sampling on the basis of vehicle-miles, the estimated vehicle-miles of travel by vehicle type, highway system, and state were used as the sampling strata to expand the

TABLE 5

ARRANGEMENT OF DATA IN NUMBER 7 TRUCK WEIGHT TABULATING
CARD FOR SPECIAL TRUCK TRIP CHARACTERISTICS STUDY

Column	Item
1	Card No. 7, code 7.
2- 3	State.
4- 5	Station number.
6- 7	Highway system (01 thru 12 to indicate administrative system and rural or urban).
8-11	Date: month (columns 8-9), day (columns 10-11).
12-13	Hour of day (using 24-hr clock, 1:00 to 1:59 p.m., coded 13).
14	Direction of travel (1—northbound, 2—east, 3—south, 4—west, 5—NE, etc.).
→ 15-16	Vehicle type (based on axle and wheel arrangement, 12 principal types).
17-18	Body type.
19	Class of operation (0—not determined, 1—private, 2—ICC, 3—other for hire).
20-22	Commodity (Freight Commodity Statistics Classification, 1954, as amended).
→ 23	Loading and trip type (0 through 9 to indicate loaded or empty and line haul, pickup and delivery, etc.).
→ 24-27	Class of origin (columns 24-25) and destination (columns 26-27) (codes 00 through 13 to indicate transfer from other modes, warehouse, factory, mine, home, etc.).
28-29	Origin state.
30-32	Origin county.
33-35	Origin city.
36	Origin in or near the city.
37-38	Destination state.
39-41	Destination county.
42-44	Destination city.
45	Destination in or near the city.
46-49	Driver's estimate of trip length in miles.
50-52	Weight of axle A in hundreds of pounds.
53-55	Weight of axle B in hundreds of pounds.
56-58	Weight of axle C in hundreds of pounds.
59-61	Weight of axle D in hundreds of pounds.
62-64	Weight of axle E in hundreds of pounds.
65-67	Weight of axle F in hundreds of pounds.
68-70	Weight of axle G in hundreds of pounds.
71-74	Total weight of vehicle in hundreds of pounds.
75-79	Serial number.
80	Trailer card control.

data by vehicle type, class of operation, loading and trip type, and class of origin and destination for this part of the study. Analysis of data obtained in 1957 for the Highway Cost Allocation Study indicated that in most cases, differences in average carried load when related to type of service are small for a particular vehicle type. Therefore, differences in loading have small effects on the proportion of ton-miles hauled by a particular vehicle type in any category, and the proportion of ton-miles of commodities hauled by loaded vehicles of a particular type are proportional to vehicle-miles of travel. An indication of proportionate ton-miles can be obtained by multiplying

vehicle-miles of travel for loaded vehicles of a type by the average carried load for that vehicle type shown in Table 1. In this way, an indication of the approximate proportion of ton-miles in that particular category can be obtained for several vehicle types combined. The effects of differences in the average loads carried by each vehicle type related to category of service will be investigated in a subsequent analysis. Another simplification for the purpose of this report was the elimination of combinations larger than the 3S2. Figure 3 illustrates the vehicle types included in this analysis. Those combinations not included account for approximately 8 percent of all highway ton-miles hauled in the nation and will be analyzed later since their contribution is proportionately much greater in the areas where they are used and, in some cases, may provide a helpful indication of future trends.

CHARACTERISTICS OF TRIP AND LOADING

The rural and urban travel characteristics of the four types of single unit trucks and the three principal types of semitrailer combinations are summarized in Table 6 and Figures 4 through 7. In these figures, each bar represents the percentage of total rural or urban travel by a vehicle type having the characteristics indicated. Of particular interest are the very substantial differences between the vehicle types, compared to the great similarity in the pattern of usage of a particular vehicle type in both rural and urban areas. For example, vehicle type 2S, which is a 2-axle 4-tire truck of 1 ton or greater capacity, performs approximately one-third of its travel in delivery type service where it is the predominant vehicle type in both rural and urban areas. Vehicle type 2S includes many of the walk-in delivery bodies.

The panels and pickups, vehicle type 2P, perform more than 60 percent of their travel in personal transportation. Over 12 percent of their travel results from personal transportation while carrying a load. The 2-axle 6-tire truck, type 2D, is used for a variety of purposes. Although point-to-point hauling is its predominant usage, personal transportation in rural areas accounts for about 11 percent of the total. With the exception of type 2S, hauling from a single loading point to a single unloading point is the predominant usage for the other three types of single-unit trucks, with the 3-axle vehicles, usually concrete mixers or dump trucks, performing approximately 45 percent of their travel in this type of service.

The three types of semitrailer combinations—2S1, 2S2, and 3S2—included in Figures 6 and 7 account for approximately 68 percent of all highway ton-miles. Here again the similarity between rural and urban usage is evident. The point-to-point movement comprises a higher proportion of the total than is the case for single unit trucks, with two-thirds of the rural travel by 3S2's in this category. It is noteworthy that for the 3-axle 2S1 combination, over 16 percent of rural travel and over 20 percent of urban travel is in delivery service. This seems to confirm observations that these smaller combinations are used for distribution to cities, towns, and shopping areas from centralized terminals or other sources. For all vehicle types studied, the percentage of

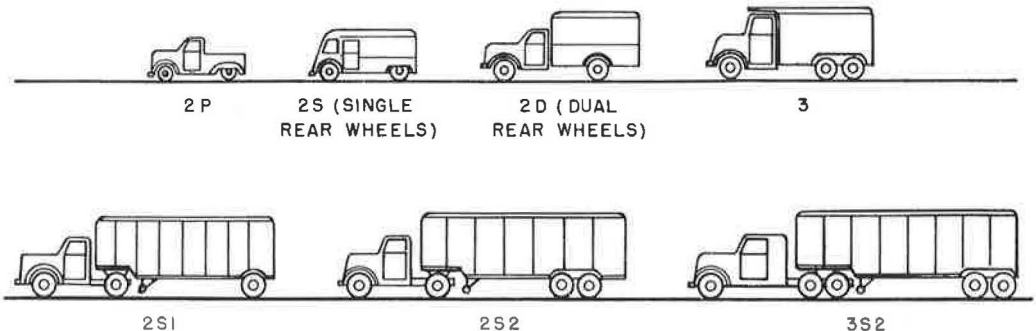


Figure 3. Principal vehicle types involved in highway commodity movements.

TABLE 6
PROPORTION OF TRAVEL

Trip and Loading Characteristics	Single-Unit Trucks			Semitrailer Combinations		
	Vehicle Type	Rural (%)	Urban (%)	Vehicle Type	Rural (%)	Urban (%)
Point to point (loaded and unloaded at single locations)	2P	21.07	16.78	2S1	41.42	40.48
	2S	22.26	20.14	2S2	57.44	54.34
	2D	37.55	31.71	3S2	66.11	53.87
	3	46.24	44.71	-	-	-
Delivery (loaded at single point and unloaded at 2 or more)	2P	6.05	8.06	2S1	16.91	21.50
	2S	32.95	34.75	2S2	7.94	11.71
	2D	20.76	26.34	3S2	5.84	8.14
	3	5.43	5.06	-	-	-
Collection (loaded at 2 or more and unloaded at single point).	2P	0.83	0.84	2S1	1.77	2.59
	2S	1.49	2.87	2S2	0.92	1.00
	2D	2.50	3.11	3S2	1.03	0.77
	3	1.13	1.38	-	-	-
Collection-delivery (loaded at 2 or more and unloaded at 2 or more)	2P	0.31	0.44	2S1	3.69	3.47
	2S	1.40	1.20	2S2	0.72	0.96
	2D	1.05	1.76	3S2	0.44	0.89
	3	0.19	0.29	-	-	-
Empty (to or from loading or unloading point)	2P	11.27	11.42	2S1	32.86	27.86
	2S	14.71	12.76	2S2	30.10	28.63
	2D	26.93	26.42	3S2	24.85	32.98
	3	39.39	41.69	-	-	-
Serve driver or passenger (empty vehicle not involved in a commodity movement)	2P	47.22	49.62	2S1	2.86	3.62
	2S	17.40	17.62	2S2	2.59	3.14
	2D	8.58	7.93	3S2	1.46	2.88
	3	6.35	6.10	-	-	-
Serve driver or passenger (loaded vehicle not involved in a commodity movement)	2P	13.25	12.84	2S1	0.49	0.48
	2S	9.79	10.66	2S2	0.29	0.22
	2D	2.63	2.73	3S2	0.27	0.47
	3	1.27	0.77	-	-	-
Total	2P	100.00	100.00	2S1	100.00	100.00
	2S	100.00	100.00	2S2	100.00	100.00
	2D	100.00	100.00	3S2	100.00	100.00
	3	100.00	100.00	-	-	-

travel involved in the collection and collection-delivery categories is quite small, generally below 5 percent of the total. For both rural and urban travel, the proportion of 2S1 collection-delivery travel is the highest of the three types of combinations with 3.7 percent of rural travel and 3.5 percent of urban travel in this category. Many household moving vans are of this vehicle type.

CHARACTERISTICS OF LOADING AND UNLOADING POINTS

The origin and destination characteristics are being analyzed as indicated by Table 7 and Figure 8 for one type of vehicle, the 2S2 combination, to determine the proportions of various components of the total highway cargo movements which may be

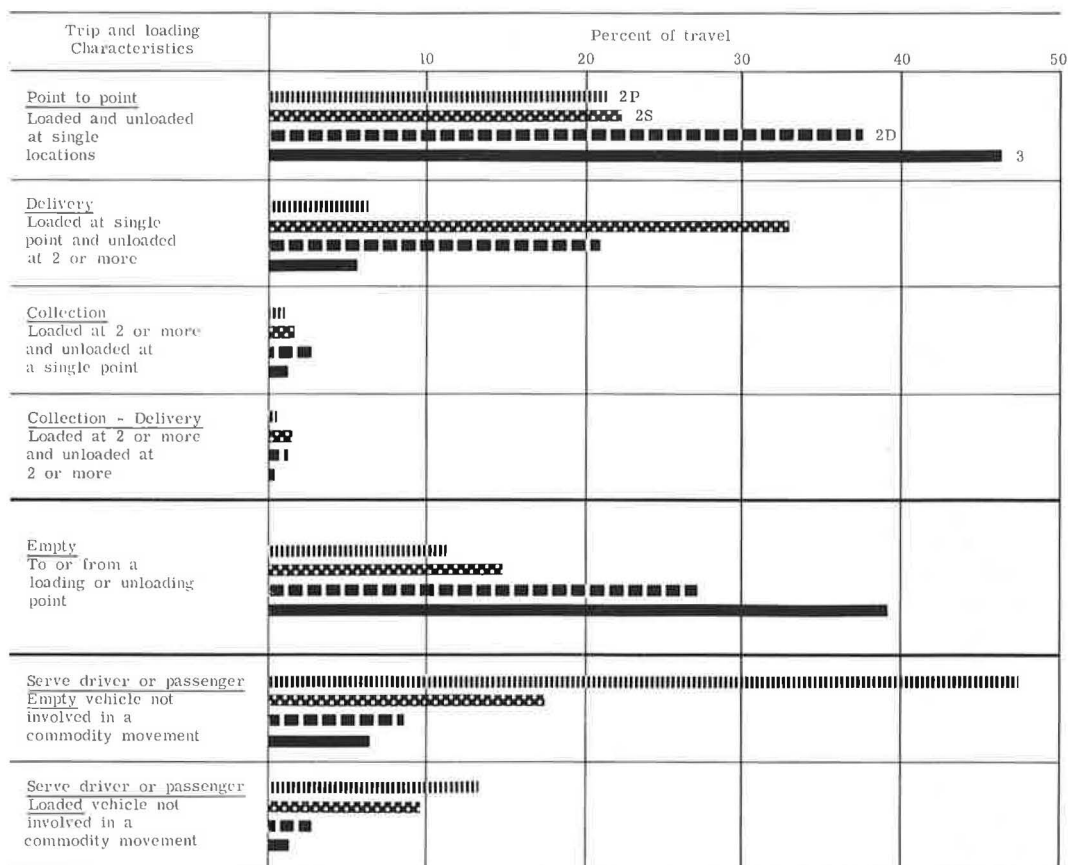


Figure 4. Rural travel distributed by trip and loading characteristics for each type of single-unit truck, travel percentages add to 100 percent for each vehicle type.

identified as complementary to or in competition with other modes of transportation. For example, the 6.1 percent from "Other modes" represents complementary movements, but the 0.83 percent from "Retail establishments" to "Final consumer" could probably not be diverted to another mode. The data in Figure 8 provide an example for one category, the 4-axle 2S2 combination, involved in cargo movements between single load and unload points as reported by the driver. This is the predominant category at the level of detail represented by a single vehicle type and trip movement characteristic and accounts for approximately 20 percent of all ton-miles hauled by highway.

Each vehicle type and category will be analyzed separately. As discussed previously, the percentage distribution of vehicle-miles within such a category will be essentially the same as the distribution of ton-miles, due to the similarity of loading of a given vehicle type. For these 2S2 combinations, movement between highway transfer points accounts for 16 percent of the total vehicle-miles of travel. This is a maximum for this category, since for long-haul movements where the driver picked up the vehicle at a truck terminal and was to drive it to another, this category was coded if he did not know the characteristics of the point where it was originally loaded or where it was to be unloaded.

Although the movements between highway transfer points are the largest single category, the "factory or packaging plant" is both the origin and the destination responsible for the greatest proportion of travel by 2S2 combinations transporting cargo

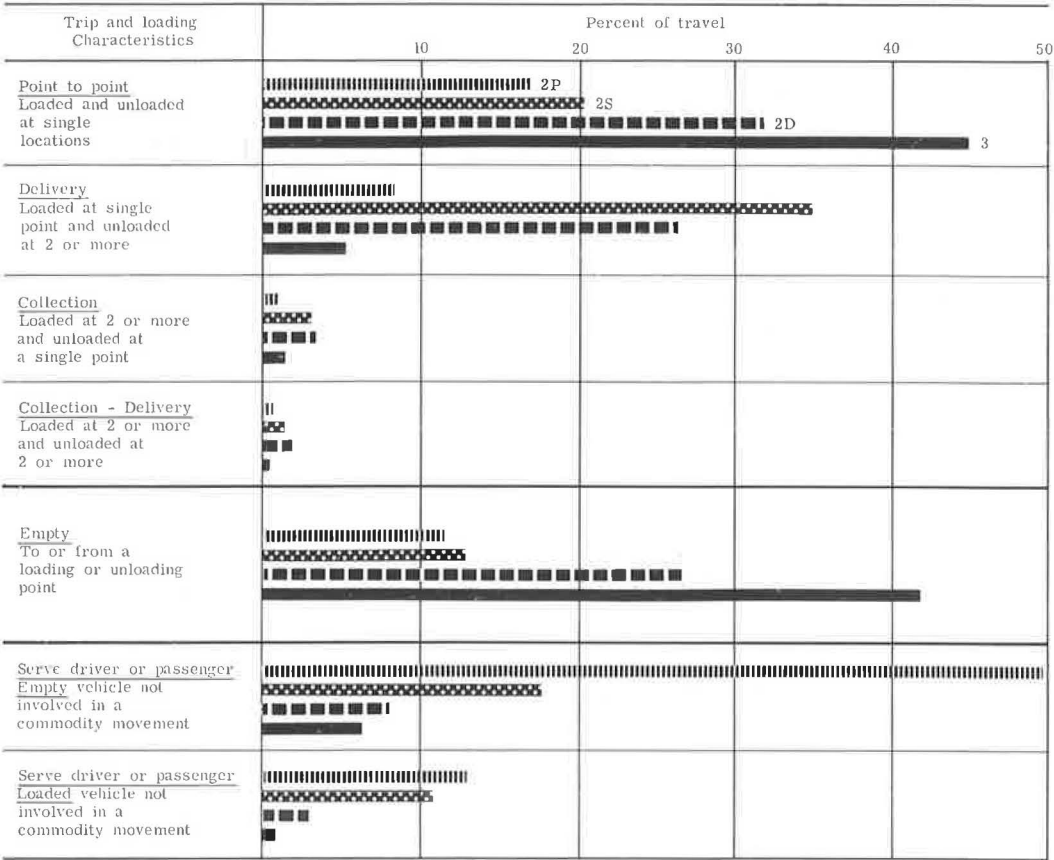


Figure 5. Urban travel distributed by trip and loading characteristics for each type of single-unit truck, travel percentages add to 100 percent for each vehicle type.

between a single loading point and a single unloading point. About 51.8 percent of the travel by this vehicle type has an origin or destination at a factory or packaging plant. Transfers from and to other modes are shown to be only 6.2 percent for origin and 3.5 percent for destination, respectively. Travel originating at the original or primary source of the commodity, such as a farm, forest, or mine, amounts to nearly 15 percent of the total, with just half going to a factory or processing plant.

Point-to-point travel by loaded 2S2's originating from a factory or packaging plant is destined about equally for other factories, wholesale warehouses, and retail establishments. A substantial proportion is also destined for the final consumer. The same is true for travel originating from wholesale warehouses. Travel originating at retail establishments is only 4.3 percent of the total for these 2S2 combinations with less than one-fifth going to the final consumer. Two items, the 3.6 percent of travel shown as originating from the final consumer and the 2.8 percent shown as destined for the primary source, seem puzzling. On reflection, the first seems a logical field interpretation applicable to household goods movement or the movement of machinery, equipment, or second-hand goods. Destinations shown as the primary source may involve returns of materials and possibly movement of agricultural commodities from farm to farm. The extent of reporting error for this item has not been determined. Subsequent analysis by commodity may clarify some of these items.

Preliminary review of data for other trip types and vehicle types indicates wide variation. For the same vehicle type, 2S2 in delivery trip type, 40 percent of the

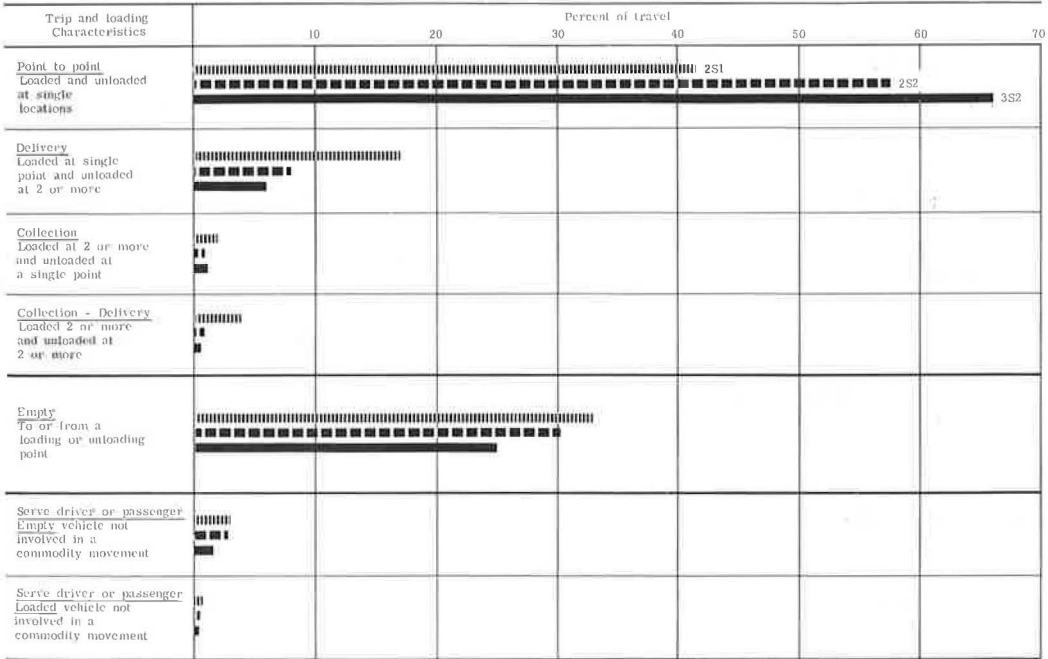


Figure 6. Rural travel distributed by trip and loading characteristics for each type of semitrailer combination, travel percentages add to 100 percent for each vehicle type.

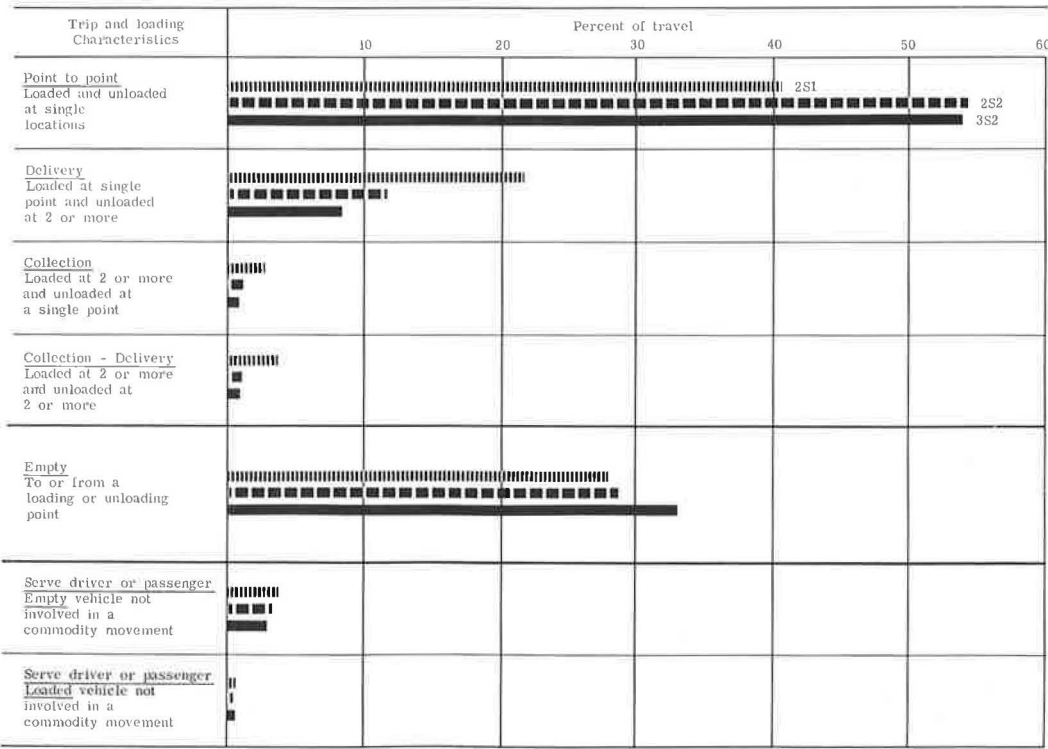


Figure 7. Urban travel distributed by trip and loading characteristics for each type of semitrailer combination, travel percentages add to 100 percent for each vehicle type.

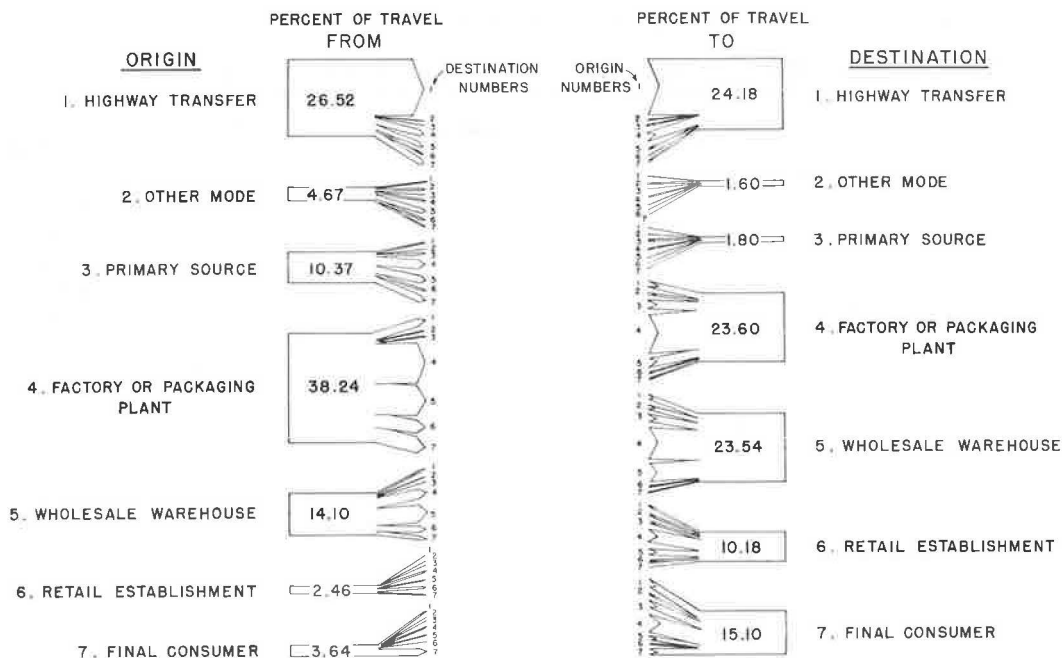


Figure 8. Distribution of rural travel by loaded 2S2 combinations loaded and unloaded at single location related to characteristics of origin and destination.

travel is related to other modes. For the 2-axle 4-tire trucks other than pickups, largely walk-in delivery trucks, nearly 20 percent of the rural travel is between manufacturing or packaging plants and retail establishments.

TABLE 7
PERCENTAGE DISTRIBUTION OF VEHICLE-MILES OF TRAVEL FOR LOADED 2S2 COMBINATIONS^a

Origin Category	Destination Category							Total
	Highway Transfer	Other Mode	Primary Source	Factory or Packaging Plant	Wholesale Warehouse	Retail Establishment	Final Consumer	
Highway transfer	19.19	0.25	0.07	2.18	1.66	0.86	2.31	26.52
Other mode	0.35	0.48	0.15	0.54	1.75	0.84	0.56	4.67
Primary source	0.39	0.17	0.89	3.16	2.62	0.89	2.25	10.37
Factory or packaging plant	2.91	0.41	0.42	13.47	10.79	4.45	5.79	38.24
Wholesale warehouse	0.65	0.23	0.14	3.21	6.08	2.03	1.76	14.10
Retail establishment	0.14	0.01	0.05	0.57	0.36	0.95	0.38	2.46
Final consumer	0.55	0.05	0.08	0.47	0.28	0.16	2.05	3.64
Total	24.18	1.60	1.80	23.60	23.54	10.18	15.10	100.00

^aPoint to point, loaded and unloaded at single locations.

SUMMARY AND CONCLUSIONS

This study has shown that highway cargo vehicles serve a wide variety of uses. Although all categories of movements by loaded vehicles have been included in estimating ton-miles hauled by highway, these data indicate the proportions which are not true commodity haulage, for example, travel by a loaded vehicle to serve the driver. The proportions of all highway cargo movements by categories of trip type and origin-destination are shown. From this, proportions which can be well served only by highway, those which involve other modes, and those which could be served by other modes to varying degrees may be judged with increased assurance. These data serve to provide an indication of the dimensions of the elements, making up the total ton-miles of the highway cargo movement. Additional criteria, such as the interrelationship of commodity, place of origin and destination, and trip length, must be investigated to obtain as complete an understanding of highway transportation as possible.

Further Analysis

The differences in loading characteristics for each vehicle type will be analyzed to determine more precise ton-mile values for each category of movement. An analysis of trip length, origins and destinations within the same state, county and city, and commodity is being made for each vehicle type, class of operation, and category of trip loading characteristics to provide an indication of the relative proportion of highway commodity movements which are least competitive with other modes or which might be considered inappropriate for inclusion in the intercity highway ton-mile values.

Conclusions

1. The patterns and characteristics of usage of trucks and semitrailer combinations show considerable difference according to the type of vehicle.
2. For a given vehicle type, there are only moderate differences in proportions of travel related to trip and loading characteristics between rural and urban areas.
3. In the case of both single-unit trucks and semitrailer combinations, the larger truck types perform a higher proportion of their travel while loaded.
4. For all types of trucks except the 2-axle single-tire 2S, the greatest proportion of travel when loaded is from a single loading point to a single unloading point; for vehicle type 2S, delivery travel exceeds all other categories for both rural and urban travel.
5. For 4-axle 2S2 combinations loaded at a single point with unloading at a single point, more than one-third of all travel originates at a factory or packaging plant, one-fifth from a highway transfer point, and one-sixth at a primary source.
6. Similar factors when available for other vehicle types and origin and destination categories will be helpful in completing the appraisal of truck usage and service.

REFERENCES

1. U.S. Bureau of Public Roads. Highway Statistics, 1962. Table HT-1.
2. Interstate Commerce Commission. Transport Economics. p. 1, April 1964.
3. Instructions for Special Truck Trip Characteristics Study. IM 50-3-63, April 10, 1963.

Appendix

1963 SPECIAL TRUCK TRIP CHARACTERISTICS STUDY (Excerpt from Coding Instructions)

*Loading and trip type, column 23. —The purpose of this item is to indicate whether loaded or empty and to obtain an indication of the type of service in which the vehicle

is engaged. Loaded and empty classifications reflect commodity movement and are consistent with the regular instructions.

Code	Description
* 1	Empty, not involved in commodity movement serving primarily as transportation for driver or passenger and travel to or from garage or parking area.
* 2	Empty, traveling to loading point or from unloading point.
3	Empty, service or repair vehicle not involved in commodity movement; may carry mounted equipment, tools, but no supplies of repair parts or other materials which are customarily unloaded.
4	Loaded service or repair vehicle not involved in commodity movement; may carry mounted equipment, tools, supplies, repair parts, or materials for use in service or repair activity which are not customarily all unloaded at a single location.
5	Loaded vehicle, loaded at a single location and to be completely unloaded at a single location.
6	Loaded vehicle, loaded at a single location and to be unloaded at two or more locations (delivery or distribution).
7	Loaded vehicle, loaded at two or more locations and to be unloaded at a single location (pickup or collection).
8	Loaded vehicle, loaded at two or more locations and to be unloaded at two or more locations (pickup-delivery or collection-distribution).
* 9	Loaded vehicle not involved in a commodity movement, including serving driver or passenger (travel to or from dwelling, garage or parking area).

*Class of origin and destination, columns 24-25 (origin) and columns 26-27 (destination).—This item is intended to reflect the point at which the highway movement of a commodity fits into the production-distribution process and should be recorded for both loaded and empty vehicles. Codes apply to origins and destinations in columns 28-45 and should be shown for both. In the case of a transfer from another vehicle or mode of transportation not involving processing, packaging or selling at the transfer point, the coding should indicate the other mode involved if this can be determined. If the other mode cannot be determined then the type of place at which the transfer was made should be indicated. For example, if a transfer between trucks is known to have occurred at a railroad warehouse, the correct coding is 01. A shipment which receives processing at a primary source from which it is transported direct to retail customers or ultimate customers, such as transit mixed concrete from a quarry or borrow pit, should be coded as from the processing plant (08) to the ultimate consumer (11). In the case of bank run gravel or borrow loaded directly into the transporting vehicle without washing, screening, or other processing, it should be coded as from the primary source (06). Similarly, a destination such as the distribution point for a chain of retail stores should be considered a wholesale distribution point (09), even though there may be a retail outlet at the same location where a small proportion (25 percent or less) may be sold at retail.

Code	Description
01	A loading point at which it is known that a transfer from or to another highway motor vehicle was or will be made, or a storage warehouse, yard, or area without processing, or selling facilities for goods of any nature served only by highway.
02	A loading point at which a transfer from or to rail was or will be made or a storage warehouse, yard, or area for goods of any nature served primarily by rail in addition to highway.
03	A loading point at which a transfer from or to water was or will be made or a storage warehouse, yard, or area for goods of any nature served primarily by water in addition to highway.
04	A loading point at which a transfer from or to air was or will be made or a storage warehouse, yard, or area for goods of any nature served primarily by air in addition to highway.
05	A loading point at which a transfer from or to pipeline was or will be made or a storage warehouse, yard, or area for goods of any nature served primarily by pipeline in addition to highway.
06	A loading point at the primary or original source of an agriculture product or raw material such as a farm, forest, mine, quarry, borrow pit, oil well, or in the case of rubble the site being cleared not including a residence or dwelling.
07	A loading point at the primary or original source which is a residence or dwelling (refuse, secondhand goods, etc.).
08	A loading point at a manufacturing, processing, assembling, or packaging establishment.
09	A wholesale distribution warehouse, store, supply yard, bulk storage tank, which may or may not have facilities for breaking down and reassembling packing and processing incidental to the wholesale activity.
10	A retail store, showroom, yard, service station, and associated warehouse from which retail sales or deliveries are made.
11	A store, office, commercial or nonprofit establishment, or construction site, not including a residence or dwelling, which is the location of the ultimate consumer, retail customers, or place of use.
12	A home, dwelling, or residence which is the location of the ultimate consumer, retail customer, or place of use.
* 13	A location other than a loading or unloading point.