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Transportation Statistics Annual Report 2013

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Introduction

The *Transportation Statistics Annual Report* describes the Nation's transportation system, the system's performance, its contributions to the economy, and its effects on people and the environment. This 18th edition of the report is based on information collected or compiled by the Bureau of Transportation Statistics (BTS), a Federal statistical agency within the U.S. Department of Transportation (USDOT).

Over 4 million miles of roads, more than 19,000 public and private use airports, about 140,000 miles of freight and passenger railroads, 25,000 miles of navigable waterways, and 2 million miles of pipelines connect the Nation's people and businesses across the continent and with the rest of the world.

The estimated value of U.S. transportation assets in 2012 was $7.7 trillion. The public owns 51.2 percent of the total transportation asset value, mostly highways and streets, but also publicly held airports, waterways, and transit facilities. Private companies own 31.2 percent of transportation assets, including railroads, pipelines, trucks, planes, and ships. Personal motor vehicles account for the remaining 17.7 percent.

The average person travels more than 13,600 miles per year, and domestic businesses ship and receive 63 tons of freight per year on average for every man, woman, and child in the United States.

The transportation sector accounts for:

- over $1 trillion in purchases and investments in transportation goods and services,
- $134 billion of public expenditures on operations and maintenance of the U.S. transportation system—just more than one-third of which was spent on highways,
- nearly 12 million jobs in transportation-related industries,
- nearly $9,000 average expenditures for each household per year,
- nearly 34,400 lives lost and over 2 million nonfatal injuries each year,

- 70.1 percent of total petroleum consumption in the United States, and
- about 1.8 billion annual metric tons of carbon dioxide emissions.

BTS compiles these and other statistics under Section 52011: *Moving Ahead for Progress in the 21st Century Act* (Public Law No. 112-141), which requires information on:

i. transportation safety across all modes and intermodally—Chapter 7;

ii. the state of good repair of United States transportation infrastructure—Chapters 2 and 5;

iii. the extent, connectivity, and condition of the transportation system, building on the BTS national transportation atlas database—Chapters 1 and 2;

iv. economic efficiency across the entire transportation sector—Chapters 4, 5, and 6;

v. the effects of the transportation system on global and domestic economic competitiveness—Chapters 4, 5, and 6;

vi. demographic, economic, and other variables influencing travel behavior, including choice of transportation mode and goods movement—Chapters 3 and 4;

vii. transportation-related variables that influence the domestic economy and global competitiveness—Chapters 4, 5, and 6;

viii. economic costs and impacts for passenger travel and freight movement—Chapters 3, 4, and 5;

ix. intermodal and multimodal passenger movement—Chapters 1 and 3;

x. intermodal and multimodal freight movement—Chapters 1 and 4; and

xi. consequences of transportation for the human and natural environment—Chapter 8.

See Appendix A in this report for a list of specific tables and figures that provide information on each of these topics. See Appendix B for a glossary of terms used throughout this report.

This report of the BTS Director to the President and the Congress summarizes the Bureau's findings through 2013.

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CHAPTER 1

Extent of the U.S. Transportation System

The Nation's transportation infrastructure comprises more than 4 million miles of roads, about 19,400 public and private use airports, nearly 95,400 miles of Class I railroads,[1] and 25,000 miles of navigable waterways as detailed in box 1-A. While China's and India's transportation systems serve many more people (an estimated 1.5 billion and 1.2 billion, respectively, in 2013), the United States ranks first in the number of airports and miles of roads and freight rail [USCIA 2013]. In 2013 the U.S. transportation system served 316.1 million residents plus millions of businesses and visitors—7.4 million and 67 million, respectively [USDOC CENSUS 2014].

- Lane-miles increased 0.4 percent between 2011 and 2012. Highway person-miles traveled and vehicle-miles traveled increased by 1.0 and 0.6 percent, respectively, from 2011 to 2012.
- The Nation's transportation assets were valued at approximately $7.7 trillion in 2012, an increase of 4.1 percent over 2011 estimates. Publicly owned infrastructure and equipment accounted for the majority of transportation capital stock.
- In 2012 the value of transportation construction increased 4.0 percent over 2011 levels, reaching $119 billion, of which 67.8 percent was spent on street and highway construction.
- According to the Bureau of Transportation Statistics' Transportation Services Index, the volume of freight transportation services grew 23.3 percent between April 2009 (the low point for the freight index of 94.8) and December 2013, while the volume of passenger transportation services increased 9.3 percent between March 2009 (the low point for the passenger index of 108.4) and December 2013. The lows for both indexes occurred during the economic recession spanning December 2007 to June 2009.

[1] In 1991 the Federal Surface Transportation Board designated Class I railroads as those carriers generating $250 million or more in annual revenue, with yearly adjustments for inflation. In 2012 the preliminary revenue threshold for Class I rail carriers was set at $452.7 million. Today there are seven Class I carriers [USDOT STB 2013].

BOX 1-A Extent of the U.S. Transportation System

MOTOR VEHICLES AND PUBLIC ROADS: 2005, 2011–2012

Public Road and Street Mileage by Functional Type (miles)

	2005	2011	2012
Interstate	46,608	46,960	47,432
Other freeways and expressways	10,560	11,495	11,469
Other principal arterial	156,959	156,262	156,613
Minor arterial	237,081	242,942	243,426
Collectors	790,495	797,645	796,997
Local	2,753,932	2,814,925	2,828,809
TOTAL, mileage	**3,995,635**	**4,077,756**	**4,092,730**
Bridges	595,362	605,087	607,378
Lane-miles	8,371,718	8,567,618	8,606,003

Motor Vehicle Registrations by Type

	2005	2011	2012
Light-duty vehicle, short wheel base	U	183,522,635	183,171,882
Passenger Car	136,568,083	U	U
Motorcycle	6,227,146	8,330,210	8,454,939
Other 2-axle 4-tire vehicles	95,336,839	U	U
Light-duty vehicle, long wheel base	U	50,318,787	50,588,676
Truck, single-unit 2-axle 6-tire or more	6,395,240	7,819,055	8,190,286
Truck, combination	2,086,759	2,451,638	2,469,094
Bus	807,053	666,064	764,509
TOTAL, registered vehicles	**247,421,120**	**253,108,389**	**253,639,386**

Person-Miles (millions)

	2005	2011	2012
Light-duty vehicle, short wheel base	U	2,843,075	2,866,797
Passenger cars	3,312,355	U	U
Motorcycle	17,492	19,972	22,940
Light-duty vehicle, long wheel base	U	807,148	803,023
Other 2-axle 4-tire vehicles	1,007,637	U	U
Truck, single-unit 2-axle 6-tire or more	109,735	103,803	104,960
Truck, combination	175,128	163,791	163,358
Bus	278,864	292,716	312,797
TOTAL, Highway PMT	**4,901,211**	**4,230,505**	**4,273,876**

Vehicle-Miles Traveled (millions)

	2005	2011	2012
Light-duty vehicle, short wheel-base	U	2,046,282	2,063,357
Passenger cars	1,708,421	U	U
Motorcycle	10,454	18,542	21,298
Light-duty vehicle, long wheel-base	U	604,175	601,088
Other 2-axle 4-tire vehicles	1,041,051	U	U
Truck, single-unit 2-axle 6-tire or more	78,496	103,803	104,960
Truck, combination	144,028	163,791	163,358
Bus	6,980	13,807	14,755
TOTAL, Highway VMT	**2,989,430**	**2,950,402**	**2,968,815**

KEY: U = Data are unavailable.

NOTE: PMT and VMT for 2005 are not comparable to data for 2011 and 2012. Motor bus and demand response figures are also included in the bus figure for highway.

SOURCES: ***Public Roads and Street Mileages, Bridges, and Lane-miles:*** U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), *Highway Statistics* (multiple years), as cited in the USDOT. Bureau of Transportation Statistics (BTS). National Transportation Statistics (NTS). Tables 1-5, 1-11, and 1-6. Available at http://www.bts.gov/ as of September 2014. ***Motor Vehicles:*** 2005, 2011: USDOT/FHWA as cited in the USDOT/BTS/NTS. Table 1-11. Available at http://www.bts.gov/ as of September 2014. 2012: USDOT/FHWA, *Highway Statistics 2012*.VM-1. ***PMT:*** USDOT/FHWA as cited in USDOT/BTS/NTS. Table 1-40. Available at http://www.bts.gov/ as of September 2014. ***VMT:*** USDOT/FHWA as cited in USDOT/BTS/NTS. Table 1-35. Available at http://www.bts.gov/ as of September 2014.

AIR: 2005, 2011–2012

Number of U.S. Airports

	2005	2011	2012
Public use	5,270	5,172	5,171
Private use	14,584	14,339	14,269
Military	U	271	271
TOTAL, Airports	**19,854**	**19,782**	**19,711**

Number of U.S. Aircraft and Pilots

	2005	2011	2012
General aviation aircraft	224,257	220,453	209,034
Commercial aircraft	7,686	7,166	6,911
TOTAL, Aircraft	**231,943**	**227,619**	**215,945**
TOTAL, Pilots	**609,737**	**617,128**	**610,576**

Passenger Enplanements

	2005	2011	2012
Domestic flights	657,261,487	638,247,667	642,289,482
International flights of U.S. carriers	143,588,422	163,848,419	170,830,193
TOTAL, Enplanements	**800,849,909**	**802,096,086**	**813,119,675**

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Passenger-Miles (thousands)

	2005	2011	2012
Domestic, revenue passenger-miles (RPM)	570,854,623	564,685,475	569,930,849
International on U.S. and foreign carriers, RPM	451,385,768	535,759,571	557,970,427
TOTAL, Air RPM	**1,022,240,392**	**1,100,445,046**	**1,127,901,276**

Freight-Miles (thousands)

	2005	2011	2012
Domestic, enplaned revenue ton-miles	15,745,785	12,133,733	12,367,270
International on U.S. carriers, enplaned revenue ton-miles	50,209,202	52,525,633	49,996,101
TOTAL, Enplaned revenue tons	**65,954,987**	**64,659,366**	**62,363,371**

NOTE: The Federal Aviation Administration estimated the 2011 numbers of *General Aviation*, including air taxis. *Commercial Aircraft* includes mainline and regional aircraft.

SOURCES: ***Airports:*** U.S. Department of Transportation (USDOT). Federal Aviation Administration (FAA) as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*. Available at http://www.bts.gov/ as of October 2014. ***Aircraft and Pilots:*** USDOT/FAA. FAA Aerospace Forecast, *Fiscal Years (multiple issues)*. Available at www.faa.gov as of September 2014. ***Passenger enplanements:*** USDOT, Bureau of Transportation Statistics (BTS), Office of Airline Information (OAI), T-100 Market data. Available at http://www.transtats.bts.gov/ as of December 2013. ***RPM and Enplaned Revenue Ton-miles:*** USDOT, BTS, OAI, T100 Segment data. Available at http://www.transtats.bts.gov/ as of December 2013.

TRANSIT: REVENUE YEARS 2005, 2011–2012

Number of Transit Vehicles

	2005	2011	2012
Motor bus	62,284	59,871	64,288
Light-rail cars	1,645	1,969	2,297
Heavy-rail cars	11,110	14,942	11,422
Trolley bus	615	479	594
Commuter rail cars and locomotives	6,290	6,971	7,307
Demand response	28,346	31,846	36,988
Ferry boat	126	140	149
Other	11,496	20,396	16,649
TOTAL, Transit vehicles	**121,912**	**136,614**	**139,694**

Person-Miles (millions)

	2005	2011	2012
Motor bus	19,425	19,883	21,272
Light-rail	1,700	2,198	2,431
Heavy-rail	14,418	17,317	17,629
Trolley bus	173	160	163
Commuter rail	9,470	11,314	11,257
Demand response	738	879	892
Ferry boat	359	389	405
Other	842	2,189	1,457
TOTAL, Transit person-miles	**47,125**	**54,328**	**55,506**

Unlinked Trips (billions)

	2005	2011	2012
Motor bus	5.33	5.23	5.30
Light-rail cars	0.42	0.46	0.50
Heavy-rail cars	2.81	3.65	3.78
Commuter rail cars and locomotives	0.38	0.48	0.49
Demand response	0.09	0.10	0.11
Other	0.14	0.16	0.26

NOTES: *Motor bus* includes Bus (MB), Commuter Bus (CB), and Bus Rapid Transit (RB). *Light Rail* includes Light Rail (LR) and Streetcar Rail (SR). *Commuter rail* includes Commuter Rail, 2080 Hybrid Rail (YR), and 9030 Hybrid Rail (YR). *Demand response* includes Demand Response (DR) and Demand Response Taxi (DT).

SOURCES: ***Transit Vehicles:*** U.S. Department of Transportation (USDOT). Federal Transit Administration (FTA). National Transit Database (NTD) as cited in USDOT. Bureau of Transportation Statistics (BTS). National Transportation Statistics (NTS). Table 1-11. Available at http://www.bts.gov/ as of December 2013. ***Passenger-miles:*** USDOT/FTA/NTD as cited in USDOT/BTS/NTS. Table 1-40. Available at http://www.bts.gov/ as of December 2013. ***Unlinked Trips:*** USDOT/FTA/NTD, Annual Data Tables (multiple tables), available at http://www.ntdprogram.gov/ as of December 2013.

RAIL: FISCAL YEARS 2005, 2011–2012

Equipment and Mileage Operated by Amtrak

	FY2005	FY2011	FY2012
Locomotives	U	484	416
Passenger cars	U	1,543	1,455
System mileage	22,007	21,225	21,300
Stations	518	517	518
Passengers (million)	25	31	31
Passenger-miles traveled	5,381	6,670	6,804

Equipment and Mileage Operated by Class I

	2005	2011	2012
Locomotives	22,779	24,250	24,707
Freight cars	474,839	380,699	364,025
System mileage	95,664	95,514	95,391
Ton-miles (trillion)	1.7	1.7	1.7

KEY: FY = Fiscal Year. U = Data are unavailable

NOTE: *Fiscal year* ending in September.

SOURCES: ***Amtrak: Locomotives, Railcars, and System mileage:*** Amtrak, *National Fact Sheet* (Annual issues). Available at www.amtrak.com as of September 2013. ***Stations and Passenger-miles traveled:*** Amtrak as cited in U.S. Department of Transportation (USDOT). Bureau of Transportation Statistics (BTS). National Transportation Statistics (NTS). Tables 1-7 and 1-40. Available at http://www.bts.gov/ as of September 2013. ***Class I railroads:*** Association of American Railroads, Railroad Facts (Annual issues) as cited in USDOT/BTS/NTS. Tables 1-11 and 1-49, available at http://www.bts.gov/ as of September 2013.

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WATER: 2005, 2011–2012

	2005	2011	2012
U.S.-Flag privately owned merchant fleet (1,000 GT or over)	231	214	198
Recreational boats, millions	13	12	12
Lock chambers	257	239	239
Lock sites	212	193	193
Waterway facilities (including cargo handling docks)	9,399	8,197	8,214
Seaports (handling over 250,000 tons)	195	179	180
Miles of navigable waterways	26,000	25,320	25,320

U.S.-Flag Vessels

	2005	2011	2012
Barge/non-self-propelled vessels	33,152	31,498	31,550
Self-propelled vessels	8,976	8,979	8,927
TOTAL, Vessels	**42,128**	**40,521**	**40,530**

KEY: GT = Gross Tons.

NOTE: *U.S.-Flag privately owned merchant fleet* includes only oceangoing self-propelled, cargo-carrying vessels of 1,000 GT and above.

SOURCES: ***Fleet:*** U.S. Department of Transportation. Maritime Administration. *2000-2014 U.S.-Flag Privately-Owned Fleet Summary* (Released 01/07/2014. Available at http://www.marad.dot.gov/ as of September 2014. ***Recreational boats:*** U.S. Department of Homeland Security. Coast Guard. *2012 Recreational Boating Statistics*. Available at http://www.uscgboating.org/ as of September 2013. ***Locks, Facilities, Waterways, Seaports, and Vessels:*** U.S. Army Corps of Engineers. Institute for Water Resources. Navigation Data Center. *The U.S. Waterway System: Transportation Facts and Information* (Annual issues). Available at http://www.navigationdatacenter.us/ as of January 2014.

PIPELINE: 2005, 2011–2012

Gas Distribution Systems Mileage

	2005	2011	2012
Distribution, main mileage	1,165,020	1,238,495	1,246,463
Distribution, estimated service mileage	797,331	881,883	891,981
TOTAL, Gas distribution	**1,962,351**	**2,120,378**	**2,138,444**

Natural Gas Transmission & Gathering Systems Mileage

	2005	2011	2012
Onshore transmission	294,800	299,641	298,454
Offshore transmission	5,668	5,313	4,848
TOTAL, Transmission	**300,468**	**304,954**	**303,303**

Onshore gathering	16,220	13,687	10,628
Offshore gathering	7,534	6,494	6,101
TOTAL, Gathering	**23,754**	**20,181**	**16,729**
TOTAL, Gas transmission & gathering	**324,222**	**325,136**	**320,031**

Hazardous Liquid or Carbon Dioxide Systems Mileage

	2005	**2011**	**2012**
Crude oil	48,732	56,102	57,065
Petroleum / refined products	62,899	64,117	64,037
Highly volatile liquids	51,284	58,599	59,853
CO_2 or other	3,846	4,550	4,655
Fuel grade ethanol	U	16	16
TOTAL, Hazardous liquid or CO_2 systems	**166,760**	**183,384**	**185,626**

KEY: U = Data unavailable

SOURCE: U.S. Department of Transportation, Pipeline Hazardous Material Safety Administration. *Accident Incident and Mileage Summary Statistics*, Available at http://www.phmsa.dot.gov/ as of February 2014.

Assets and Investments

Transportation capital stock includes structures (e.g., bridges, stations, and ports) and equipment (e.g., automobiles, aircraft, and ships). According to the Bureau of Economic Analysis, U.S. transportation capital stock was valued at an estimated $7.7 trillion in 2012, an increase of about $300 billion (4.1 percent) over 2011 estimates.[2] Table 1-1 shows the estimated value of transportation capital stock increased steadily from 2005 to 2012, except for a small dip in 2009.

Transportation assets are owned by both the public and private sectors. Freight railroad facilities and equipment are almost entirely owned by the private sector, while state and local governments own highways and bridges, airports, seaports, and transit structures. In total, publicly owned transportation accounted for over one-half of transportation capital stock; public highways and streets accounted for the largest share (42.5 percent) of this stock and much of the growth over the past few years. "Other" publicly owned transportation, such as airports, seaports, and transit structures, accounted for 8.6 percent.

In-house transportation is the largest category among the private sector components. It accounted for 16.6 percent of transportation capital stock in 2012, most of which was highway-related (e.g., fleets of trucks owned by grocery chains). Railroads, the next largest private sector category, accounted for 5.1 percent of U.S. capital stock, followed by air with 2.8 percent. Motor vehicles owned by households and individuals, some of which are

[2] Subtracted out from the reported totals are the amount of depreciation of aging equipment and structures and the value of assets taken out of service.

TABLE 1-1 Estimated Value of Transportation Capital Stock by Mode: 2005–2012

Billions of current dollars

	2005	2006	2007	2008	2009	2010	2011	2012
Public highways and streets	2,054	2,350	2,635	2,804	2,831	2,936	3,130	3,265
Personal vehicles and parts	1,313	1,317	1,331	1,279	1,300	1,288	1,323	1,357
In-house transportation	1,119	1,181	1,224	1,230	1,155	1,152	1,204	1,274
Other publicly owned transportation	408	464	516	550	559	586	631	663
Railroad transportation	319	329	341	355	357	366	379	393
Air transportation	207	209	214	225	214	212	213	216
Pipeline transportation	113	120	130	159	152	166	178	182
Other privately owned transportation	120	127	128	130	125	123	126	129
Commercial truck transportation	95	109	109	111	105	105	113	120
Private transit and ground passenger transportation	40	41	43	43	42	42	42	41
Water transportation	37	39	40	41	40	40	39	39
TOTAL	**5,825**	**6,286**	**6,710**	**6,927**	**6,879**	**7,015**	**7,378**	**7,679**

KEY: U = unavailable.

NOTES: Data include only privately owned capital stock except for those otherwise noted. Capital stock data are reported after deducting depreciation. *Personal vehicles* are considered consumer durable goods. *In-house transportation* includes transportation services provided within a firm whose main business is not transportation. For example, grocery companies often use their own truck fleets to move goods from their warehouses to their retail outlets. *In-house transportation* figures cover the the current cost net capital stock for fixed assets (e.g., autos, aircraft, ships, etc.) owned by a firm. *Other publicly owned transportation* includes publicly owned airway, waterway, and transit structures but does not include associated equipment. *Other privately owned transportation* includes sightseeing, couriers and messengers, and transportation support activities, such as freight transportation brokers. Details may not add to totals due to rounding.

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, *Fixed Asset Tables*, tables 3.1ES, 7.1B, 8.1; and Nonresidential Detailed Estimates, Net stocks, current cost table. Available at http://www.bea.gov/ as of February 2014.

TABLE 1-2 Value of Construction Put in Place: 2005–2012

Millions of dollars

	2005	2006	2007	2008	2009	2010	2011	2012
Private transportation construction	7,124	8,654	9,009	9,934	9,056	9,894	9,537	11,372
Public construction, total	81,718	90,877	99,116	106,698	109,702	110,863	104,485	107,196
Air, land, water transport facilities	17,928	19,310	22,868	25,537	27,646	28,446	25,200	26,838
Highway and streets	63,790	71,567	76,248	81,161	82,056	82,417	79,285	80,358
Total transportation construction	**88,842**	**99,531**	**108,125**	**116,632**	**118,758**	**120,757**	**114,022**	**118,568**

NOTE: Numbers may not add to totals due to rounding.

SOURCE: U.S. Department of Commerce, Census Bureau, Value of Construction Put in Place, available at www.census.gov/construction/c30/c30index.html as of February 2014.

used for business purposes, accounted for 17.7 percent of capital stock.

The total value of transportation construction put in place in 2012 was nearly $119 billion, an increase of 4.0 percent over 2011 levels (table 1-2), of which 67.8 percent was spent on public highway and street construction. Private transportation construction accounted for 40.4 percent of that increase. Chapter 6 details transportation infrastructure spending and the revenues generated by each transportation mode.

Roads, Bridges, and Vehicles

Roads

Public roads, including interstate highways, other major arterials, and local routes, totaled nearly 4.1 million miles in 2012, changing little from 2005 (as shown in box 1-A). Lane-miles increased 2.8 percent between 2005 and 2012. Local roads are by far the most extensive, amounting to 2.8 million miles (69.3 percent of total system miles.) However, interstate highways, which accounted for only about 47,400 miles (1.2 percent of total system miles), handled the highest volumes of traffic as measured by vehicle-miles traveled—24.6 percent in 2012. Large Western and Midwestern states, such as Texas, California, Illinois, Kansas, and Minnesota, have the most public road mileage.[3] The District of Columbia, followed by Hawaii, Delaware, Rhode Island, and Vermont, had the lowest public road and street mileage [USDOT FHWA 2013a].

[3] Alaska, the largest state by land area, has relatively few miles of roads, which reflects the lightly populated and relatively undeveloped character of the large landmass that lies outside of the Anchorage to Fairbanks corridor.

Bridges

About 607,400 bridges were in use in 2012, ranging in size from rural one-lane bridges crossing creeks to urban multilane and multilevel interstate bridges. Rural local bridges accounted for about 33.8 percent of the total bridge network. By comparison, bridges in the urban and rural interstate system accounted for about 9.2 percent of all bridges in 2012, but carried the highest volumes of motor vehicle traffic. Texas had the most bridges, accounting for 8.6 percent of the entire U.S. bridge network, followed by Ohio with 4.5 percent and Illinois with 4.4 percent [USDOT FHWA 2013b]. Chapter 2 includes a detailed discussion on the physical condition of the Nation's bridges.

Vehicles

Government, businesses, private individuals, and nongovernmental organizations owned and operated about 254 million motor vehicles in 2012, up by 2.5 percent from 2005 levels (box 1-A). However, motor vehicle registrations dropped 4.5 percent and new light-duty vehicles (cars and light trucks) reached a low in 2009 as businesses and households deferred purchases during the economic recession [USDOE ORNL 2013] that began in December 2007 and continued through June 2009 [NBER 2013].

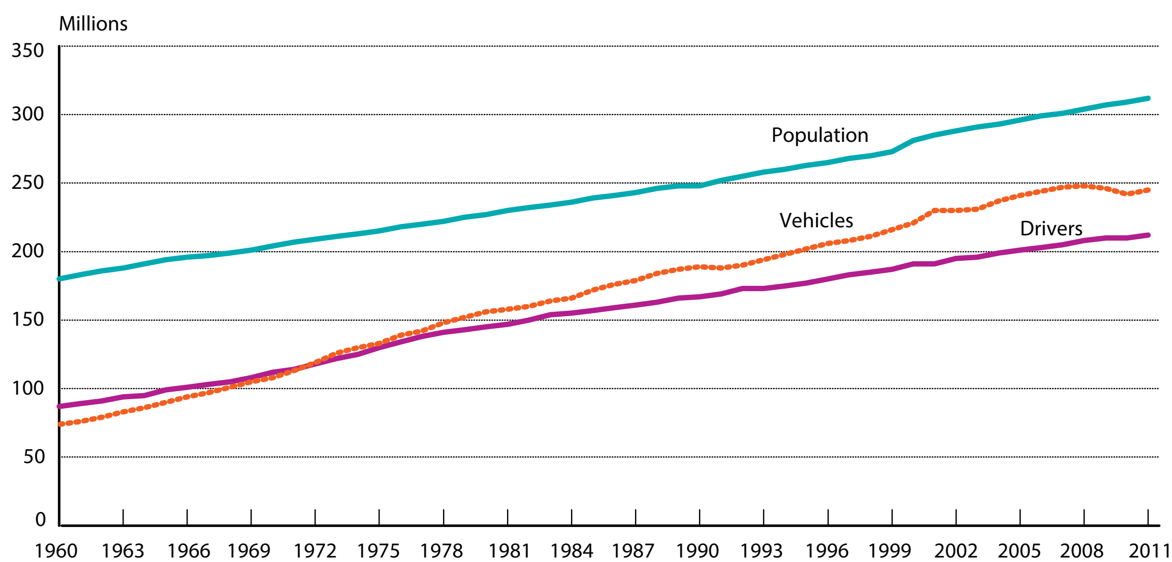
Motor vehicle registrations have grown at a faster rate than licensed drivers and the population since the 1960s (figure 1-1). This growth produced an increase in the average number of motor vehicles owned by households. Motor vehicle registrations have since rebounded from the economic recession, but remain 1.2 percent below the peak set in 2008. In 2011 U.S. motor vehicle registrations comprised 23.3 percent of the world total, down from 27.5 percent in 2005. By comparison, China accounted for 8.7 percent of the world's motor vehicle registrations in 2011, up from 3.5 percent in 2005 [USDOE ORNL 2013]. Increases in vehicle registrations from 2011 to 2012 varied widely by vehicle type. For example, among passenger vehicles, registrations for light-duty short-wheelbase vehicles decreased by 0.2 percent, and light-duty long-wheelbase vehicles increased by 0.5 percent. Motorcycle registrations rose by 0.2 percent, continuing a long-term upward trend.[4]

The numbers of single-unit and combination trucks registrations were up 4.7 and 0.7 percent, respectively, between 2011 and 2012. According to the U.S. Census Bureau's 2012 Economic Census, many of these vehicles were operated by the more than 111,200 trucking establishments in the United States. Between the Census Bureau's 2007 and 2012 Economic Census, a period of time that included the December 2007 through June 2009 recession, the number of trucking establishments decreased by 7.6 percent [USDOC CENSUS 2012].

The number of buses increased by 14.8 percent between 2011 and 2012, but remained below 2005 levels. Buses owned by schools, churches, and other groups accounted for nearly 60 percent of the drop in registrations [USDOT FHWA 2012]. Several factors contributed to this decrease, including school budget cuts, rising fuel costs resulting in a consolidation of routes, and a rise in the

[4] For additional information, please see the BTS Special Report on Motorcycle Trends in the United States.

FIGURE 1-1 Licensed Drivers, Vehicle Registrations, and Resident Population: 1961–2011



SOURCE: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2011.* Chart DV-1C. Available at http://www.fhwa.dot.gov/policyinformation/statistics/2011/dv1c.cfm as of December 2013.

number of children arriving at school by other means, including private vehicle [AASA 2012]. During the 2011–2012 school year, 29.2 percent of school districts reduced bus transportation services and availability.

About 3,600 carriers operated more than 35,000 motorcoaches (or over-the-road buses) in the United States in 2012. An additional 300 Canadian carriers operated over 4,000 motorcoaches, some of which also operate in the United States. Two-thirds of carriers provide more than one service—almost every carrier (97.4 percent) provided charter service, followed by tours (45.0 percent), airport shuttle services (25.3 percent), scheduled services (22.7 percent), sightseeing (20.8 percent), special operations (14.9 percent), and commuter services (10.0 percent). The motorcoach industry provided about 637 million person trips, more than 319 million of which were to students (18 years of age and younger) and seniors (55 years or older)—who accounted for 50.1 percent of motorcoach passengers in 2012 [ABA 2014].

Alternative fuel and hybrid vehicles account for a small but growing segment of the Nation's vehicle fleet. Alternative fuel vehicles numbered approximately 1.2 million, less than 1 percent of all U.S. vehicles in 2012 [USDOE EIA 2013a]. Flex fuel vehicles, which account for 72.4 percent of alternative fuel vehicles, can use conventional gasoline or gasoline-ethanol mixtures of up to 85 percent ethanol (E85) (table 1-3a). Liquid petroleum gas/propane (LPG) and compressed/liquefied natural gas (CNG/LNG) powered vehicles accounted for 11.7 and 10.2 percent, respectively, of the total alternative fuel vehicle fleet in 2012.

Hybrid vehicles, which are not considered alternative fuel vehicles, are powered by a combination of gasoline/diesel and electric engines. Hybrid sales totaled 432,000 in 2012, up more than 65 percent over 2011 sales. There are over 2.1 million hybrids on the road today [USDOE EIA 2013b].

Between 2007 and 2011, the number of alternative vehicle fueling stations (biodiesel, electric charging, ethanol, hydrogen, natural gas, and propane) increased from about 6,000 to nearly 27,000. The addition of 13,000 electric charging stations contributed to this growth (table 1-3b) [USDOE EIA 2013b]. Chapter 8 includes a detailed discussion on the Nation's transportation energy use and environmental impacts.

Aviation

The United States has more airports than any other nation, accounting for 32.3 percent of the world's total [USCIA 2013]. Box 1-A shows that in 2012 the United States had about 19,700 airports, ranging from rural grass-landing strips to urban rooftop heliports to large, paved, multiple-runway airports. Many commercial airports now serve aircraft that are larger than those serviced a decade ago as airlines seek to maximize profits by increasing capacity and by seating more passengers. The passenger load factor – an indicator of capacity utilization – for U.S. airlines has grown from 73.6 percent in 2003 to 82.8 percent in 2013 [USDOT BTS OAI 2014]. Most of the nearly 5,200 public-use facilities are general aviation airports, serving a wide range of users. In addition, there are about 14,300 private airports, which are relatively small. Figure 1-2 shows the passenger boardings

TABLE 1-3a Alternative Fuel Vehicles in Use: 2011

	Light duty	Medium duty	Heavy duty	Total
Ethanol — Flex Fuel	819,133	43,387	317	862,837
Liquid Petroleum Gas—Propane (LPG)	76,647	26,855	35,975	139,477
Natural Gas	66,147	23,473	32,030	121,650
Compressed Natural Gas (CNG)	65,980	23,343	28,891	118,214
Liquefied Natural Gas (LNG)	167	130	3,139	3,436
Electric — Battery	66,409	87	779	67,295
Hydrogen (H)	425	1	101	527
Total	**1,028,761**	**93,803**	**69,222**	**1,191,786**

TABLE 1-3b Total Alternative Fueling Station Counts: August 2013

Includes Public and Private Stations	Totals by fuel
Electric—Electric Vehicle Supply Equipment (EVSE)	19,185
Liquefied Petroleum Gas—Propane (LPG)	2,876
Ethanol—Flex Fuel (E85)	2,625
Compressed Natural Gas (CNG)	1,242
Biodiesel (B20 and above)	733
Liquefied Natural Gas (LNG)	74
Hydrogen (H)	53
Total	**26,788**

NOTES: Each electric charging unit (or EVSE), including legacy chargers is counted once for each outlet available, but count does not include residential electric charging infrastructure.

SOURCES: **Alternative Fuel Vehicles:** U.S. Department of Energy, Alternative Fuels Data Center, *Alternative Fuel Vehicles in Use 2011* (as of 05/16/13), available at http://www.eia.gov/ as of September 2013. **Alternative Fuel Stations:** U.S. Department of Energy, Alternative Fuels Data Center, *Alternative Fueling Station Counts* (as of 08/31/2013), available at http://www.afdc.energy.gov/fuels/stations_counts.html as of September 2013.

at the top 50 airports in 2013. These airports account for 83.2 percent (about 580 million) of the U.S. passenger enplanements on all domestic flights in 2013 [USDOT BTS OAI 2014].

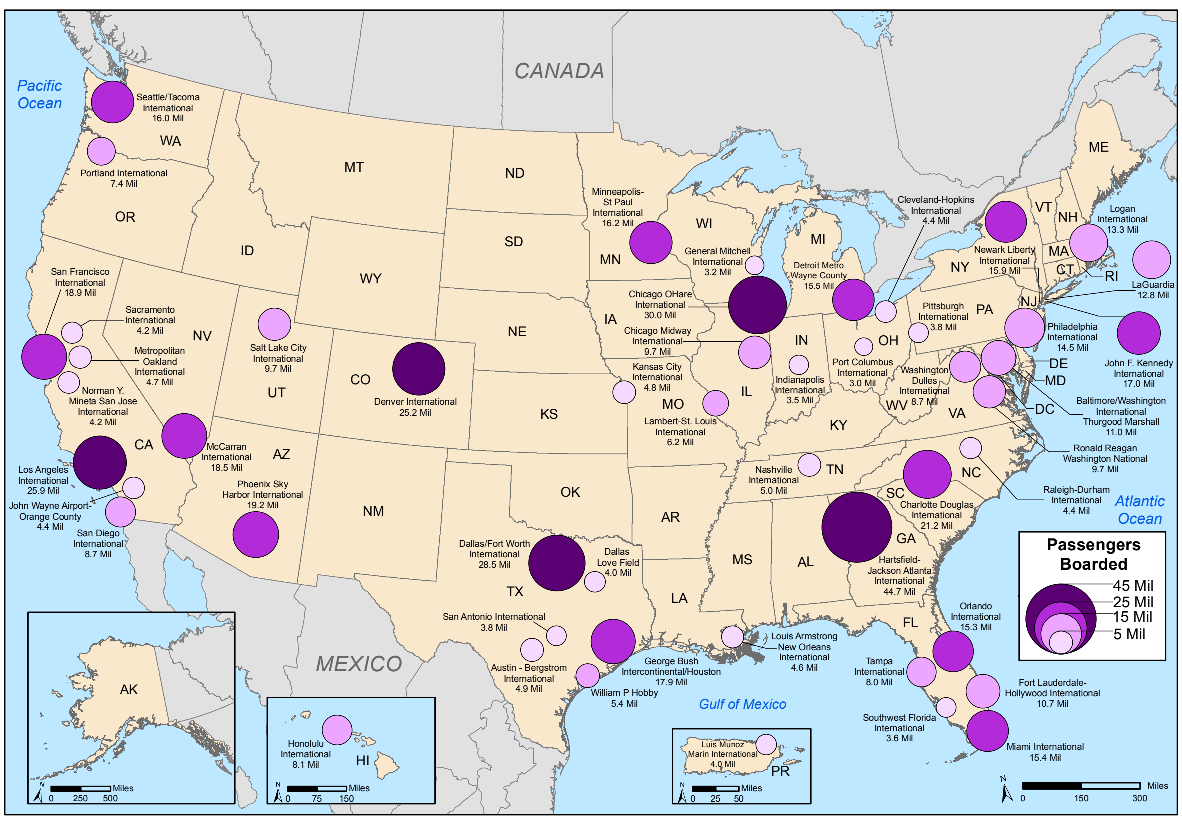
Public Transit

Public transit provided 10.4 billion unlinked trips in 2012, up by 1.2 billion (12.8 percent) over the 2005 total. Over 800 urban transit agencies and more than 1,500 rural and tribal government transit agencies offer a range of travel options, including commuter, transit, and trolley bus; subway and light rail; and ferryboat. Buses accounted for a majority (about 46.0 percent) of the 139,700 transit vehicles (box 1-A). In 2012 these transit agencies operated nearly 4,900 stations, 78.7 percent of which comply with the *Americans with Disabilities Act*. Transit agencies vary widely in size, ranging from 1 to 12,500 vehicles (e.g., the New York City Metropolitan Transportation Authority) [USDOT FTA NTD 2012].

Railroads

The United States had almost 140,000 miles of track in 2012 [USCIA 2013], including about 95,400 miles owned and operated by the

FIGURE 1-2 Passengers Boarded On Domestic Flights at the Top 50 U.S. Airports: 2013



SOURCE: U.S. Department of Transportation, Bureau of Transportation, Office of Airline Information, Air Carrier Summary Data (Form 41 and 298C Summary Data), T-3 Data, available at http://www.bts.gov as of September 2014.

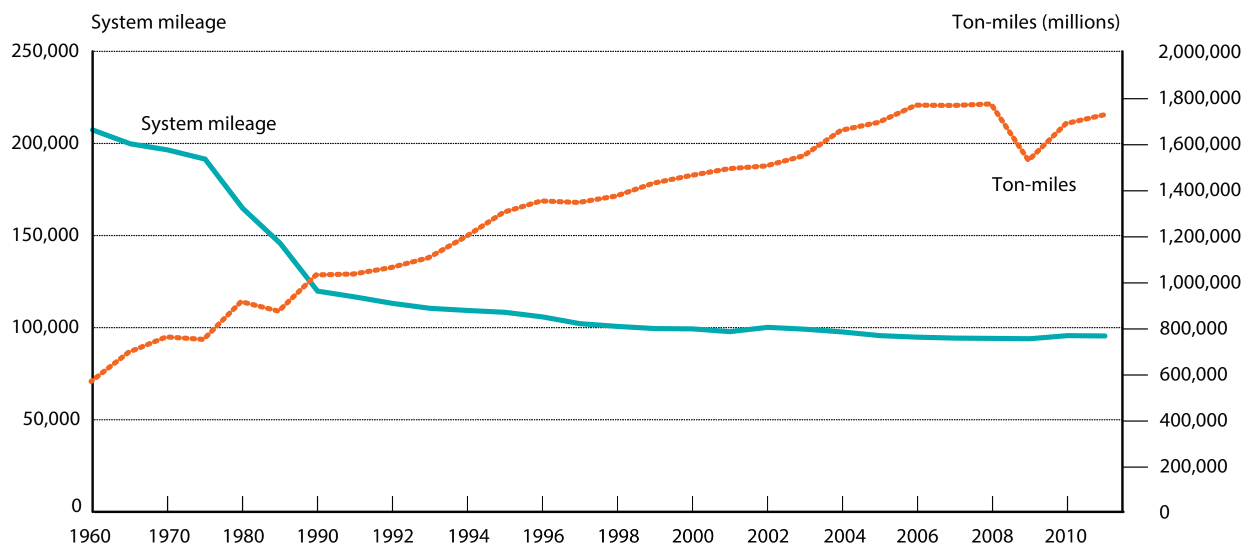
seven Class I railroads [USDOT BTS 2013b].[5] Amtrak, local, and regional railroads operated the remaining track, approximately 44,000 miles. Class I railroads owned and operated over 24,000 locomotives and more than 380,700 freight railcars [USDOT BTS NTS 2013b].

Over the past 50 years, Class I railroads and connecting facilities have developed increasingly efficient ways to carry and transfer cargo (e.g., double-stack container railcars and on-dock rail), allowing more cargo to be carried with fewer railcars. Figure 1-3 shows that the system mileage of Class I railroads in 2011 was less than one-half the mileage in 1960. However, freight rail ton-miles nearly tripled to 1.7 trillion during the same period (despite a decline during the last recession).

The National Rail Passenger Corp. (Amtrak) is the primary operator of intercity passenger rail service in the United States. Amtrak transported 31.6 million passengers in fiscal year 2013, up from 20.9 million in 2000 [AMTRAK 2013a]. Amtrak has set ridership records in 10 of the last 11 years. The Northeast Corridor (NEC), from Washington, DC, to Boston, MA, accounted for well over one-third of all riders. Figure 1-4a shows the top 25 stations by ridership across the country, and figure 1-4b shows the stations by ridership in the NEC. Ridership was also high around Chicago as well as at several locations in California and the Pacific Northwest.

[5] Includes BNSF Railway, CSX Transportation, Grand Trunk Corp., Kansas City Southern, Norfolk Southern, Canadian Pacific operations in the United States, and Union Pacific.

FIGURE 1-3 Class I Railroad System Mileage and Ton-miles of Freight: 1960, 1965, 1970–2011



SOURCES: **Mileage**: Association of American Railroads as cited in U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS), *National Transportation Statistics* (NTS), Table 1-49, Available at http://www.bts.gov as of February 2014 and **Ton-miles**: Association of American Railroads as cited in USDOT, BTS, NTS, Table 1-49, Available at http://www.bts.gov as of February 2014.

FIGURE 1-4a Top 25 Busiest Amtrak Stations: FY 2012

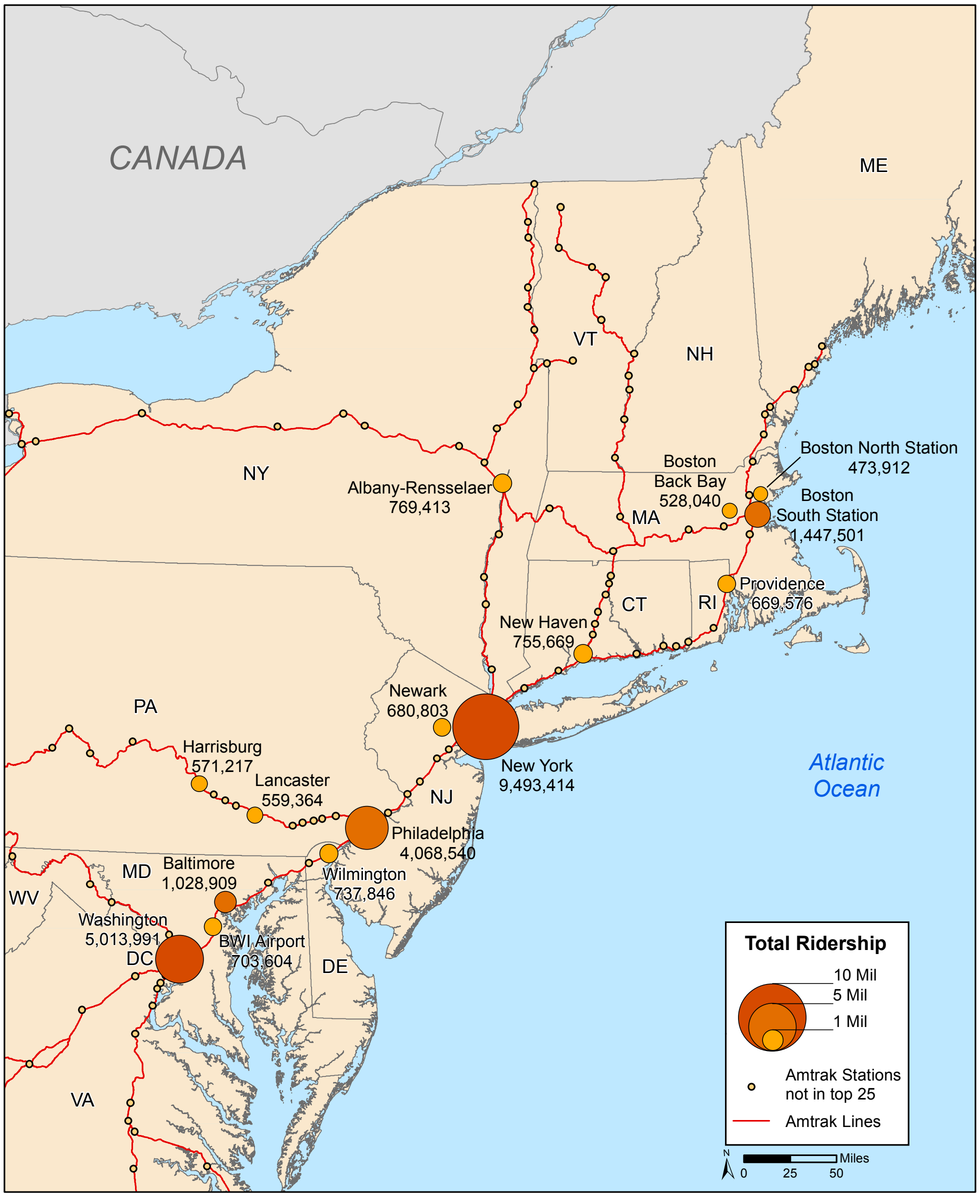
SOURCE: Amtrak as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 1-44. Available at http://www.bts.gov as of September 2013.

Amtrak operated 21,300 route miles in 2012 and more than 500 stations that served 46 states and Washington, DC [AMTRAK 2013b]. Amtrak, as part of a 30-year *Amtrak Fleet Strategy*, plans to renew its entire fleet of passenger rail cars and locomotives by 2042 [AMTRAK 2012]. Amtrak's fleet of rail cars and locomotives decreased by 11.2 and 10.3 percent, respectively, from fiscal years 2012 to 2013, but the railroad is expected to take delivery of 130 new long-distance single-level railcars and 70 electric locomotives and has issued a request for proposal for its Next Generation High Speed Trainsets [AMTRAK 2014].

Ports and Waterways

More than 8,200 U.S. water transportation facilities, including cargo handling docks, handled 2.3 billion short tons of goods in 2012. Of these facilities, 2,000 handled both foreign and domestic cargo, less than 80 handled foreign cargo only, and nearly 6,200 handled domestic cargo only. About 69 percent of cargo-handling facilities are located on the

FIGURE 1-4b Amtrak Stations Along the Northeast Corridor: FY 2012



SOURCE: Amtrak as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 1-44. Available at http://www.bts.gov as of September 2013.

coasts; gulf coast facilities accounted for 26.1 percent of the total, followed by the Atlantic coast (21.8 percent) and the Pacific coast (20.6 percent). The remaining 31.4 percent of cargo-handling facilities are situated along the Great Lakes or inland waterways [USACE IWR NDC 2013]. These facilities are served by a fleet of 40,500 domestic vessels—31,500 barges and 9,000 self-propelled vessels, including almost 3,000 push boats used to move the barges [USACE IWR NDC 2012].

Los Angeles, CA, was the top port in terms of 2012 container traffic, handling 5.7 million twenty-foot equivalent units (TEU); followed by Long Beach, CA (4.7 million TEU); New York, NY and NJ (4.4 million TEU); Savannah, GA (2.3 million TEU); and Norfolk, VA (1.7 million TEU) [USACE IWR NDC 2014]. Many of these coastal seaports are served by post-Panamax vessels[6] that continue to increase in size. Containerships had an average capacity of 3,969 TEU in 2011, up 13.3 percent from 3,503 TEU in 2006. The average deadweight tonnage of cargo vessels calling at U.S. ports was 53,832 in 2011, up 6.3 percent from 50,653 in 2006 [USDOT MARAD 2013b]. Today's largest containerships can carry upwards of 18,000 TEU [ABS 2011].

Larger vessels afford greater economies of scale and costs savings. However, they require investments in U.S. ports such as increasing bridge clearances, channel depths, landside access, and port and terminal infrastructure [USACE IWR 2012]. Carriers are shifting trade routes, ports are investing in infrastructure, and shippers are adjusting their supply chains in anticipation of these larger vessels and the expanded Panama Canal [USDOT MARAD 2013c]. U.S.-flag vessels accounted for 10.8 percent of 2012 calls at U.S. ports, down from 11.7 percent 5 years earlier [USDOT MARAD 2013a].

U.S. ferries carried an estimated 103 million passengers and just over 37 million vehicles in 2009 [USDOT BTS 2014]. Figure 1-5 shows the average number of passengers and vehicles by state. In 2009, 218 ferry operators worked in 37 states, 10 in U.S. territories and 3 between U.S. and non-U.S. locations (e.g., Canada). The U.S. ferry fleet was composed of 652 vessels, 622 of which were in active service. California had the most ferry vessels with 62, followed by New York (56), Massachusetts (52), and Washington State (46). Nearly all of the vessels carried passengers (93.4 percent), while less than half (43.6 percent) carried vehicles, and less than a quarter carried freight (22.2 percent).

Pipelines

Natural gas was transported via about 320,000 miles of natural gas transmission pipeline and over 2.1 trillion miles of natural gas distribution main and service pipelines (box 1-A). Pipelines moved 65 percent of U.S. energy supplies in 2012 [USDOT PHMSA 2013a]. Natural gas pipelines delivered 23.4 trillion cubic feet of gas to consumers [USDOE EIA 2014a]. Over 185,600 miles of crude/refined oil and hazardous liquid pipelines [USDOT PHMSA 2013b] carried 109 million of barrels across the United

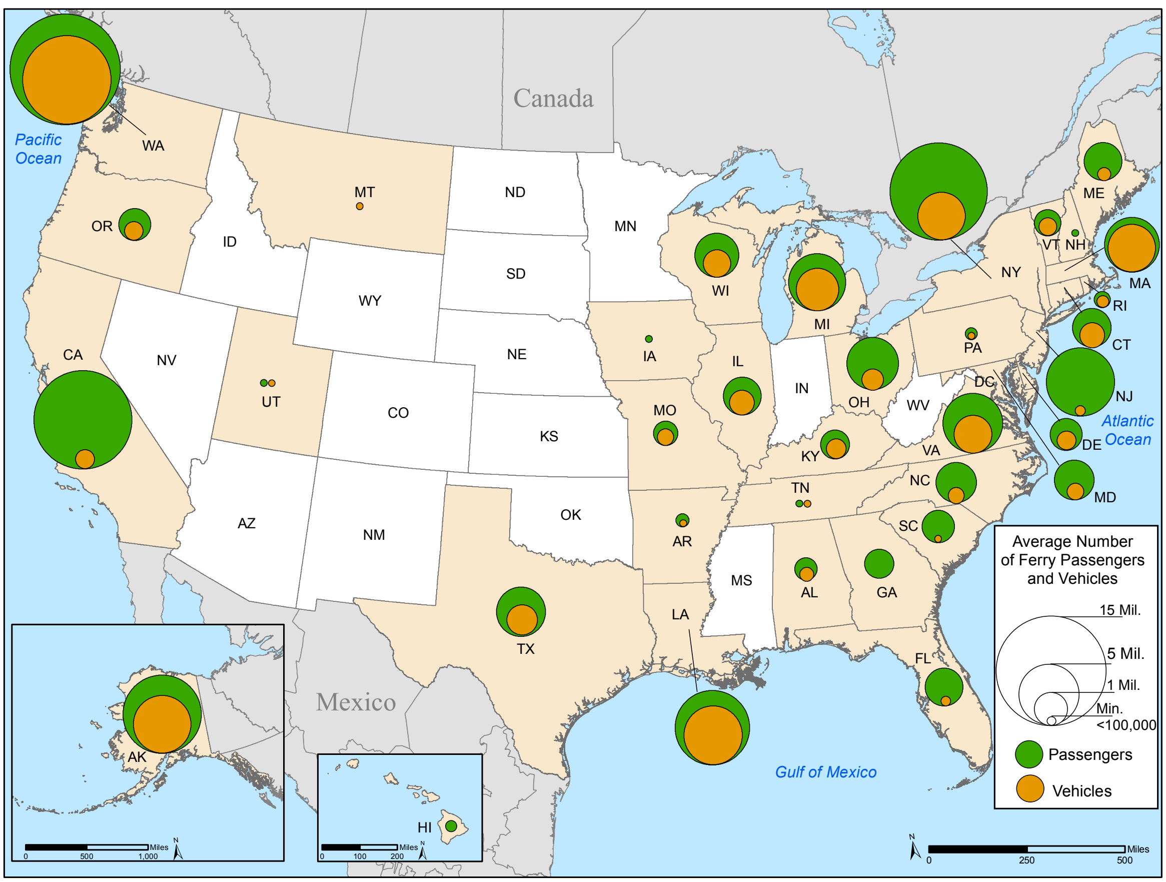
[6] Vessels exceeding the length and width of the lock chambers in the Panama Canal.

States [USDOE EIA 2014b]. These pipelines connect to 65 million households, 5 million commercial businesses, and to the 1,900 electrical generating units that supply approximately 25 percent of U.S. electricity [AGA 2013].

Passenger Access and Connectivity

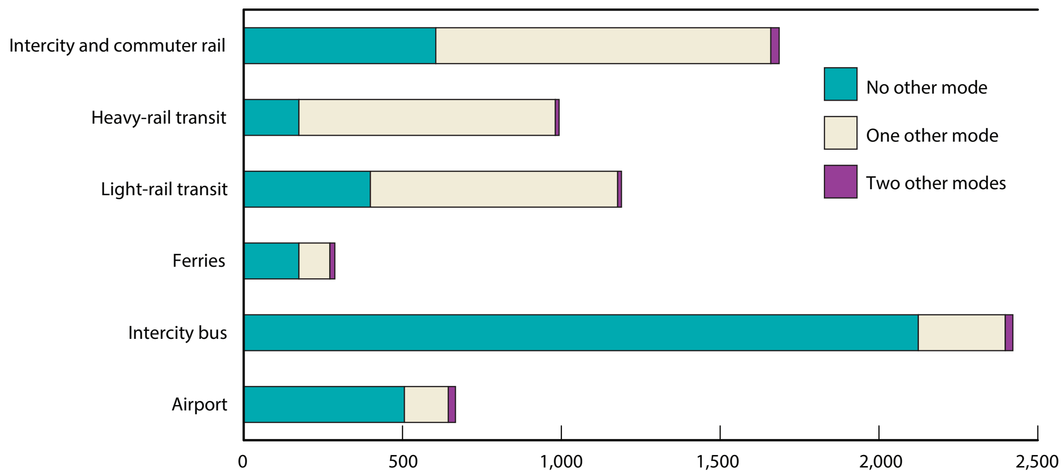
Public transportation passengers often need to connect to another mode of transportation to reach their destinations. According to the 2009 National Household Travel Survey, 99 percent of all transit trips used at least two modes of transportation. Intermodal links between transportation modes (e.g., transit, intercity bus, or train station access at airports) give travelers more mobility options. The Bureau of Transportation Statistics' (BTS') Intermodal Passenger Connectivity Database inventories the connectivity of passenger transportation facilities (e.g., air, long-distance bus and ferry, and intercity rail service) and certain transit facilities (e.g., local ferry, heavy rail, light rail, and commuter rail). The intermodal database includes over 7,200 intercity passenger travel

FIGURE 1-5 Average Number of Ferry Passengers and Vehicles by State: 2010



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Census of Ferry Operators 2010*, Available at http://www.bts.gov as of January 2014.

FIGURE 1-6 Intermodal Passenger Facilities by Mode: September 2013



Number of Connections by Facility Type

Number of Facilities:	No other mode	One other mode	Two other modes	Grand Total
Airport	506	138	22	666
Intercity bus	2,123	274	24	2,421
Ferries	173	98	16	287
Light rail transit	398	779	12	1,189
Heavy rail transit	173	808	11	992
Intercity and commuter rail	604	1,055	26	1,685
	3,977	**3,152**	**111**	**7,240**

Percent of Connections by Facility Type

Percent of Facilities:	No other mode	One other mode	Two other modes
Airport	76.0%	20.7%	3.3%
Intercity bus	87.7%	11.3%	1.0%
Ferries	60.3%	34.1%	5.6%
Light rail transit	33.5%	65.5%	1.0%
Heavy rail transit	17.4%	81.5%	1.1%
Intercity and commuter rail	35.8%	62.6%	1.5%
	54.9%	**43.5%**	**1.5%**

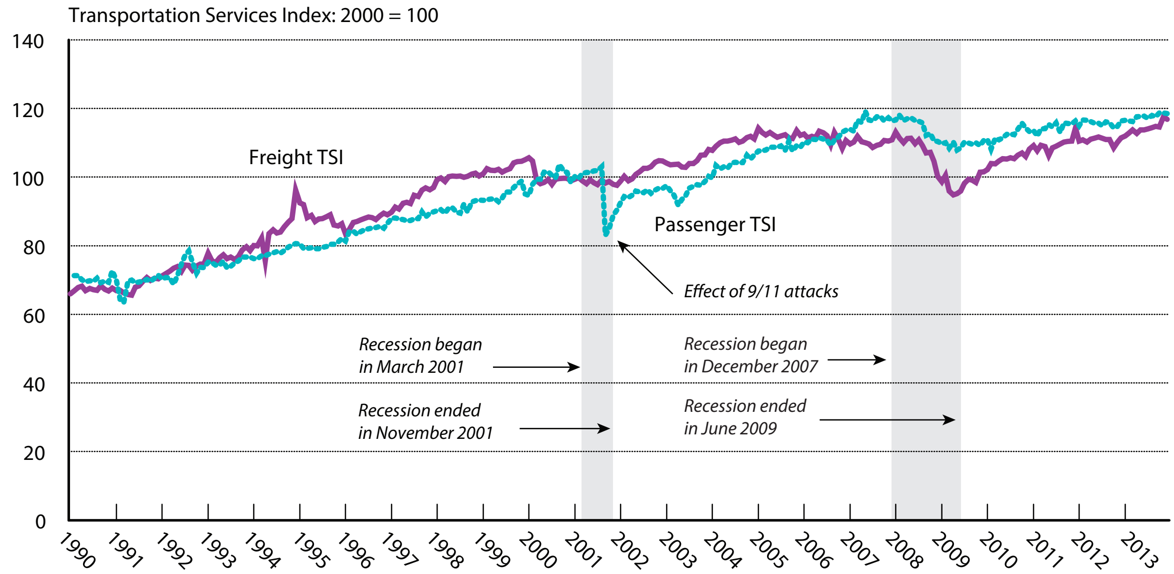
Type of Connections by Facility

	Type of Connections:			
Type of Facility:	Air	Bus	Ferry	Rail
Airport	666	156	5	21
Intercity bus	57	2,421	15	250
Ferries	5	105	287	20
Light rail transit	6	789	8	1,189
Heavy rail transit	7	818	5	992
Intercity and commuter rail	17	1,078	12	1,685

NOTES: *Types of connections include*: a. Ferry (transit and intercity), b. Bus (intercity, transit, code share, and supplemental), c. Rail (intercity, light, heavy, and commuter), and d. Air. *Type of facilities include*: a. Ferry (transit and intercity, b. Intercity bus, c. Rail (intercity, light, heavy, and commuter), and d. Air.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *Intermodal Passenger Connectivity Database* (as of 09/13/2013), available at www.bts.gov as of September 2013.

FIGURE 1-7 Freight and Passenger Transportation Services Index: January 1990–December 2013



SOURCE: **TSI**: U.S. Department of Transportation, Bureau of Transportation Statistics, *Transportation Services Index* (Updated monthly), available at www.bts.gov as of April 2014. **Recession Dates**: National Bureau of Economic Research, *U.S. Business Cycle Expansions and Contractions*, available at www.nber.org/cycles.html as of January 2014.

facilities (figure 1-6), of which 54.9 percent do not offer connections to other transportation modes, 43.5 percent connect to one other mode, and 1.5 percent connect to two other modes of transportation (e.g., bus, air, rail, or ferry) [USDOT BTS 2013a].

Eighty-three percent of the heavy rail-stations offered connections to other modes and are the most connected of all travel options, followed by light-rail transit (with 66.5 percent), and Amtrak/intercity and commuter rail (with 64.2 percent). About a quarter (24.0 percent) of airports connect with other transportation modes. Only 12.3 percent of intercity bus facilities have connections to other modes [USDOT BTS 2013a].

Transportation Services Index

Figure 1-7 shows the volume of for-hire passenger and freight services provided by airlines, railroads, trucking companies, transit agencies, inland waterway operators, and pipeline companies for each month between January 1990 and December 2013 as compiled by BTS' Transportation Service Index (TSI).[7] Despite several temporary declines since 2000, for-hire transportation services have regained momentum over time. In December 2013 the volume of freight transportation services was 77.2 percent higher than in January 1990 and up 10.7 percent from January 2000. The volume

[7] The index does not include all for-hire transportation as intercity bus service, taxi, and sightseeing services are not covered.

of passenger services as of December 2013 was 68.2 percent higher than in January 1990 and 25.2 percent greater than in January 2000. The TSI has rebounded from the economic recession, which began in December 2007 and continued through June 2009 [NBER 2013], when both indexes hit lows—94.8 for freight in April 2009 and 108.4 for passenger in March 2009.

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CHAPTER 2

Physical Condition of the U.S. Transportation System

The efficiency, reliability, and safety of the U.S. transportation system depend on assets that are properly maintained and in good physical condition as they perform their intended function of moving people and goods. This chapter examines the condition of the principal transportation modes, including infrastructure, vehicles and control systems, and the estimated cost of keeping or bringing the system into a state of good repair. Interconnections that link one mode with one or more other modes are also important system elements, but a lack of public data on these connections prevents meaningful analysis of their condition.

- The condition of the U.S. transportation infrastructure is improving, but additional work is needed. The percentage of structurally deficient bridges declined from 12.3 percent in 2007 to 11 percent in 2012.
- One impact of bridge deterioration is reduced load limits. In 2013, 11.8 percent of all bridges had reduced load limits, which caused commercial vehicle operators to use smaller trucks or take circuitous routes, increasing the costs of their operations.
- Airport runways are in good condition; only 2 percent are considered poor.
- The average age of inland waterway navigation locks is more than 50 years. The oldest locks tend to have longer tow delays and more frequent service outages than newer locks.
- There is a general lack of data on vehicle and control system condition, regardless of mode, and on most aspects of intermodal connections.

Roads, Bridges, and Vehicles

The U.S. Department of Transportation's (USDOT) Federal Highway Administration (FHWA) reports the International Roughness Index (IRI), which measures the smoothness of pavement and is a key indicator of the condition of highways and bridges.[1] Table 2-1 provides summary data on the

[1] A highway that has a roughness rating greater than 170 inches per mile is considered in poor condition.

TABLE 2-1 Condition of U.S. Roadways by Functional System: 1999, 2001, 2003, 2005, 2007, 2009, and 2011

Percent of Mileage with an International Roughness Index over 170

	1999	2001	2003	2005	2007	2009	2011	Change from 1999 to 2011, percentage point
Rural								
Interstates	2.4	1.9	1.6	1.7	1.9	1.7	1.8	-0.6
Other principal arterials	4.5	3.7	3.5	3.6	3.2	3.1	3.2	-1.3
Minor arterials	6.8	6.9	6.1	5.4	5.7	6.2	6.6	-0.3
Major collectors	20.9	20.9	18.3	16.1	16.2	16.2	18.6	-2.4
Urban								
Interstates	7.3	7.4	7.7	6.0	5.9	5.0	5.2	-2.1
Other freeways and expressway	10.7	10.2	10.7	7.8	7.2	6.5	7.8	-2.9
Other principal arterials	30.6	29.3	29.0	27.4	26.9	26.4	28.1	-2.5
Minor arterials	26.9	33.2	34.4	33.6	31.9	30.2	37.3	10.4
Collectors	37.9	50.0	51.6	49.7	47.0	44.8	53.7	15.8

NOTES: Numbers may not add to totals due to rounding. Data are reported as the International Roughness Index (IRI) in inches per mile. Lower IRI represents smoother riding roadways. For more information on the rating system, refer to National Cooperative Highway Research Program (NCHRP) report 20-24(37)G, Technical Guidance for Deploying National Level Performance Measurements, available at http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-24(37)G_FR.pdf as of November 2011.

SOURCES: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 1-27. Available at http://www.bts.gov/ as of January 2014.

percentage of rough surface mileage for different functional classes of highways. The physical deterioration of roads and bridges typically does not produce abrupt failures; rather, continued rough riding produces repetitive and gradual increases in vehicle maintenance and other highway user costs. In 2011, 13.9 percent of all rural roads and 35.3 percent of all urban roads had an IRI above 170, which is considered unsatisfactory [USDOT BTS 2014].

In urban areas the results are mixed. From 1999 to 2011, interstate highways, other expressways, and other principal arterials had 2 to 3 percent reductions in the mileage of road surfaces with an IRI above 170, with most of the improvement occurring after 2003. In contrast, over the same period, minor arterial and collector roads showed 10.4 and 15.8 percent increases, respectively, in the mileage of roads with an IRI above 170. One reason for the increase may be continuing commercial and residential development in many medium to large urban areas. The roadway infrastructure in such rapidly developing areas often consists primarily of local roads that were not built for the heavy trucks and high traffic volumes that come with development. The overall condition of all rural roadway categories improved between 1999 and 2011, with major collectors showing the greatest improvement (2.4 percent),

TABLE 2-2 Condition and Average Daily Traffic (ADT) of U.S. Highway Bridges: 2002, 2007, and 2012

	2002	2007	2012	Change from 2002 to 2012, percentage point
TOTAL all bridges	**590,868**	**599,765**	**607,378**	**0.03**
Urban	135,339	151,171	160,605	0.19
Rural	455,529	448,594	446,773	-0.02
	2002	**2007**	**2012**	**Change from 2002 to 2012, percentage point**
Structurally deficient bridges, percent	14.2	12.3	11.0	-0.03
Urban	9.5	8.8	7.5	-0.02
Rural	15.6	13.5	12.3	-0.03
Functionally obsolete bridges, percent	15.4	14.9	14.0	-0.01
Urban	24.9	24.9	24.0	-0.01
Rural	12.5	11.5	10.4	-0.02
	2002	**2007**	**2012**	**Change from 2002 to 2012, percentage point**
TOTAL ADT all bridges	**3,968,243,689**	**4,342,305,019**	**4,485,265,660**	**0.13**
Urban ADT	2,911,076,044	3,278,861,311	3,442,148,976	0.18
Rural ADT	1,057,167,645	1,063,443,708	1,043,116,684	-0.01
	2002	**2007**	**2012**	**Change from 2002 to 2012, percentage point**
Structurally deficient bridges ADT, percent	8.0	7.3	5.9	-0.02
Urban ADT	8.3	7.6	6.0	-0.02
Rural ADT	7.0	6.5	5.7	-0.01
Functionally obsolete bridges ADT, percent	22.0	22.0	21.3	-0.01
Urban ADT	24.5	24.9	23.9	-0.01
Rural ADT	15.1	13.1	12.5	-0.03

KEY: ADT = Average Daily Traffic

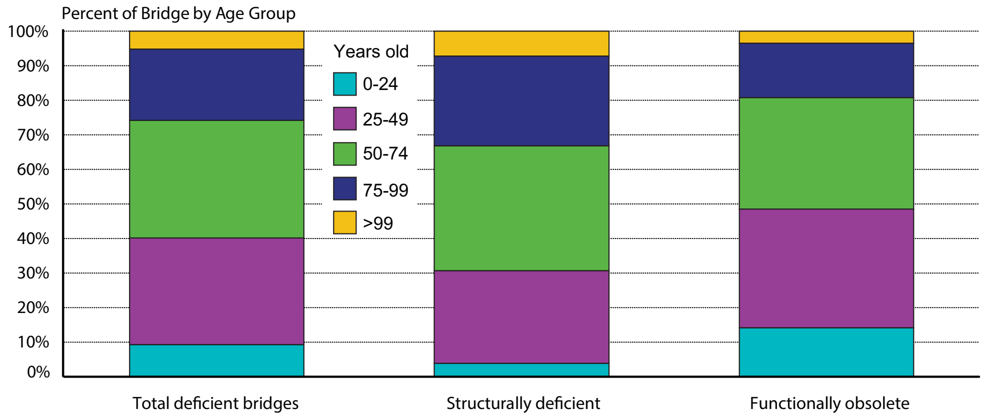
NOTES: Bridges with a Year Built or Year Reconstructed within the past 10 years will not be assigned a deficient status. Therefore, when referring to the deficiency being calculated not using the 10-yr rule, the status will be calculated without taking into consideration the year built or the year reconstructed. U.S. totals include the 50 states, the District of Columbia, and Puerto Rico. Table includes: Rural–Interstate, principal arterial, minor arterial, major collector, minor collector and local roads; Urban–Interstate, other freeways or expressways, other principal arterial, minor arterial, collector, and local roads. Data for 2001-12 are as of December of those years.

SOURCES: **Condition**: U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), Office of Bridge Technology, *National Bridge Inventory* as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*. Table 1-28. Available at http://www.bts.gov/ as of January 2014. **ADT**: USDOT/FHWA. *2002, 2007, 2012 Count, Area, Length, and ADT of Bridges by Highway System*. ADT tables. Available at http://www.fhwa.dot.gov/bridge/fc.cfm as of February 2014.

although major collectors remained the only category with a double-digit percentage of mileage with an IRI above 170. Rural interstate highways and minor arterials had 1.8 and 6.6 percents of mileage, respectively, with an IRI above 170 in 2011.

There has been slow but steady improvement in the condition of highway bridges, as shown in table 2-2. Two categories of bridge deficiency are tabulated: structurally deficient and functionally obsolete. Structurally deficient bridges have reduced load bearing capacity due to the deterioration of one or more bridge elements. Such bridges are not necessarily unsafe, but they do require maintenance and repair to remain in service and will eventually require rehabilitation or replacement. Functionally obsolete bridges, while structurally sound, often carry traffic volumes that exceed their design limits and may need to be widened or replaced. Table 2-2 shows the percentage of structurally deficient bridges that declined from 2002 to 2012, with the largest decline recorded for rural bridges. There was a

FIGURE 2-1 Bridge Condition by Age Group: 2011



	Age in years (as of 12/31/2011)				
	0-24	25-49	50-74	75-99	>99
Total Bridges	**179,777**	**220,266**	**133,613**	**59,677**	**11,730**
Total Deficient Bridges					
Number	13,365	44,395	49,028	29,646	7,443
Percent	7.4	20.2	36.7	49.7	63.5
Structurally Deficient					
Number	2,571	18,159	24,370	17,593	4,826
Percent	1.4	8.2	18.2	29.5	41.1
Functionally Obsolete					
Number	10,794	26,236	24,658	12,053	2,617
Percent	6.0	11.9	18.5	20.2	22.3

NOTES: Excludes 39 bridges with no recorded age. Bridges with a Year Built or Year Reconstructed within the past 10 years will not be assigned a deficient status. Therefore, when referring to the deficiency being calculated not using the 10-year rule, the status will be calculated without taking into consideration the year built or the year reconstructed. U.S. totals include the 50 states, the District of Columbia, and Puerto Rico. Table includes: Rural–Interstate, principal arterial, minor arterial, major collector, minor collector and local roads; Urban–Interstate, other freeways or expressways, other principal arterial, minor arterial, collector, and local roads.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *National Bridge Inventory*. Available at https://www.fhwa.dot.gov/bridge/nbi.cfm as of November 2013.

decline in the percentage of structurally deficient urban bridges and a decline in the percentage of urban traffic using structurally deficient bridges. Urban bridges carry 76.7 percent of all bridge traffic, a percentage that rose from 2002 to 2012. There was a small decline in the percentage of urban functionally obsolete bridges and a small decline in the percentage of urban traffic using functionally obsolete bridges. Despite the improvement, 24.0 percent of urban bridges were functionally obsolete for the years shown in the table.

Figure 2-1 provides additional information on deficient bridges by age group, although age alone is not an automatic indicator of structural integrity. For example, the 130-year-old Brooklyn Bridge is still deemed safe for daily use. However, in recent decades notable highway bridge collapses all involved structures that had been in place less than 35 years: the I-95 Mianus River Bridge in Connecticut, the I-87 Schoharie Creek Bridge in New York, and the I-35W Mississippi River Bridge in Minnesota [LITTLE 2013], which collapsed in 1983, 1987, and 2007, respectively. The trend, however, is clear—the likelihood that a bridge will be found deficient increases almost linearly with the age of the bridge. About one-half of bridges in place for 75 years or more are rated as deficient.

The more prevalent negative impact of bridge deterioration is the imposition of reduced load limits. In 2013 there were 71,692 bridges in the National Bridge Inventory with some type of load restriction, comprising 11.8 percent of all bridges listed [USDOT FHWA 2014]. These load limit reductions cause commercial vehicle operators to either use trucks with smaller payloads or take circuitous routes, both of which increase costs.

TABLE 2-3 Average Age of Light-Duty Vehicles in the United States: 2001-2013

	Age in Years		
Year	Passenger cars	Light trucks	All light vehicles
2001	9.3	8.4	8.9
2002	9.8	9.4	9.6
2003	9.9	9.5	9.7
2004	10.0	9.5	9.8
2005	10.1	9.5	9.8
2006	10.2	9.5	9.9
2007	10.3	9.6	10.0
2008	10.4	9.8	10.1
2009	10.5	10.1	10.3
2010	10.8	10.5	10.6
2011	11.1	10.8	10.9
2012	11.3	11.1	11.2
2013	11.4	11.3	11.4
Change from 2001, percent	22.6%	34.5%	28.1%

NOTE: Data for average age of automobiles are as of July 1 of each year.

SOURCE: R.L. Polk Co. as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*.Table 1-26. Available at http://www.bts.gov/ as of November 2013.

There is no organized database on the operating condition of vehicles traveling on the Nation's highways. Table 2-3 shows that the average age of the light-duty vehicle fleet increased by 28.1 percent over the 2001 to 2013 period and stood at about 11.4 years in 2013. Meanwhile, the heavy-duty commercial truck fleet, after increasing in age through 2010, is getting younger [POLK 2013]. In 2010, as replacement costs rose and the economic recession set in, the average age of freight trucks peaked at 6.6 years—a full year older than the long-term historic average of 5.6 years. Since the 2010 peak, the average age of freight trucks has been decreasing [CALPIN AND PLAZA-JENNINGS 2012] as the vehicle replacement rate accelerated with improvements in the U.S. economy. However, age cannot be used as a measure to gauge vehicle condition.

Traffic control systems, such as traffic signs, signals, and pavement markings, are an important element of the highway system, but there is no national database on traffic control systems and their condition. An estimated 311,000 traffic signals have been installed in the United States, with an aggregate public capital investment of $83 billion [NTOC 2012]. There are no comparable estimates of the numbers of other types of traffic control devices.

The biennial report on highway and transit system condition and performance prepared for the U.S. Congress by the USDOT contains detailed data, economic modeling, and analysis that highlight the relationships between physical condition, system performance, and investment. Current annual capital spending on highways and bridges is set at $100.2 billion, which exceeds estimates on the amount needed to maintain current condition and performance. These estimates range from $65.3 billion to $86.3 billion per year, depending on future system usage as measured by vehicle-miles traveled (VMT). These estimates indicate that sustained spending at current levels could result in improved system conditions and performance, but falls short of the $123.7 billion to $145.9 billion per year that FHWA estimates is needed to rehabilitate, expand, and enhance the system [USDOT FHWA and FTA 2013].

Public Transit

Table 2-4 provides information on the condition of rail transit infrastructure for 1997 and 2006, the latest year for which data are available. Elevated structures, such as rail transit bridges, viaducts, and tunnels, had the highest percentage of facilities rated good or excellent, and both showed an increase in the latter rating category over the reporting period. In most of the infrastructure categories, condition ratings tended to move toward "adequate," rather than "better" or "worse." Communication systems (telephones, radios, and computer networks) achieved the best overall ratings, with over 99 percent rated as adequate or higher, and this category had the highest increase in the percentage of systems rated as excellent.

The average age of transit vehicles over the 2001 to 2012 period is shown in table 2-5. Commuter rail locomotives and passenger coaches aged the most among rail vehicles

TABLE 2-4 Substandard or Poor Condition Rail Transit Infrastructure (Percent): 1997 and 2006

	1997	2006	Difference between 1997 and 2006, percentage points
Stations			
Substandard	13.0	31.3	18.3
Poor	15.0	3.0	-12.0
Communication Systems			
Substandard	12.0	0.6	-11.4
Poor	10.0	0.0	-10.0
Train Control Systems			
Substandard	11.0	14.4	3.4
Poor	13.0	5.5	-7.5
Traction Power Systems			
Substandard	7.0	7.2	0.2
Poor	14.0	4.2	-9.8
Revenue Collection Systems			
Substandard	10.0	8.8	-1.2
Poor	12.0	21.5	9.5
Elevated structures			
Substandard	29.0	7.9	-21.1
Poor	1.0	7.3	6.3
Underground tunnels			
Substandard	19.0	15.4	-3.6
Poor	9.0	14.8	5.8

NOTE: Percents may not add to 100 due to rounding.

SOURCE: U.S. Department of Transportation (USDOT), Federal Transit Administration as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*. Table 1-31. Available at http://www.bts.gov/ as of November 2013.

over that period and are among the oldest of all transit equipment. The heavy-rail car fleet age decreased by 1.9 years between 2001 and 2012, but is still 19.8 years old on average, the oldest part of the rail and transit fleet. Light-rail vehicles maintained an average age of about 15 to 16 years over the reporting period. The transit bus fleet aged slightly, indicating that many transit agencies retired and replaced older buses. As would be expected, the transit bus fleet remains considerably newer than the rail fleet, which has locomotives and cars that may last for decades.

Maintaining urban transit vehicles in good condition requires maintenance facilities that are well suited to the task. Table 2-6 shows that most maintenance facilities are rated as adequate or better, but 465 bus maintenance

TABLE 2-5 Average Age of Urban Transit Vehicles: 2001, 2006, 2011, and 2012

	2001	2006	2011	2012	Change between 2001 and 2012, percent
Transit rail					
Commuter rail locomotives[a]	14.2	16.9	17.6	17.8	25.4
Commuter rail passenger coaches	18.1	18.6	19.4	20	10.5
Commuter rail self-propelled passenger cars	26.2	15.9	19.7	18.5	-29.4
Heavy-rail passenger cars	21.7	21.6	19.2	19.8	-8.8
Light rail vehicles (streetcars)	16.4	15.3	16.5	16.2	-1.2
Transit bus[b]					
Articulated	5.9	6.2	6.5	7	18.6
Full-size	7.8	7.4	8.0	8.0	2.6
Mid-size	5.6	6.2	6.4	6.4	14.3
Small	4.0	4.3	4.2	4.3	7.5
Trolley	20.4	9.0	11.4	12.4	-39.2
Other					
Vans	3.3	3.1	3.5	3.6	9.1
Ferry boats	24.7	21.7	20.3	21.0	-15.0

[a] Locomotives used in Amtrak intercity passenger services are not included.

[b] *Full-size* buses have more than 35 seats; *Mid-size* buses have 25-35 seats; *Small buses* have fewer than 25 seats.

SOURCE: U.S. Department of Transportation (USDOT), Federal Transit Administration as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*.Table 1-29. Available at http://www.bts.gov/ as of June 2014.

facilities (36.3 percent of the total) and 53 rail facilities (26.4 percent) were rated as substandard or poor in 2006, the latest year for which data are available. For both bus and rail, the biggest increases over the 2002 to 2006 period occurred in the excellent and substandard or poor facilities categories.

There appears to be a direct relationship between public transit system condition and performance and transit ridership (see e.g., GRAVA 2002 for detailed discussions of the ridership history of each transit mode). Deferred maintenance, outdated equipment and passenger stations, and numerous stops produce an overall transit image that may discourage prospective riders. Conversely, modern, well designed and maintained systems might attract riders who would otherwise travel by other means.

According to USDOT's biennial conditions and performance report, the current total investment across all transit systems is $16.5 billion annually. Bringing all systems to a state of good repair would require an increase to $18.5 billion per year. However, increasing system capacity to accommodate higher transit ridership would require an estimated $22.0 billion to support a 1.4 percent growth rate versus an estimated $24.5 billion to support a 2.2 percent growth rate [USDOT FHWA and FTA 2013].

TABLE 2-6 Estimated Condition of Urban Bus and Rail Transit Maintenance Facilities: 2002 and 2006

	2002	2006	Change from 2002 and 2006, percent
Bus, number of facilities[a]	**1,219**	**1,280**	**5.0**
Excellent	83	210	153.0
Good	68	69	1.5
Adequate	672	536	-20.2
Substandard	387	344	-11.1
Poor	10	121	1110.0
Rail, number of facilities	**152**	**201**	**32.2**
Excellent	27	42	55.6
Good	18	19	5.6
Adequate	76	87	14.5
Substandard	27	51	88.9
Poor	3	2	-33.3

[a] These data are derived from the Transit Economic Requirements Model (TERM). TERM uses statistically determined decay curves to simulate the deterioration of the Nation's transit vehicles, facilities, and other infrastructure components. National Transit Database (NTD) data are applied to these decay curves to estimate conditions. The NTD began gathering information on facilities owned by bus systems providing services under contract in 1999 (known as purchased transportation), however, TERM did not base condition estimates on this full set of facilities until 2002.

NOTE: Numbers may not add to totals due to rounding.

SOURCES: U.S. Department of Transportation (USDOT), Federal Transit Administration as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*. Table 1-30. Available at http://www.bts.gov as of November 2013.

Railroads

Intercity Passenger Rail

Amtrak owns a small fraction of its 21,300 route miles, primarily 363 miles of the 456-mile Northeast Corridor between Boston, MA, and Washington, DC, plus three other shorter segments totaling 261 miles [AMTRAK 2012b]. The vast majority of passenger train services outside the Northeast Corridor are provided over tracks owned by and shared with the Class I freight railroads.[2] Hence, the condition of the infrastructure Amtrak uses is largely dependent on the condition of the host railroads, with the exception of the Northeast Corridor.

Amtrak owns, operates, and maintains its own rolling stock. Table 2-7 shows the ages of most of Amtrak's passenger cars and locomotives. The four largest groups of passenger cars range in age from 16 to 64 years and have accumulated an average of more than four million miles per car. The locomotive fleet and trainsets (e.g., Acela) are younger, ranging in age from 12 to 32 years. Amtrak is in the process of acquiring 70 new electric locomotives to create a homogenous fleet by replacing all of its aging AEM-7 units as well

[2] Includes BNSF Railway, CSX Transportation, Grand Trunk Corp., Kansas City Southern, Norfolk Southern, Canadian Pacific operations in the United States, and Union Pacific.

TABLE 2-7 Amtrak Passenger Rail Fleet: 2011

Equipment Type	Active Units (as of 12/1/2011)	Age in 2012 (Years)	Average Mileage (Thousands)
Selected passenger cars			
Amfleet I	473	35 - 38	4,125
Amfleet II	145	31 - 32	5,640
Superliner (I & II)	428	16 - 33	4,880
Heritage	99	56 - 64	5,000
Horizon	95	22 - 24	2,750
Auto Carrier	80	7	1,160
Selected locomotives			
P42	196	11 - 16	2,250
AEM-7	47	24 - 32	3,915
F59PHI	21	14	1,580
Trainsets			
Acela[a]	20	12 - 13	1,620
Northwest Service[b]	5	13	1,920

[a] 20 sets = 40 power cars; 120 trailer cars plus one (1) non-revenue track geometry car

[b] 13 unpowered passenger cars per set

NOTE: A *trainset* comprises one or more power cars mated with a number of unpowered passenger cars that always operate as one entity. AEM-7 is a type of twin-cab electric locomotive. P42 and F59PHI are types of diesel-electric locomotives.

SOURCE: Amtrak, *Amtrak Fleet Strategy Version 3-1* (March 29, 2012). Available at http://www.amtrak.com/ as of November 2013.

as the relatively new HHP-8 locomotives,[3] which have reliability issues. Amtrak is also purchasing 130 new long-distance railcars to replace its vintage Heritage cars and increase capacity [AMTRAK 2012a]. These and other upgrades should decrease the average age of the fleet.

Freight Rail

The U.S. freight rail system is privately owned and operated, and rail carriers are under no obligation to report freight track conditions to public sector agencies. Thus universal track condition reports are unavailable. Railroads are responsible for ensuring track safety, and to that end they regularly inspect their track and perform necessary repairs. The Federal Railroad Administration (FRA) regulations require railroads to maintain track inspection records and make them available to FRA or state inspectors on request. The FRA's rail safety audits focus on regulatory compliance and prevention and correction of track defects. Presently, there is no regular program for assembling and analyzing the many thousands of inspection reports that are prepared each year.

There is, however, one FRA program that generates systematic data on track condition. The Automated Track Inspection Program (ATIP) utilizes a small fleet of highly instrumented track geometry inspection cars

[3] AEM-7 and HHP-8 are a type of twin-cab electric locomotive.

TABLE 2-8 Automated Track Inspection Program (ATIP) Exceptions[1] Per 100 miles: 2004-2011

Year	2004	2005	2006	2007	2008	2009	2010	2011	Average
Profile	4.2	3.4	3.5	3.2	2.4	1.9	2.1	2.4	2.6
Alignment	2.7	1.6	1.3	1.7	1.4	1.8	2.0	2.0	1.8
Gage	13.6	8.5	6.6	5.1	12.2	7.2	3.1	2.1	6.4
Cross-level	8.7	5.2	5.6	2.0	2.0	2.2	1.2	1.3	2.7
Warp	8.1	11.2	6.7	4.7	3.7	4.0	2.8	1.8	4.4
Runoff	0.1	0.8	0.7	0.4	0.6	0.7	0.6	0.8	0.6
Twist	0.6	5.5	1.9	1.8	1.7	1.5	1.3	1.0	1.6
Limited Speed	6.8	6.3	5.9	9.9	9.7	8.7	11.8	3.1	8.2
Total Per 100 Miles	**38.0**	**36.1**	**26.3**	**28.7**	**33.7**	**27.9**	**24.8**	**14.5**	**27.1**
Miles Inspected	34,699	29,051	26,886	59,165	52,997	74,715	83,013	74,541	

[1] Exceptions mean track did not meet normal operation standards

KEY: ATIP = Automated Track Inspection Program

NOTES: In 2007 three new inspection cars came online. Defects are briefly defined as variations from design values for the following track geometry properties:

Profile - rail surface elevations

Alignment - track direction (tangent or curvature)

Gage - distance between rails

Cross-level - elevation difference between the rails

Warp - maximum change in cross-level over a specified distance

Runoff - elevation (ramp) difference of a line along the top of the rail is used for the projection

Twist - rate of introduction and removal of cross-level on transitions from straight to curved track alignment

Limited Speed - reduced operating speed due to track geometry constraints

Detailed definitions and standards may be found in U.S. Department of Transportation, Federal Railroad Administration, *Track and Rail and Infrastructure Integrity Compliance Manual*, July 2012.

SOURCE: U.S. Department of Transportation, Federal Railroad Administration, Office of Safety, ATIP Statistics (December 31, 2011). Available at http://www.fra.dot.gov/ as of February 2014.

to survey tens of thousands of miles of high traffic density and other high priority routes each year. Table 2-8 provides a summary of the inspection results for the years 2004 to 2011. Of the eight track characteristics that are monitored, the incidence of three–gage, cross-level, and warp—are lower in more recent years than in earlier years, but other results are more variable.

The installation of new rail and crossties is one indicator of how track conditions are maintained and improved. The Association of American Railroads (AAR) reported that the Class I railroads installed nearly 790,400 tons of rail and 15,853,000 crossties in 2012, which is more than the annual average of 713,200 tons of rail and 15,050,000 crossties from 2007 to 2011 [AAR 2014].

The AAR also provides data on the age of the seven Class I railroad locomotive fleets (table 2-9). More than 4,500 locomotives were added during the 2001 to 2011 period, reducing the

TABLE 2-9 Class I Railroad Locomotive Fleet by Year Built (Locomotive Units): 2001, 2006, and 2011

Year built[a]	2001	2006	2011
Before 1980	7,862		
1980-1984	2,153	8,237	
1985-1989	1,672	1,735	8,304
1990-1994	2,667	2,740	2,367
1995-1999	4,020	4,535	4,461
2000-2004	1,371	4,673	4,268
After 2004	N/A	1,812	4,850
Total	**19,745**	**23,732**	**24,250**
Median age, years	19	14	14

[a] Disregards year of rebuilding.

KEY: N/A = Not applicable

SOURCE: Association of American Railroads as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*. Table 1-32. Available at http://www.bts.gov/ as of November 2013.

median age of the fleet from 19 to 14 years. No comparable compilation of the age distribution of railcars is available.

Table 2-10 shows railroad capital expenditures trends. As shown, capital expenditures totaled $11.6 billion in 2011, more than doubling the spending in 2001. In contrast, revenue ton-miles increased 15.7 percent over that period. Freight rail is a profit-making enterprise that self-funds its investments, and carriers have a strong incentive to maintain, rehabilitate, and upgrade their systems as needed to remain competitive in the market place and earn returns for their investors.

Ports and Waterways

Dams and navigation locks are two of the principal infrastructure features of the U.S. domestic waterway transportation system. They enable shallow draft operations on most rivers. The principal exceptions are the Lower Mississippi River and the Missouri River, which are free-flowing but still require some types of hydrologic structures, such as large rock and concrete groins and revetments, to manage the flow of the river and preserve navigation. The U.S. Army Corps of Engineers (USACE) owns and operates 239 lock chambers at 193 sites, which account for most of the U.S. inland navigation locks. The average age of all locks is over 50 years [USACE 2012]. The USACE maintains comprehensive data on lock traffic, lockage time and delay, and lock outages for waterway performance analysis.

Table 2-11 provides data on representative locks throughout the inland waterway system. These data show some of the relationships

TABLE 2-10 Class I Railroad Capital Expenditures: 2001, 2006, and 2011
Millions of Dollars

	2001	2006	2011	Percent change from 2001 to 2011
Roadway and Structures	4,421	6,982	7,945	79.7%
Equipment	1,013	1,470	3,656	260.9%
Total Investment	**5,434**	**8,452**	**11,601**	**113.5%**
Revenue Ton-Miles (billion)	1,495	1,772	1,729	15.7%

SOURCE: Association of American Railroads, *Railroad Facts* (Annual Issues). Available at https://www.aar.org/ as of April 2014.

between lock age and performance factors such as tow delay and lock chamber downtime. For example, the Emsworth Lock on the Ohio River is one of the oldest structures in the system and is considered functionally obsolete. It has lock chambers designed for vessels of an earlier era and has lengthy out-of-service delays. The newer locks on the Ohio River, such as John T. Myers, are larger and had relatively low average tow delays of about 40 minutes in 2013 and tend to have numerous short-duration service outages. Lock 52 on the Ohio River is the busiest and also one of the oldest with chambers that are 45 years and 86 years old. It had one of the highest average tow delays in the entire inland waterway system, 8.6 hours in 2013.

On the Upper Mississippi River, the Melvin Price Lock has the two newest lock chambers listed in table 2-11. It passes over 40 million tons of freight per year with little delay or downtime. Just 15 miles downstream, Lock 27, with two identical size but much older chambers (61 years), has an average tow delay that exceeds 6 hours. The Inner Harbor Navigation Lock, in New Orleans, is one of the principal bottlenecks in the Gulf Intracoastal Waterway. The small chamber size of the 91-year-old lock results in an average tow delay of more than 12 hours.

Shallow and deep-draft ports and channels are other important infrastructure elements of the waterway system. There are several thousand inland river ports and terminals, the vast majority of which are privately owned and serve very specific cargo-handling needs (e.g., coal loading and petrochemical transfers). Deep draft ports are large and capital-intensive facilities, typically with extensive docks, wharves, cranes, warehouses, and other cargo transfer equipment and intermodal connections that integrate ocean transport with inland connectors. Private terminal operators do not routinely release data publicly on the condition of their facilities. The USACE maintains an extensive database of marine terminals, both shallow draft and deep draft, but it is largely static and does not include condition or performance data items and summary tabulations.

TABLE 2-11 Selected Inland Waterway Lock Characteristics: 2013

River	River Mile [a]	Lock Chamber Name	Length, feet	Width, feet	Age, years	Tons in 2013, million [b]	Avg. Delay per Tow, hr. [b]	Outages in 2013[b]		
								Number	Hours	Avg. hr. per outage
Ohio	6.2	Emsworth Lock & Dam Aux.	360	56	93					
Ohio	6.2	Emsworth Lock & Dam	600	110	93	19.6	3.02	54	1,048	19.41
Ohio	846	John T. Myers Lock & Dam Aux.	600	110	39					
Ohio	846	John T. Myers Lock & Dam	1200	110	39	60.7	0.65	99	70	0.71
Ohio	938.9	Lock & Dam 52 Aux.	600	110	86					
Ohio	938.9	Lock & Dam 52	1200	110	45	84.0	8.61	44	999	22.70
Mississippi	200.8	Melvin Price Lock & Dam Aux.	600	110	20					
Mississippi	200.8	Melvin Price Lock & Dam	1200	110	24	40.1	0.99	6	14	2.33
Mississippi	185.5	Chain of Rocks L/D 27 Aux.	600	110	61					
Mississippi	185.5	Chain of Rocks L/D 27	1200	110	61	49.8	6.24	4	73	18.25
GIWW East	7	Inner Harbor Navigation Canal Lock	640	75	91	15.7	12.42	29	93	3.21
Columbia	292	McNary Lock & Dam	675	86	61	6.1	0.17	0	0	N/A

[a] Miles from the 0.0 milepoint reference location, usually at the mouth of the river, except on the Ohio River where mile 0.0 is at the source of the river at Pittsburgh, PA.

[b] Includes all lock chambers at sites with more than one chamber.

KEY: Aux = Auxiliary; GIWW = Gulf Intracoastal Waterway; L/D = Lock & Dam; N/A = Not Applicable.

SOURCES: U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center, *Locks by Waterway, Tons Locked by Commodity Group, CY 1993 - 2013*. Available at http://www.navigationdatacenter.us/lpms/cy2013comweb.htm as of April 2014. U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center, *Locks by Waterway, Lock Usage, CY 1993 - 2013*. Available at http://www.navigationdatacenter.us/lpms/lock2013web.htm as of April 2014. U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center. *Locks by Waterway, Lock Unavailability, CY 1993 - 2013*. Available at http://www.navigation-datacenter.us/lpms/data/lock2013webunavail-021914.htm as of April 2014. U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center, *Lock Characteristics General Report*. Available at http://www.navigationdatacenter.us/lpms/pdf/lkgenrl.pdf as of April 2014.

The main characteristic of navigation channels that relates to condition is whether the authorized depth is actually available. Nearly all channels need periodic dredging to maintain the authorized depth. Most channel dredging occurs under the auspices of the Army Corps of Engineers. In 2012 the Corps' and contractor's dredges removed 238 million cubic yards of material, up from 228 million in 2011. In 2012 maintenance dredging accounted for 84.0 percent of the removed material; the average cost per cubic yard decreased 15.6 percent to $3.99 [USACE 2013]. The Corps maintains detailed dredging data, but it does not produce summary tabulations that differentiate the work by deep or shallow draft channels.

U.S. flag vessels operate on both shallow and deep draft waterways and numerous foreign flag vessels call at deep draft ports. Table 2-12 provides age distributions of U.S. flag vessels for the 2001 to 2011 period. Inland waterway towboats and barges account for the largest share of U.S. vessels. Towboats are the oldest vessels in this assemblage; 71 percent are older than 25 years, which is their median age. In contrast, barges are among the youngest vessels due to a combination of retirement and replacement of older dry cargo barges and acquisition of new tank barges. This is largely in response to the *Oil Pollution Act* of 1990 (Pub. L. 101-380) that decreed tank barges and vessels must have double hulls by January 1, 2015. The U.S. Maritime Administration reported that the average age of ocean vessels per call at U.S. ports decreased from 11.2 years in 2006 to 9.7 years in 2011 [USDOT MARAD 2013].

TABLE 2-12 U.S. Flag Vessels by Type and Age (Percent): 2001, 2006, and 2011

	Vessel Type							
Age[a]	Dry Cargo	Tanker	Towboat	Passenger	Crewboats	Dry Barge	Liquid Barge	Total
2001, total vessels	**966**	**120**	**5,150**	**733**	**1,573**	**28,920**	**4,122**	**41,588**
Age (%): <6	11.8	10.0	7.2	11.5	19.4	23.6	15.1	20.0
6–10	7.9	2.5	3.2	11.1	7.1	9.7	9.4	8.8
11–15	13.7	4.2	2.4	18.8	4.3	7.1	2.1	6.2
16–20	14.4	26.7	13.4	15.0	23.6	14.7	8.0	14.2
21–25	15.9	23.3	18.9	10.5	28.7	21.2	19.5	20.7
>25	35.9	33.3	54.7	32.7	16.7	23.2	45.7	29.6
2006, total vessels	**946**	**90**	**5,285**	**828**	**1,721**	**27,961**	**4,250**	**41,109**
Age (%): <6	13.0	15.6	6.8	6.4	13.8	14.1	19.6	13.6
6–10	10.9	11.1	6.4	10.6	16.1	21.5	11.7	17.8
11–15	7.9	2.2	3.3	12.2	6.0	10.4	9.1	9.1
16–20	13.4	3.3	2.5	17.9	3.2	7.0	2.0	6.1
21–25	10.1	23.3	13.1	13.3	20.9	13.0	6.9	12.6
>25	44.5	44.4	67.8	39.6	39.8	32.9	50.7	39.9
2011, total vessels	**851**	**77**	**5,458**	**826**	**1,784**	**26,996**	**4,502**	**40,521**
Age (%): <6	6.9	22.1	11.6	2.3	14.5	23.0	26.7	20.7
6–10	12.5	9.1	5.3	7.3	10.9	10.1	13.9	9.9
11–15	11.9	11.7	6.5	10.0	13.4	22.4	11.0	18.1
16–20	7.8	3.9	3.0	12.0	5.6	10.0	8.3	8.7
21–25	13.0	3.9	2.4	18.9	2.9	5.9	1.7	5.2
>25	47.9	49.4	71.1	49.4	52.7	27.6	38.2	36.7
>25 Change from 2001	12.0	16.0	16.4	16.7	36.0	4.4	-7.5	7.1
Median age, years								
2001	23	23	>25	18	18	18	23	23
2006	23	23	>25	23	23	18	>25	23
2011	23	23	>25	>25	18	13	18	18

[a] Age is based on the year the vessel was built or rebuilt.

NOTES: Figures include vessels available for operation. Totals may be greater than sum because of unclassified vessels and vessels of unknown age, hence percentages may not add to 100, and also due to rounding.

SOURCE: U.S. Army Corps of Engineers as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*. Table 1-34. Available at http://www.bts.gov as of November 2013.

While there is no definitive list of waterway transportation system investment needs, several recent studies have made estimates. A Congressional Research Service study estimated that the Corps' navigation project backlog amounted to $60 billion [CRS 2011]. Based on the fact that navigation projects account for one-third of the Corps' 2012 budget, the American Association of State Highway and Transportation Officials (AASHTO) estimated the agency's navigation project backlog totaled $20 billion [AASHTO 2013].

Aviation

The main elements of the aviation system include airport runways and terminals, air traffic control systems, and aircraft. The Federal Aviation Administration (FAA) compiles data on runway pavement conditions, which are presented in table 2-13. Most airport pavements were in good condition between 2003 and 2013, with 2 percent in the poor category. There are no similar data for other elements of aviation infrastructure.

The Airports Council International (ACI) surveyed its U.S. members to ascertain their capital project needs for the 2013 to 2018 period. The survey indicated a total need of $71.3 billion. Age and technological obsolescence are likely the drivers for much of this need, as many airports were built more than 40 years ago. Terminal improvements at large hub airports account for 50 percent of projected investment needs, while runways,

TABLE 2-13 U.S. Airport Runway Pavement Conditions: 2003, 2008, and 2013

	2003	2008	2013	Change from 2003 to 2013, percentage points
NPIAS[a] airports, number	**3,346**	**3,356**	**3,330**	**-0.01**
Condition (%): Good	75	79	81	6
Fair	21	18	17	-4
Poor	4	3	2	-2
Commercial service airports[b], number	**510**	**522**	**511**	**0.002**
Condition (%): Good	80	81	83	3
Fair	18	17	15	-3
Poor	2	2	2	0

KEY: NPIAS = National Plan of Integrated Airport Systems.

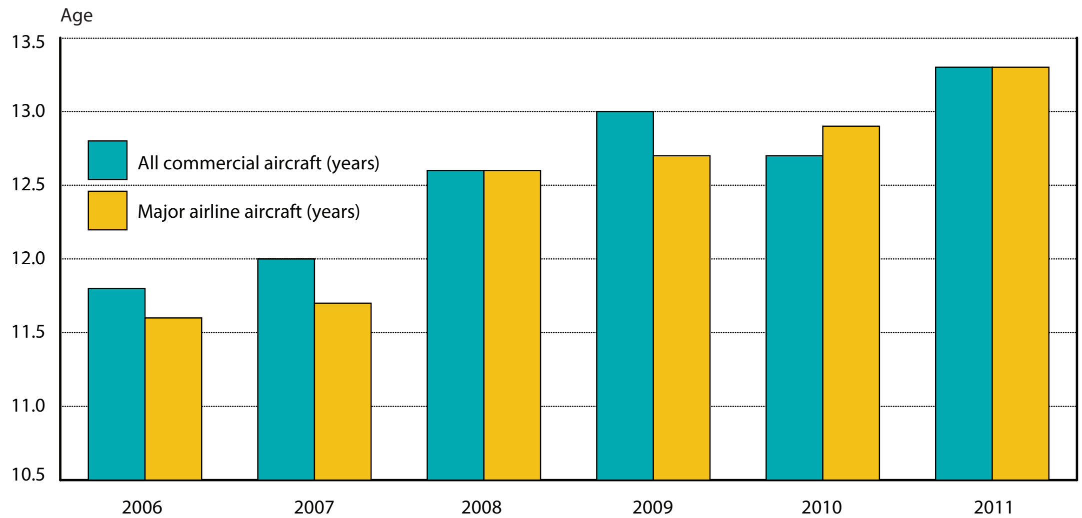
[a] The U.S. Department of Transportation, Federal Aviation Administration's (FAA's) National Plan of Integrated Airport Systems is composed of all commercial service airports, all reliever airports, and selected general aviation airports. It does not include over 1,000 publicly owned public-use landing areas, privately owned public-use airports, and other civil landing areas not open to the general public. NPIAS airports account for almost all enplanements. In 2005, there were approximately 16,500 non-NPIAS airports.

[b] Commercial service airports are defined as public airports receiving scheduled passenger service, and having at least 2,500 enplaned passengers per year.

NOTES: Data are as of January 1 of each year. Runway pavement condition is classified by the FAA as follows:
Good: All cracks and joints are sealed.
Fair: Mild surface cracking, unsealed joints, and slab edge spalling.
Poor: Large open cracks, surface and edge spalling, vegetation growing through cracks and joints.

SOURCE: U.S. Department of Transportation (USDOT), Federal Aviation Administration as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 1-25. Available at http://www.bts.gov as of November 2013.

FIGURE 2-2 Average Age of U.S. Commercial Aircraft: 2006–2011



NOTES: Large Certificated Air Carriers have one or more airframes designed to occupy a maximum passenger capacity of 60 seats or a maximum payload capacity of 18,000 pounds) as stated in 14 CFR Part 141 Sec 03. Average aircraft age is estimated using the difference of the current year against the year of an airframes delivery to the original owner from the manufacture. Average aircraft age reflects commuter and air taxi on-demand services and not the age of engines or recently replaced airframe machinery. *All Commercial Aircraft* includes commuter, air taxi on-demand services, scheduled, non-scheduled passenger and/or freight service. *Major Airline Aircraft* includes airframes owned by airlines with total operating revenues greater than $1 billion annually. *Major Airlines Share of Commercial Aircraft* includes Major airlines (based on operating revenue) airframes in contrast to National, Regional, commuter and air taxi on-demand services.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Office of Airline Information. TranStats Database, Form 41 Schedule B-43. April 2013.

taxiways, and aprons will need 55 percent of investment dollars at medium and small hubs [ACI 2013].

The FAA is in the midst of a major effort to upgrade the U.S. air traffic control (ATC) system to increase its capacity. A major reason for this effort is that the ATC system relies on ground-based radar and voice communication technologies that date to the 1940s, which limit its ability to increase capacity in line with increasing air traffic demand. Current FAA efforts are focused on developing the Next Generation Air Transportation System (NextGen), which will utilize GPS satellite technology and related communications and information technology improvements.

Figure 2-2 shows average ages of U.S. commercial aircraft from 2006 to 2011. The average age increased to 13.3 years in 2011, up from 11.8 in 2006. While the period of review spanned five years, the average age increased by only 1.5 years, indicating some fleet turnover occurred from 2006 to 2011. Turnover generally refers to new aircraft entering service and/or older aircraft retiring from the fleet.

Pipelines

The Pipeline and Hazardous Materials Safety Administration (PHMSA) collects annual report data from pipeline operators, covering their system mileage, commodities transported, and inspection activities, but there is no publicly available database that tracks pipeline condition. A serious failure, such as the Pennsylvania pipeline failure in January 2011, serves as a reminder that this part of the transportation system has the same problems with aging infrastructure as the other modes profiled in this chapter [USDOT PHMSA 2014].

Table 2-14 shows the gas distribution mains and transmission lines and Hazardous Material (HAZMAT) pipeline miles installed as of 2013 by decade since 1940 as well as the pre-1940s mileage. Gas distribution mains have 12.4 percent installed pre-1940s or unknown, followed by HAZMAT with 7.2 percent, and gas transmission lines with 4.2 percent. Pipeline construction boomed during the 1950s and 1960s when 46.2 percent of the today's existing gas transmission lines and 36.8 percent of the HAZMAT pipeline were installed.

Challenges

As with railroads, pipeline companies are private enterprises that are responsible for their own system maintenance, rehabilitation, and expansion. Hence, there are little data or estimates available on systemwide capital investments.

With the largest transportation system in the world, the United States faces a continuing challenge of maintaining system conditions in sufficiently good shape to meet the enormous mobility requirements of the American

TABLE 2-14 Gas and Hazardous Material Pipeline Miles Installed by Decade: 2013

Miles

	Gas Distribution Mains	Percent	Gas Transmission	Percent	Hazardous Liquid (2012)	Percent
Pre 1940s or Unknown	155,352	12.4%	12,857	4.2%	13,363	7.2%
1940-1949	25,101	2.0%	21,869	7.2%	15,539	8.4%
1950-1959	102,866	8.2%	67,803	22.4%	34,573	18.6%
1960-1969	191,499	15.3%	71,933	23.8%	33,741	18.2%
1970-1979	131,673	10.5%	31,928	10.6%	29,892	16.1%
1980-1989	154,739	12.4%	26,160	8.6%	17,190	9.3%
1990-1999	234,353	18.7%	30,995	10.2%	18,994	10.2%
2000-2009	206,217	16.5%	30,369	10.0%	16,895	9.1%
2010-2019	49,604	4.0%	8,645	2.9%	5,451	2.9%
TOTAL Miles	**1,251,404**		**302,558**		**185,637**	

SOURCE: U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA), *Pipeline Miles by Decade*. Available at https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Dashboard as of April 2014.

economy and society. As indicated earlier, the condition of transportation infrastructure is improving, but additional improvements are needed. The average age of all inland waterway navigation locks is more than 50 years, and 11.0 percent of bridges are considered structurally deficient. If these condition issues are not addressed, they could affect system performance in the coming years.

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CHAPTER 3

Moving People

The Nation's transportation system exists for the safe and efficient movement of people and goods. Despite recent decreases in overall transportation activity due to the economic recession, the system has grown over the decades in answer to the long-term increasing demand for goods and in response to long-term increases in the number of people who travel as well as in the amount of travel by each person. In 2012 miles of travel by personal vehicle and commercial aviation remained below 2007 levels, while miles of travel by transit and intercity passenger rail continued to grow. At this time, it is too early to tell whether this is a long-term trend or a temporary shift. The numbers from recent years lead to important questions: How much has local and long-distance travel

- All indicators show declines in personal travel for every age group, particularly among young people since the early 2000s. It is too soon to tell whether this decline is temporary or indicative of a long-term trend.
- International visitors to the U.S. rose from a low of 55 million in 2009 to 67 million in 2012, generating $166 billion in export revenue—the highest in this century.
- Carpooling to work has declined since 1980, while driving alone to work has increased. Working exclusively at home has tripled from 2 million in 1980 to over 6 million in 2012.
- Transit use for the trip to work reached a low point in the mid-1990s and has since slowly regained in share. It now accounts for 5 percent of these trips, with higher levels in some metropolitan areas (e.g., New York City, San Francisco, and Washington, DC, being the highest).
- In 2011 about 9 percent of households had no vehicle. However, only 4 percent of households with a worker were without a vehicle, underscoring the critical role the personal vehicle plays in getting employees to and from work.
- In 2013, 9.7 million domestic and international flights arrived at and departed from U.S. airports; 825 million revenue passengers enplaned. Both numbers are below the 2007 peak.

changed in recent years? Are recent changes in travel a temporary departure from long-term trends caused by economic recession, or do changes in travel indicate fundamental shifts in the demographics, geography, and travel preferences of the U.S. population?

Recent Trends in Local Travel

As illustrated in table 3-1, personal travel is dominated by frequent, repetitive patterns such as the daily commute to work and weekly shopping trips. Daily travel includes trips to work, school or shopping, visiting friends or relatives, and attending religious services. Box 3-A discusses the primary data sources on local and long-distance travel. Figure 3-1a shows the shares of person trips by trip purpose and figure 3-1b shows the person-miles of travel for these purposes in 2009. Work and work-related trips are typically longer than other types of local travel, making up 25.3 percent of total mileage traveled but only 18.7 percent of total trips. The shorter trips were for shopping, personal business, and social/recreation—each with greater shares of the number of trips but a lower share of person-miles of travel than the work commute. For the last 15 years, about one-fifth of trips involve trip-chaining in which people sandwich in daily errands and activities, such as dropping off and picking up children at school/day care or stopping at a fitness center, while on the way to and from work. Such trip-chains are positive in that they save time, distance traveled, and fuel. But chaining also is negative in that trips may be made during peak travel periods rather than during less crowded times, thus adding to congestion. Trip-chaining is not a growing phenomenon, remaining at about 18 percent of total trips over the last 15 years [USDOT FHWA NHTS 2011]. It also reinforces unaccompanied use of

TABLE 3-1 Average Annual PMT, Person Trips, and Trip Length by Trip Purpose: 2009 NHTS

Purpose	Total trips in year per household	Average trip length in miles per household	Person-miles travelled per household
Work	541	11.8	6,256
Work-related	106	20.0	2,078
Shopping	725	6.5	4,620
Family/personal errands	748	7.0	5,134
School/church	333	6.3	2,049
Social and recreational	952	10.7	9,989
Other	61	51.5	2,878
TOTAL	**3,466**	**9.7**	**33,004**

KEY: *PMT* = Person-Miles of Travel.

NOTES: *Family/Personal Errands* includes personal business, shopping, and medical/dental appointments.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, 2009 National Household Travel Survey, *Summary of Travel Trends*. Table 5. Available at http://nhts.ornl.gov/ as of November 2013.

FIGURE 3-1a Average Annual Person Trips by Trip Purpose: 2009 NHTS

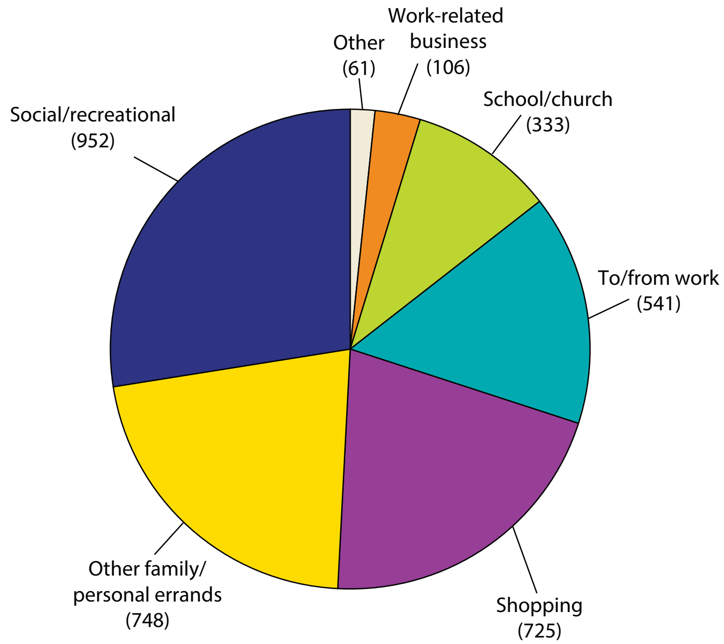
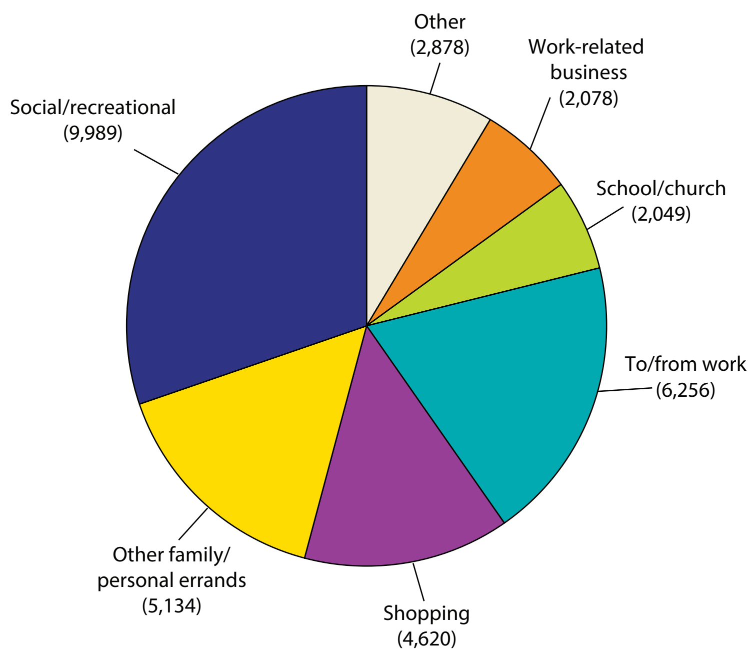


FIGURE 3-1b Average Annual PMT by Trip Purpose: 2009 NHTS



KEY: *PMT* = Person-Miles of Travel.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, 2009 National Household Travel Survey, *Summary of Travel Trends*. Table 5. Available at http://nhts.ornl.gov/ as of November 2013.

the automobile, making it less convenient for drivers to carpool or to use other modes such as transit.

Figure 3-2 traces the number of trips per person per day made for major purposes as shown in the national travel surveys. The number of work and school/church trips has been stable over the period of 1977–2009; however, the shares of work trips have declined relative to other trips as travel for other trip purposes increased.

The number of trips varies throughout the week (figure 3-3). Friday accounts for the most trips, because of more social/recreational and family/personal/errand trips, and Sunday for the least. Reduced numbers of work trips and errands on Saturday and Sunday are partially offset by shopping and social/recreational trips.

As shown in figure 3-4, 83.4 percent of person trips for all purposes are taken in personal vehicles. Walking is used for a significant number of errands and social/recreational trips. Family/personal errands and social/recreational activities accounted for more than two-thirds of trips. They were followed by trips to and from work, which accounted for 15.6 percent.

Supporting the high percentage of travel by personal vehicle, 9 out of 10 households have access to automobiles and other vehicles. The share of households without a vehicle declined from over 20 percent in 1960 to 8.7 percent in 2007 and then began to slowly increase as the economy weakened. The most recent data indicate that 9.2 percent of households in 2012, roughly 10.7 million, do not have access to a vehicle [USDOC CENSUS ACS 2012]. The number of households without vehicles has stayed about the same at 10–11 million despite a growing number of households over the past 40 years [AASHTO 2013].

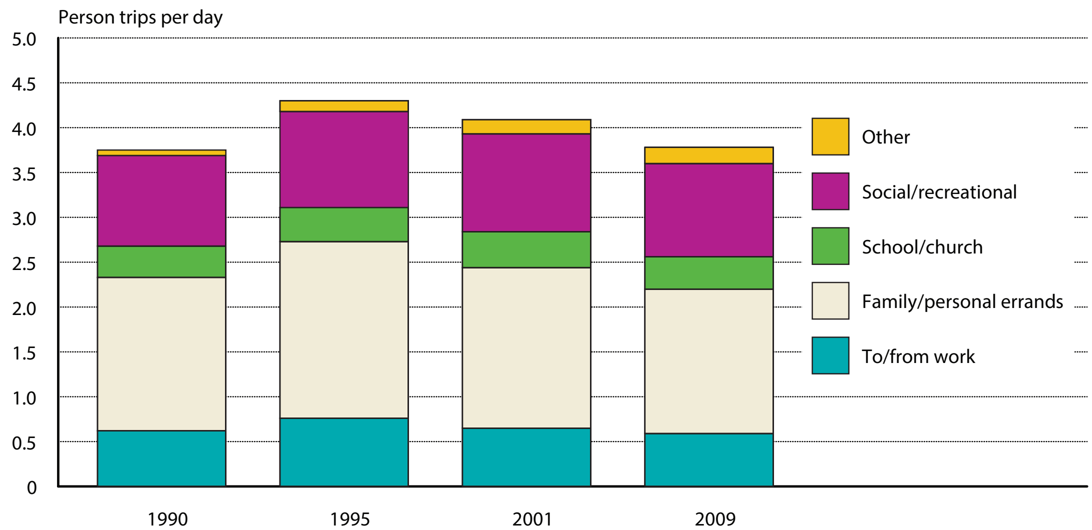
BOX 3-A Information Sources on Local and Long-Distance Travel

The most detailed national information source on all forms of local travel is the National Household Travel Survey (NHTS), which was last conducted in 2009. The NHTS and its predecessor, the Nationwide Personal Transportation Survey, have measured the characteristics of households and their travel once or twice each decade since 1969. The Federal Highway Administration plans to conduct a new NHTS in 2015.

Between 1960 and 2000, commuting questions were included in the long form of the decennial census. Journeys to work have been measured annually by the Census Bureau in its American Community Survey since 2006. Detailed information for census tracts within cities is calculated from multiyear averages.

Most households without access to vehicles do not have members in the labor force. Only 4 percent of households with workers have no vehicles. These households mostly rely on transit or, to a lesser extent, carpooling. About 12 percent of households have more workers than vehicles. The other 88.4 percent are roughly evenly split (about 44 percent each) between households with more vehicles than workers and households where the number of vehicles is the same as the number of workers [AASHTO 2013].

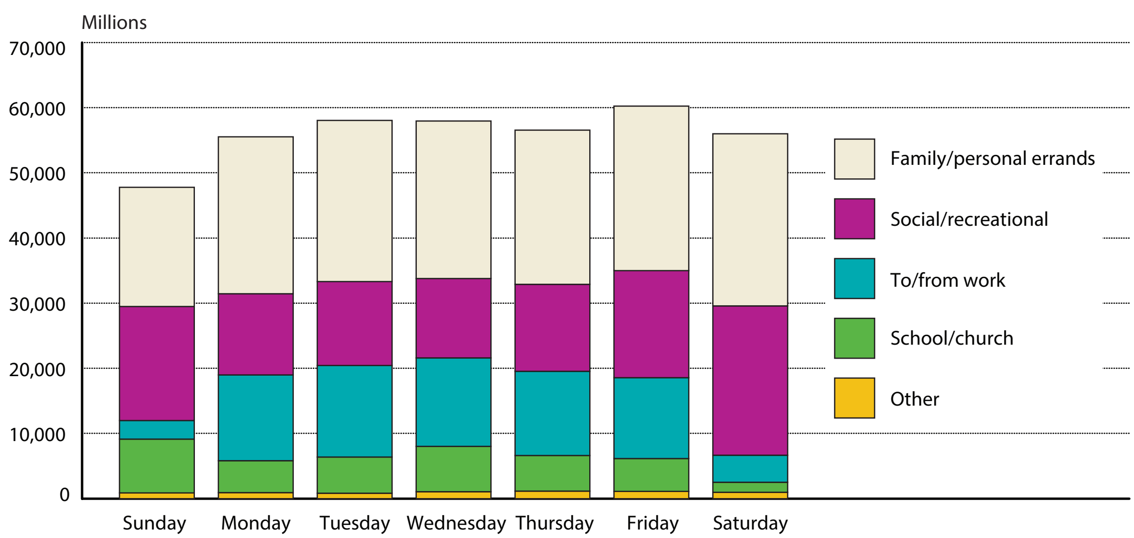
FIGURE 3-2 Long-Term Trend in Trips per Day by Purpose: 1990 and 1995 NPTS, and 2001 and 2009 NHTS



NOTES: 1990 data have been adjusted to make them more comparable with later data in the series. 1995 "To or From Work" person trips and person miles are believed to be overstated (see Appendix 2 of the *1995 Summary of Travel Trends*). *Person trip* is a trip by one person in any mode of transportation. *Family/Personal Errands* includes personal business, shopping, and medical/dental appointments. *Other* includes trips for work-related business.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, 2009 National Household Travel Survey, *Summary of Travel Trends*. Table 11. Available at http://nhts.ornl.gov/ as of November 2013.

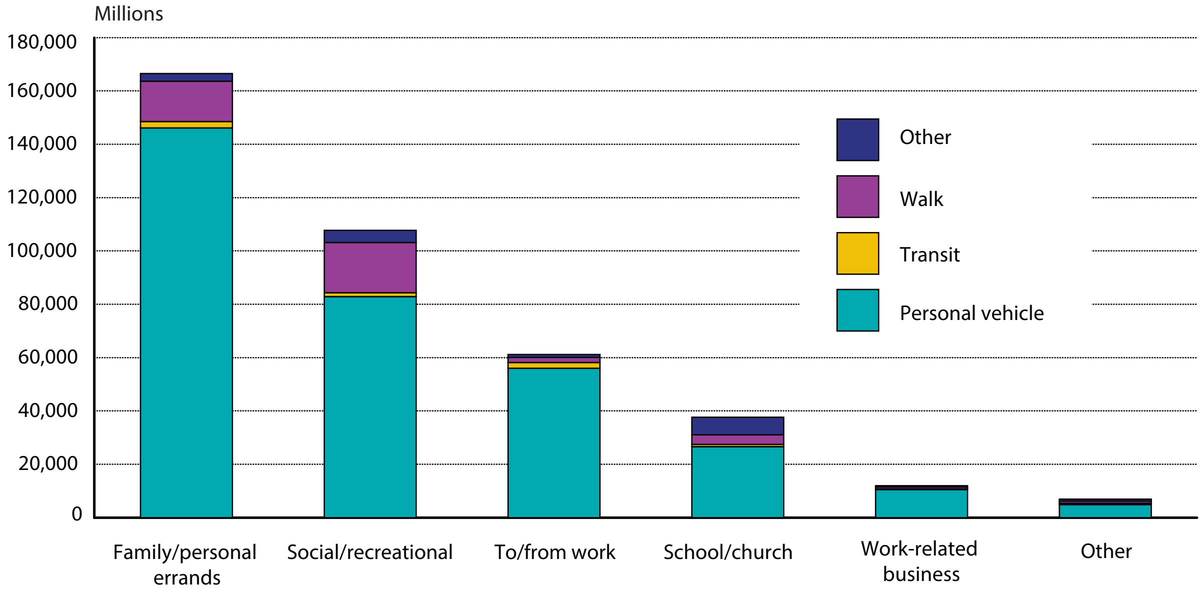
FIGURE 3-3 Annual Number of Person Trips by Purpose and Day of Week: 2009 NHTS



NOTES: *Person trip* is a trip by one person in any mode of transportation. *Family/personal errands* includes personal business, shopping, and medical/dental appointments. *To or from work* includes work-related business trips.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, 2009 National Household Travel Survey (NHTS), *Online Analysis Tool*. Available at http://nhts.ornl.gov as of November 2013.

FIGURE 3-4 Annual Number of Person Trips by Mode and Purpose: 2009 NHTS



NOTES: *Person trip* is a trip by one person in any mode of transportation. *Family/Personal Errands* includes personal business, shopping, and medical/dental appointments.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, 2009 National Household Travel Survey (NHTS), *Online Analysis Tool*. Available at http://nhts.ornl.gov as of November 2013.

Personal vehicles provided from 84 to 88 percent of journeys to work since 1980 (table 3-2). Carpools and walking dropped as a share of commuting every decade since 1980, while transit increased slightly between 2000 and 2010 after dropping from 1980 to 2000. Although use of private vehicles and walking dropped in share, both increased in absolute numbers from 2000 to 2010 as shown in figure 3-5. Driving alone continued to rise in share while carpooling declined.

The geography of commuting involves two opposing trends. On one hand, workers and their places of work have grown farther apart over recent decades. Workers leaving their home county to work in another county more than quadrupled from 9 million to 38 million and almost doubled in share of all workers between 1960 and 2010. On the other hand, an increasing number of workers are working at home. Part of the longer term growth in working at home had been masked in earlier decades by the number of people who worked on the farm where they also lived [AASHTO 2013].

In 2010, 13.4 million people worked from home at least one day per week, an increase of about 4.2 million people (35.4 percent) from 1997. Home-based workers include those who work exclusively at home as well as those who work at both home and at a job site. Advanced communication and information technologies

TABLE 3-2 Commuting by Mode of Transportation: 1980, 1990, and 2000 Decennial Census and 2010–2012 ACS

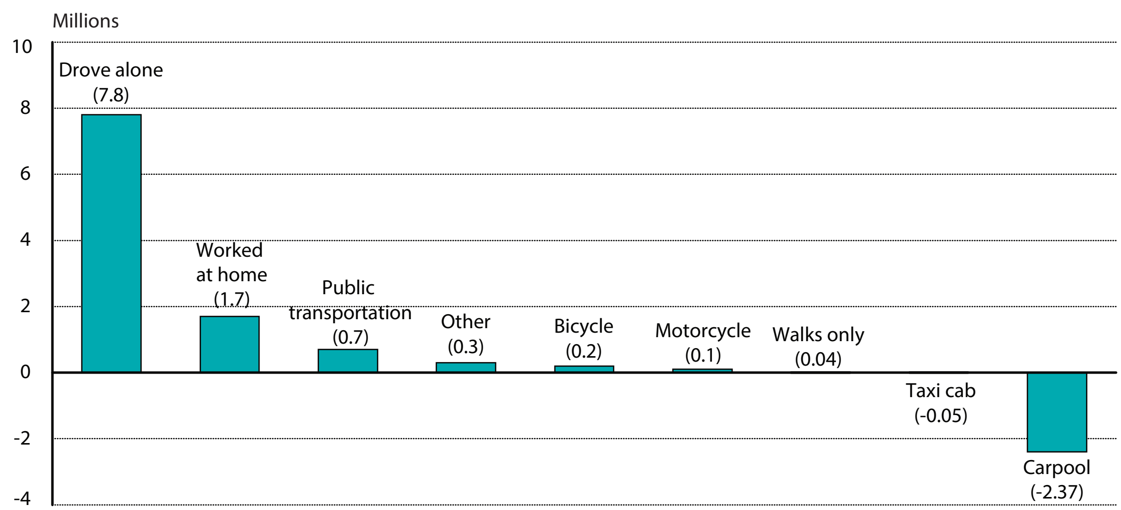
Thousands	1980 Number	1980 Percent	1990 Number	1990 Percent	2000 Number	2000 Percent	2010 Number	2010 Percent	2011 Number	2011 Percent	2012 Number	2012 Percent
All workers	**96,617**	**100.0**	**115,070**	**100.0**	**128,279**	**100**	**136,941**	**100.0**	**138,270**	**100.0**	**140,863**	**100.0**
Automobile, total	81,258	84.1	99,593	86.5	112,736	87.9	118,124	86.3	119,027	86.1	121,136	86.0
Drives self	62,193	64.4	84,215	73.2	97,102	75.7	104,858	76.6	105,639	76.4	107,460	76.3
Carpool, total	19,065	19.7	15,378	13.4	15,634	12.2	13,266	9.7	13,388	9.7	13,676	9.7
2-person	NA	NA	NA	NA	NA	NA	10,294	7.5	10,382	7.5	10,548	7.5
3-person	NA	NA	NA	NA	NA	NA	1,733	1.3	1,759	1.3	1,830	1.3
4+ person	NA	NA	NA	NA	NA	NA	1,239	0.9	1,246	0.9	1,298	0.9
Public transportation	6,175	6.4	6,070	5.3	6,068	4.7	6,769	4.9	6,956	5.0	7,053	5.0
Taxicab	167	0.2	179	0.2	200	0.2	151	0.1	165	0.1	162	0.1
Bicycle	468	0.5	467	0.4	488	0.4	731	0.5	778	0.6	325	0.2
Motorcycle	419	0.4	237	0.2	142	0.1	267	0.2	288	0.2	865	0.6
Walks only	5,413	5.6	4,489	3.9	3,759	2.9	3,797	2.8	3,888	2.8	3,969	2.8
Other means	703	0.7	809	0.7	901	0.7	1,178	0.9	1,175	0.8	1,209	0.9
Works at home	2,180	2.3	3,406	3.0	4,184	3.3	5,924	4.3	5,994	4.3	6,144	4.4

KEY: ACS = American Community Survey; NA = not applicable.

NOTES: Principal means of transportation to work refers to the mode of travel used to get from home to work most frequently. If more than one means of transportation was used each day, those surveyed were asked to specify the one used for the longest distance during the trip from home to work. Component values may not add to totals due to rounding.

SOURCES: **1980, 1990, 2000**: U.S. Department of Commerce (USDOC), Census Bureau (CB), Decennial Census. *About Commuting (Journey to Work)*. Available at http://www.census.gov/ as of February 2014. **2010-2012**: USDOC/CB as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 1-41. Available at http://www.bts.gov as of November 2013.

FIGURE 3-5 Workers Net Change by Mode of Transportation: 2000 to 2010



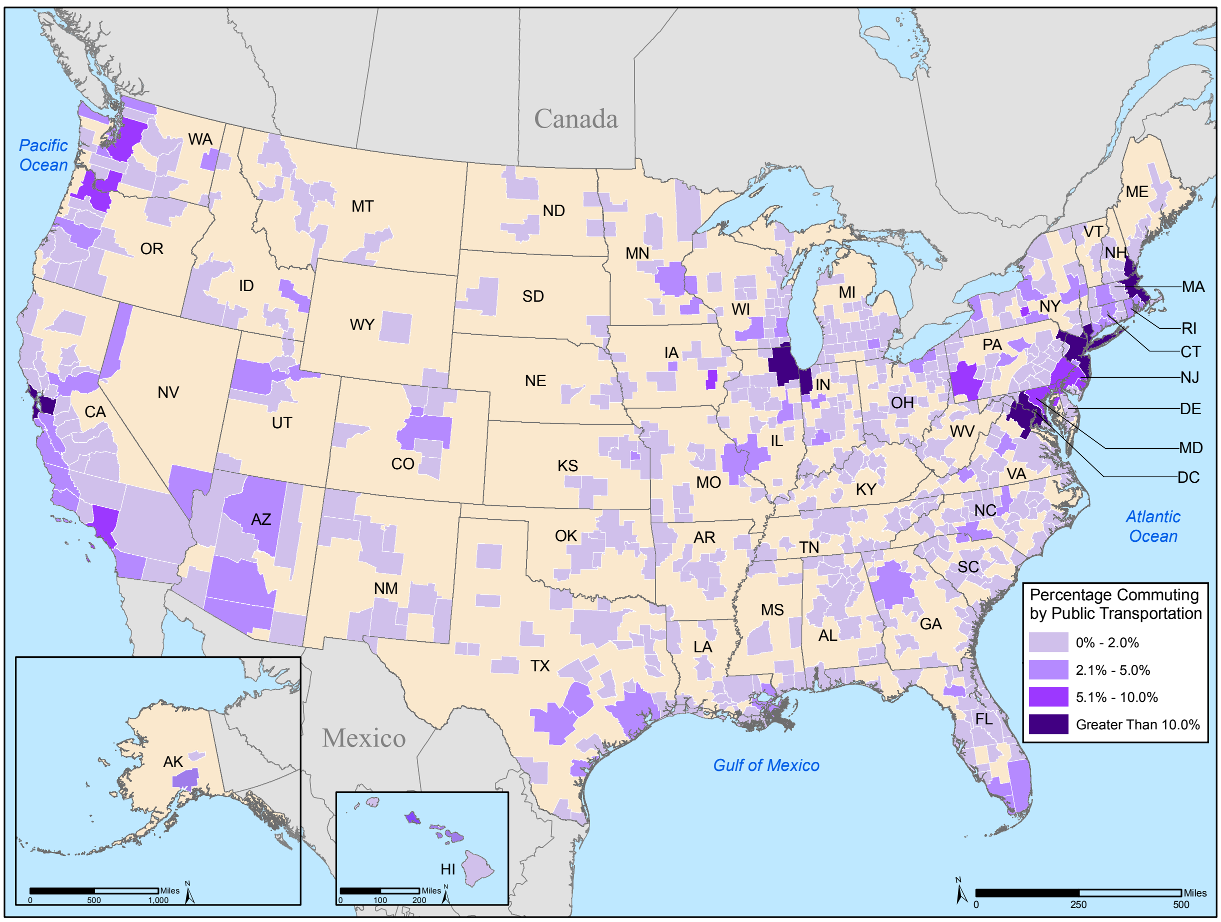
NOTES: *Drove alone* includes people who usually drove alone to work as well as people who were driven to work by someone who then drove back home or to a non-work destination. *Public transportation* refers to bus, streetcar, subway, railroad, and elevated trains for 200, and includes ferryboats for 2010. From 2000, *Bicycle* data are included under Motorcycle. *Other* include ferryboats, surface trains, and van service and other means not classified for years 2000, and excludes ferryboats from 2010.

SOURCES: **2000**: U.S. Department of Commerce (USDOC), Census Bureau (CB), Decennial Census. *About Commuting (Journey to Work)*. Available at http://www.census.gov/ as of February 2014. **2010**: USDOC/CB as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 1-41. Available at http://www.bts.gov as of November 2013.

have increased labor force mobility. Monday and Friday are the most likely days to telework, and Thursday is the least likely day to work from home [USDOC CENSUS 2013b].

National trends do not tell the full picture of travel in individual metropolitan areas. For example, transit use for commuting serves a higher share of work trips in larger metropolitan areas: 11.0 percent in areas with a population over 5 million, 4.0 percent in areas between 2.5 and 5 million, and 2.2 percent in areas between 1 and 2.5 million (figure 3-6). At the highest extreme, 58.7 percent of workers living in the borough of Manhattan in New York City commute by transit and another 20 percent walk [USDOC CENSUS ACS 2012]. In many places, the daily rhythms of local travel are affected by long-distance travel.

FIGURE 3-6 Percentage Commuting by Public Transportation: 2012



SOURCE: U.S. Department of Commerce. Census Bureau. Commuting (Journey to Work). Available at http://www.census.gov/ as of June 2014.

Recent Trends in Long-Distance Travel

Highway traffic between distant places contributes to local congestion on intercity highways. Traffic to and from airports also contributes to local congestion. Person movement in recreational areas is dominated by seasonal variation (e.g., holidays, such as Memorial Day) as out-of-town visitors increase traffic counts along interstates that connect major cities and on local roads that lead to resort areas [DELDOT 2014].

When defined as trips to a place over 50 miles away, long-distance travel is primarily served by personal vehicles or air carriers. In 2001 personal vehicles accounted for 89.3 percent of long-distance trips and 55.9 percent of long-distance person-miles, while 7.1 percent of trips and about 40.5 percent of the long-distance person-miles were by air [USDOT FHWA NHTS 2011]. Box 3-B discusses the difficulties distinguishing local highway travel from long-distance highway travel.

Long-distance travel included approximately 67 million international visitors to the United States, as shown in figure 3-7a, in 2012, an increase from the less than 63 million in 2011 [USDOC OTTI 2013]. Figure 3-7b shows the fluctuation in international visits since 2004, reflecting the impacts of the global recession in 2009 [USDOC BEA 2013].

U.S. and foreign airlines carried nearly 824 million passengers on domestic and international flights to and from the United States in 2013. Passenger enplanements were up by about 1.4 percent from 2012, but remained 11.5 million below their 2007 peak. In 2013 domestic enplanements accounted for 78.4 percent of passengers, while international enplanements on U.S. and foreign airlines accounted for 21.6 percent [USDOT BTS OAI 2014]. U.S. airlines carried 54.0 percent of the passengers between the United States and international points. As shown in table 3-3, planes have become more crowded since 2005 as measured by load factors.

The 9.7 million domestic and international flights in 2013 were down 13.3 percent from their 2007 peak just prior to the beginning of the recession in December 2007. Domestic flights in 2013 accounted for 85.8 percent of total U.S. flights, while international flights of U.S. and foreign carriers accounted for 14.2 percent [USDOT BTS OAI 2014].

BOX 3-B Missing Pieces of The Picture

The missing pieces of the long-distance travel picture include trips by personal vehicles, general aviation, and cruise ships. Vehicle-miles of travel on rural interstate highways are occasionally used as a surrogate for long-distance highway travel, but there is no methodology for separating local from long-distance travels within rural areas. Takeoffs and landings of general aviation aircraft are not a good indicator because many flights take off and land at the same airport rather than carry people to distant destinations. Numbers of passengers boarding and debarking from cruise ships in each port are measured, but the passenger lists have not been compiled into trips since June 2012.

FIGURE 3-7a Foreign Visits by Main Markets: 2004–2012

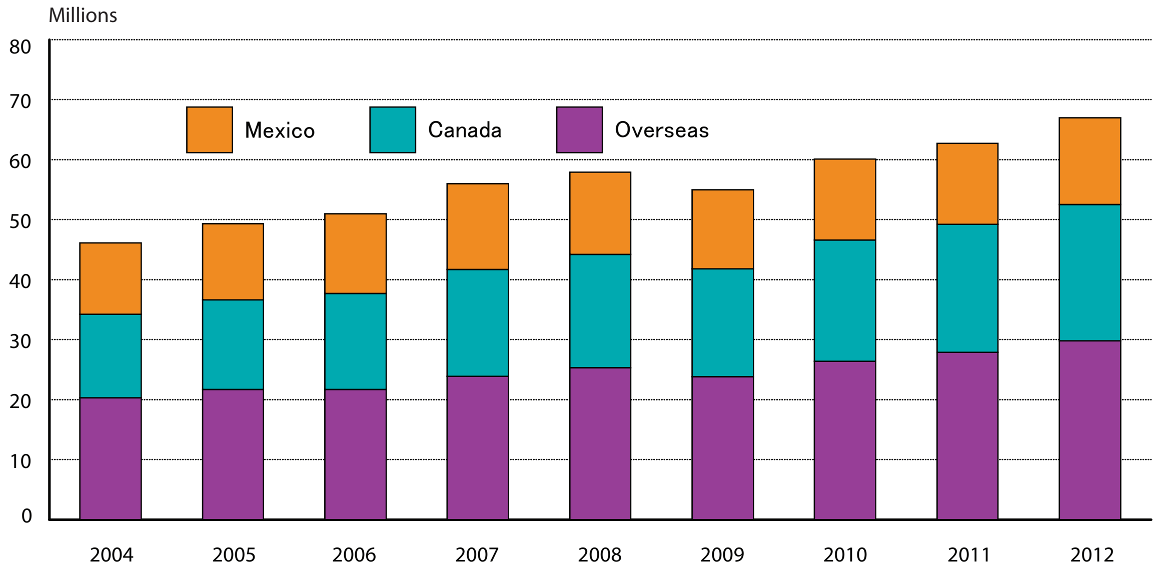
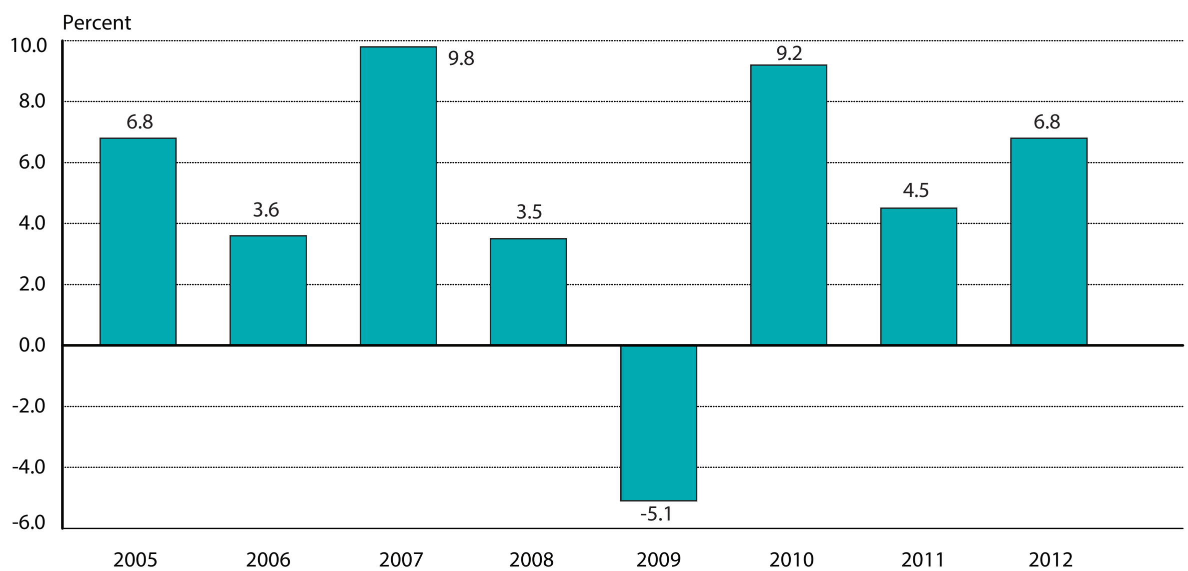


FIGURE 3-7b Percent Change From Previous Year in Total Foreign Visits: 2005–2012



SOURCE: U.S. Department of Commerce, Office of Travel and Tourism Industries, *Travel Forecast*. Available at http://travel.trade.gov as of November 2013.

TABLE 3-3 Annual Airline (U.S. and Foreign Carriers) Passenger Enplanements: 2005–2013

Scheduled flights only

	Domestic enplanements	Domestic load factor (percent)	International enplanements	International load factor (percent)	Total domestic and international enplanements	Total domestic and international load factor (percent)
2005	657,261,487	77.2	143,588,422	78.7	800,849,909	77.8
2006	658,362,620	79.1	149,740,591	78.6	808,103,211	78.9
2007	679,185,450	79.9	156,250,990	79.1	835,436,440	79.5
2008	651,710,182	79.7	157,737,629	77.6	809,447,811	78.7
2009	618,067,255	81.1	149,749,333	78.3	767,816,588	79.7
2010	629,537,593	82.2	157,938,675	81.6	787,476,268	81.9
2011	638,247,667	82.9	163,848,419	80.3	802,096,086	81.6
2012	642,289,482	83.4	170,835,828	81.7	813,125,310	82.5
2013	645,614,872	83.3	178,613,451	82.1	824,228,323	82.7

NOTE: *International enplanements* include U.S. and foreign carriers. *Load factor* is calculated by dividing demand, as measured by revenue passenger-miles (RPMs), by capacity, as measured in available seat-miles (ASMs).

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Office of Airline Information, *Airline Data and Statistics*, Passengers. Available at http://www.bts.gov/programs/airline_information/ as of July 2014.

Long-distance travel on railroads in the United States involves two carriers: Amtrak (also known as the National Rail Passenger Corp.) and the Alaska Railroad. Amtrak ridership has been growing since the late 1990s. After years of tallying about 20 million annual person trips, Amtrak ridership increased to 25 million in the early years of the 21st century, and then rose to a record 31.6 million riders in fiscal year 2013 [AMTRAK 2013]. Annual ridership peaked on the Alaska Railroad in 2007 at more than one-half million trips, but was down to 489,645 trips in 2013. Customers traveling aboard railcars owned by cruise lines and pulled by the Alaska Railroad accounted for about half of the 2013 Alaska Railroad passengers [ARRC 2014].

Long-distance travel by motorcoach is summarized in table 3-4. The motorcoach industry provided 637 million person trips in the United States and Canada, covering almost 76 billion miles for an average trip length of about 115 miles. In 2012 the 20 large carriers, with more than 100 buses each, accounted for less than 1 percent of operators, but provided 34.7 percent of person trips. Small carriers, with less than 10 buses each, accounted for 82.4 percent of operators, but provided only 24.2 percent of trips. The remaining carriers, with between 10 and 99 buses, provided 41.1 percent of person trips. About half of all bus passengers are either students or senior citizens [ABA 2014].

TABLE 3-4 Motor Coach Carriers, Coaches, Person Trips, and Person Trips per Coach by Fleet Size: 2012

Fleet size	Carriers	Coaches	Passenger trips (millions)	Passenger trips per coach
100 or more	20	9,296	221	23,803
50-99	49	3,256	73	22,467
25-49	156	6,053	85	14,005
10-24	469	7,692	104	13,518
1-9	3,260	13,310	154	11,590
Total	**3,954**	**39,607**	**637**	**16,094**

SOURCE: American Bus Association. *Motorcoach Census 2013*. Available at http://www.buses.org/ as of January 2014.

Forces of Change in Travel

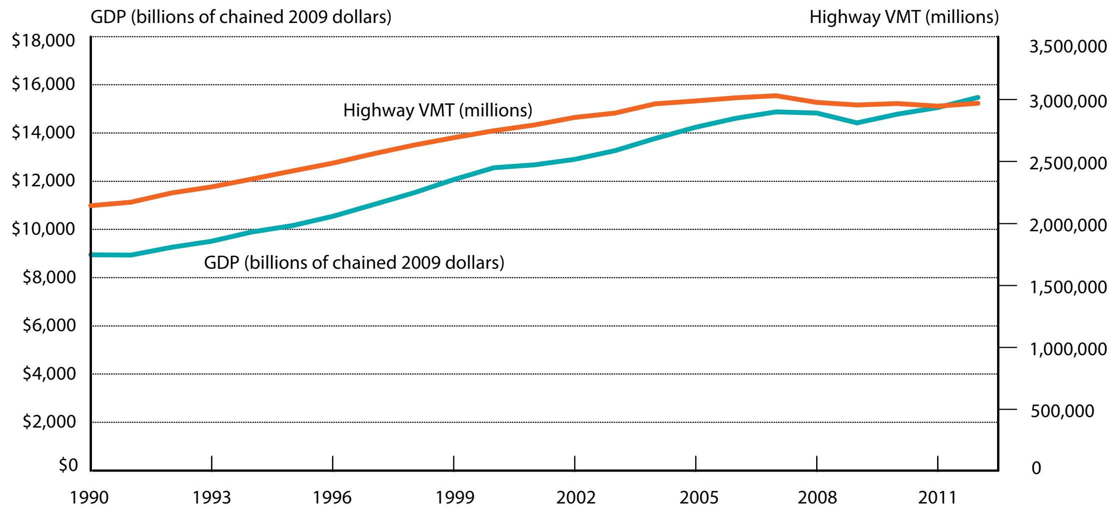
After decades of growth, person-miles of travel (PMT) by the dominant mode of personal vehicles has changed very little since 2008, but personal vehicles continue to account for 86.4 percent of PMT. As described earlier, air travel showed a pattern of growth and decline during the recession. Modest increases in travel by other modes (e.g., transit and intercity passenger rail) do not offset the decline in highway PMT on total travel [USDOT BTS NTS 2014].

Economics and Recession

It remains to be seen if the forces contributing to declining PMT are temporary or long lasting. The recession was clearly a major factor in recent trends. Vehicle-miles traveled (VMT) and the number of domestic commercial aviation enplanements both peaked in 2007. U.S. Gross Domestic Product (GDP) grew at approximately 4 percent per year in the 1990s and about 3 percent per year in the early 2000s, but declined 0.3 percent in 2008 and 2.8 percent in 2009, before again growing each year from 2010 through 2012. VMT of highway vehicles dropped 1.8 percent in 2008, 0.7 percent in 2009, and 0.7 percent in 2011, but had modest growth in 2010 and 2012. Figure 3-8 shows the interrelationship between GDP and VMT. Enplanements on domestic airline flights and ridership on the tourism-sensitive Alaska Railroad also peaked with the economy in 2007 but have yet to return to prerecession levels. Only urban transit and intercity rail passenger volumes grew throughout the recession. The number of passengers on international flights to and from the United States returned to prerecession levels beginning in 2011.

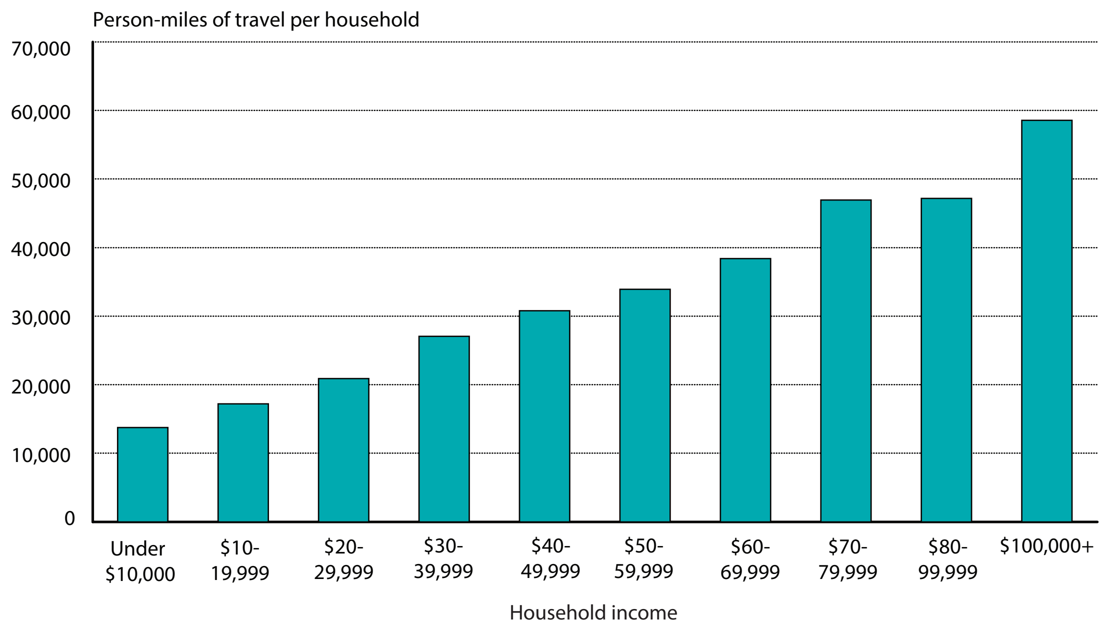
As shown in figure 3-9, person-miles of travel increase with household income. It remains to be seen when the economy and income growth will return to prerecession levels and stimulate a return to prerecession growth in travel, or whether other factors will break the traditional relationships between economic growth and travel.

FIGURE 3-8 U.S. Gross Domestic Product (GDP) and Highway Vehicle-Miles Traveled (VMT): 1990–2012



SOURCES: **GDP**: U.S. Department of Commerce, Bureau of Economic Analysis as cited U.S. Department of Transportation (DOT), Bureau of Transportation Statistics (BTS), *National Transportation Statistics*, Table 3-2. Available www.bts.gov as of June 2014. **VMT**: DOT, Federal Highway Administration as cited in DOT, BTS. *National Transportation Statistics*, Table 1-35. Available www.bts.gov as of June 2014.

FIGURE 3-9 Person-Miles of Travel per Household by Income Level: 2009 NHTS



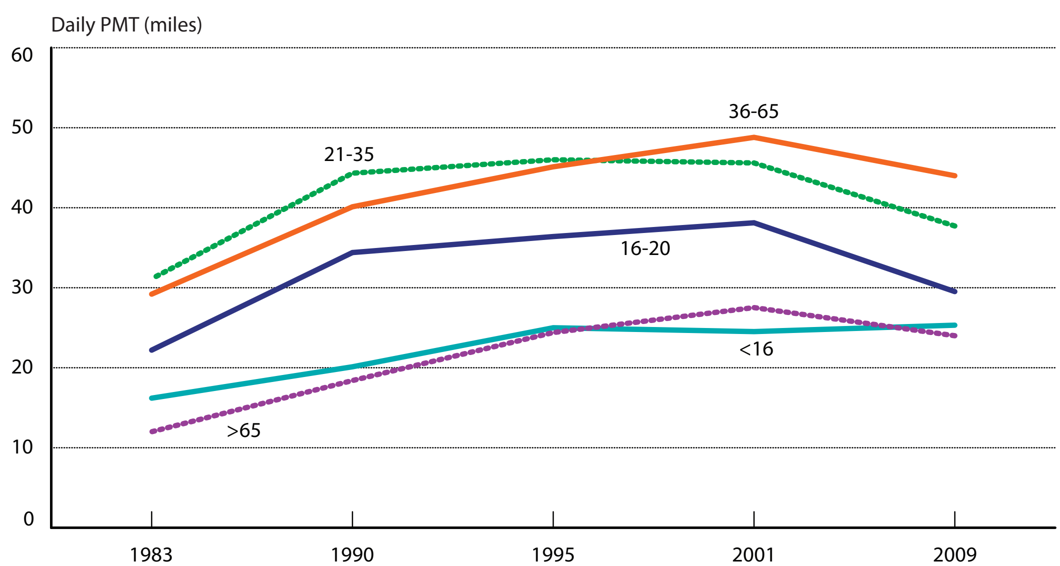
SOURCE: U.S. Department of Transportation, Federal Highway Administration, *2009 National Household Travel Survey*, Online Analysis Tool. Available at http://nhts.ornl.gov/ as of November 2013.

Demographic and Geographic Shifts

Demographic factors are the traditional driving force behind travel demand in the long-term. Since 1950 the U.S. population has more than doubled—increasing from about 151 million to nearly 314 million in 2012 [USDOC CENSUS 2014]. The U.S. population is still growing, albeit at lower rates than in prior decades, and growth is not even across the country. More than 75 percent of the growth in the Nation between 1950 and 2010 was in the South and West. Although two-thirds of the Nation's counties and 85 percent of metropolitan counties gained population from 2000 to 2010, 175 metropolitan counties and 920 non-metropolitan counties lost a total of 2 million residents [AASHTO 2013].

Demographic factors and the economy combine to affect travel demand through the growth of the labor force and the subsequent increase in journeys to work, and through growth in the income generated by the labor force, which becomes available for spending on discretionary travel. Growth in the number of workers exceeded the increase in population during the 1970 to 1990 period. In the 1950s the United States added about 7 million workers. In the 1970s the Nation had added more than 18 million more workers and exceeded that total the following decade. In the first decade of this century, only 8.6 million workers were added to the labor force [AASHTO 2013].

FIGURE 3-10 Daily Person-Miles of Travel (PMT) by Age Group: 1983, 1990, and 1995 NPTS, and 2001 and 2009 NHTS



NOTES: 1990 person trips were adjusted to account for survey collection method changes. Please see Appendix 2 of *2001 Summary of Travel Trends* for specifics.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, National Household Travel Survey (multiple years), *2009 Summary of Travel Trends*. Table 14. Available at http://nhts.ornl.gov/ as of November 2013.

Figure 3-10 illustrates the effect of age on travel. Age is closely associated with the progression of the household life cycle (e.g., single person, married couple, households with small children and/or school age children, empty nesters, and retired individuals). Both the youngest (under 16 years of age) and the oldest (over 65 years of age) travel the least compared to other age groups. The other three age groups shown in the figure account for the majority of person-miles traveled (PMT), particularly those between 26 and 65 years of age. This is a harbinger of future trends as older members of the labor force move toward the 65-year-age threshold, when many people move into retirement. Travel across all age groups (except those 16 years old and under) showed declines from 2001 to 2009. The youngest and oldest age cohorts seemed least affected by the December 2007 to June 2009 recession and its aftermath, while the working age groups were most affected, particularly the youngest segment [NBER 2013]. Whether this is cyclical or a fundamental change in travel behavior is not clear.

The baby boom generation, born between 1945 and 1965, has been the driving force for travel activity at the local and intercity level since World War II. As children, baby boomers affected school and child care-related travel, and then as adults they markedly increased the labor force—not only due to their sheer numbers but because women joined the labor force in large numbers. The resulting increase in the average number of commuters per household affected the journey to work as well as other travel patterns, such as dropping children at child care and school. Today, as the trailing edge of the baby boom generation approaches retirement age, boomers are still affecting travel patterns. They are the first generation to have grown up in the automobile age, with both women and men close to reaching the saturation point in terms of driver licenses and vehicle availability. Retired baby boomers thus could be expected to be more mobile in their retirement years than previous generations, as indicated by an increase in PMT among those aged 65 and older [AASHTO 2013].

The millennial generation born after 1980 is often described as having very different attitudes toward location and transportation than their baby boomer parents. Millennials are described as less dependent on the automobile and more likely to live in central cities [SAKARIA STEHFEST 2013]. National data do not corroborate this description: among 16-to-24 year old members of the U.S. labor force who migrated between suburbs and principle cities, 250,000 left the suburbs for cities and 450,000 left the cities for suburbs, for a net loss of approximately 200,000 from 2011 to 2012 [AASHTO 2013]. Teenagers are delaying the time when they acquire a driver's license and purchase their first new car, but the delay may have far more to do with the economy and availability of jobs for youth than with shifting preferences of the younger cohort [AAA 2012]. Transportation as a share of spending is higher for people under the age of 35 than for any other age group [USDOL BLS CEX 2012].

After decades of predictable growth, recent indicators of U.S. travel have become less clear. Many factors, such as the travel predilections of the aging baby boom generation, uncertainties about future levels of immigration, and the duration of continuing effects of the recent recession on travel, will enter into the equation. In order to understand possible changes in travel dynamics, good data about local, long-distance, and international travel will need to be collected on a regular basis. The central question for data development will be to distinguish what changes are cyclical phenomena, and therefore transient, from those that are structural and a fundamental part of a new era of travel behavior.

Challenges for Travel

An important component of accessibility is having access to transportation options, in particular for those groups in society who have the most difficulty traveling. Chapter 1 mentions the degree of connectivity[1] between public transportation modes. Access to transportation for people without a personal vehicle and transportation for the elderly, people with disabilities, and rural residents are all challenges for the transportation system.

Access to Transportation for People Without a Vehicle

Many people without access to a personal vehicle, especially the poor, have difficulty reaching stores, services, and workplaces outside of their immediate neighborhoods. The most recent data indicate that the percentage of households with no vehicle rose slightly to 9.3 percent in 2011 and then declined to 9.2 percent in 2012, roughly 10.7 million households, about the same number of households without a vehicle as in 1980 [AASHTO 2013]. In the most densely populated parts of cities (10,000 plus people per square mile), 28.4 percent of households had no vehicle in 2009 [USDOT FHWA NHTS 2011].

People living below the poverty level are less likely to own, or have access to, a personal vehicle to get to work than the population as a whole. The percentage of people in poverty increased from 12.2 to 15.9 percent between 2000 and 2012 nationally as the number of poverty stricken increased from 33.3 million to 48.8 million [USDOC CENSUS ACS 2013]. BTS analysis of the 2009 NHTS found that households with annual incomes less than $25,000 were eight times more likely on average to be zero-vehicle households than households with annual incomes above that level [USDOT FHWA NHTS 2011]. Of workers below the poverty level, 63.6 percent drive to work compared to 76.4 percent of workers overall in 2012. Compared to commuters as a whole, people below the poverty level are more likely to take public transportation, walk, or use other transportation modes (compare figures 3-11a to 3-11b).

Transportation Access for Elderly and Disabled Passengers

Another important component of accessibility is having access to transportation options, in particular for those groups in society who have

[1] Connectivity gives shippers and travelers additional transportation alternatives that unconnected, parallel systems do not offer.

FIGURE 3-11a How Workers Below the Poverty Level Get To Work: 2012

Percent of workers below the poverty level

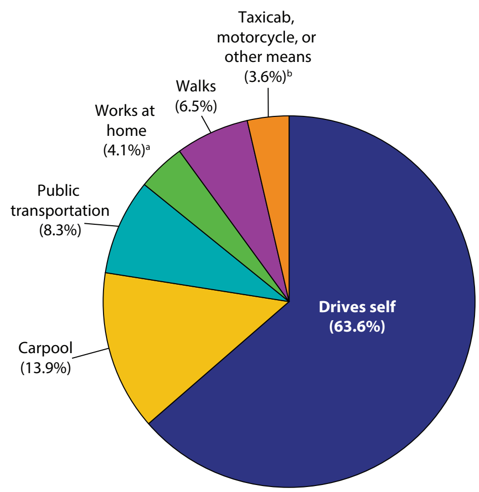
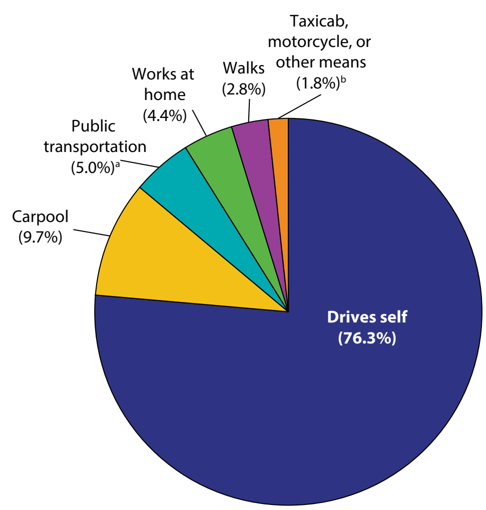


FIGURE 3-11b How Workers Get To Work: 2012

Percent of workers 16 years and over



[a] *Public transportation* category includes workers who used a bus or trolley bus, streetcar or trolley car, subway or elevated, railroad, or ferryboat. [b] *Other* means includes ferryboats, surface trains, and van service and other means not classified.

NOTES: Percents may not add to 100 due to rounding. For additional information, please refer to the *American Community Survey's 2012 Subject Definitions*, available at http://www.census.gov/acs/. Workers are civilians and members of the Armed Forces, 16 years and older, who were at work the previous week. Persons on vacation or not at work the prior week are not included.

SOURCE: *Below Poverty Level*: U.S. Department of Commerce, Census Bureau, 2012 American Community Survey, 1-year estimates, table B08122. Available at http://www.census.gov/acs/www/index.html as of February 2014. *Total*: U.S. Department of Commerce, Census Bureau, 2012 American Community Survey, 1-year estimates, table B08006. Available at http://www.census.gov/acs/www/index.html as of February 2014.

the most difficulty in traveling, that is, the elderly and those with physical or cognitive impairments. The American Association of Retired Persons Public Policy Institute estimated that the percent of all trips in the United States taken by persons age 65 and older increased from 11 percent in 2001 to 12 percent in 2009, accounting for 45.2 billion trips [AARP 2011]. The total number of miles traveled by people age 65 and older increased by 7 percent, accounting for 10 percent of all miles traveled in the United States in 2009. Transit use by people age 65 and older as a share of all the trips they take increased by 40 percent between 2001 and 2009, which represented more than 1 billion trips on public transportation in 2009 (a 55 percent increase from what was reported in 2001).

Over the last two decades, the Nation's transit fleet has made notable progress in making transit service accessible to those with disabilities. Through the installation of lifts and ramps or improvements in station infrastructure, people using wheelchairs or who have other travel disabilities now find it easier to access transit than in the recent past [USDOT FTA 2013]. In 2011 the percentage of accessible buses reached 99 percent, compared to 60 percent in 1995. Also during this period, accessible portions of the commuter rail fleet doubled to 85 percent, and accessibility on the light rail and heavy rail fleets reached 88 and 99 percent, respectively. The trolleybus fleet grew from 47 to 100 percent accessible. Demand-response transit fleets have also become more accessible, increasing from 84 to 89 percent.

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CHAPTER 4

Moving Goods

In 2011 the freight transportation system served 7.4 million business establishments, 118.7 million households, and more than 89,000 government units [USDOC CENSUS SUSB, 2013, and GOVS]. In recent years the freight transportation network has handled growth in domestic freight and increasing amounts of international freight shipments in response to large increases in U.S.-international trade. Not only has the network had to adapt to handle international traffic, but the growth in international freight has also had an effect on the way domestic freight moves. All of these changes in the freight network have created new challenges for the commercial and industrial sector as well as affected communities and managers of publicly owned infrastructure.

- In 2012 the Nation's freight system moved 53.9 million tons of goods worth $47.5 billion each day—about 62.6 tons of freight per capita per year.
- Trucks carried the largest share of freight shipments moving less than 500 miles from point of origin. Railroads and pipelines, combined, carried over one-half of the tonnage shipped from 750 miles to 1,000 miles. Air cargo and shipments by multiple modes (e.g., shipments transferred from rail to truck) accounted for over one-half of the value of freight moved more than 2,000 miles.
- After back-to-back declines in 2008 and 2009, the tonnage and value of freight moved in 2012 surpassed the previous highs reached in 2007, by just over 4 percent each.
- The value of U.S.-international trade increased from $2.6 trillion in 2000 to $3.8 trillion in 2012 (adjusted for inflation using the Consumer Price Index), a 43.4 percent increase. This increase has created additional traffic between international gateways and domestic destinations.

Weight and Value

The U.S. freight transportation system moved more than 19.7 billion tons of goods valued at $17.4 trillion in 2012, according to estimates derived from the Freight Analysis Framework (FAF) (table 4-1). This means the freight transportation system carried, on average, about 53.9 million tons of goods worth more than $47.5 billion each day. This amounts to about 62.6 tons of freight per capita per year in the United States. See box 4-A for information about the FAF and the Commodity Flow Survey.

During the recession, freight transportation saw large decreases in tonnage in 2008 and 2009. However, by 2011 the economy had started to recover, and freight tonnage reached 93.3 percent of the 2007 levels. FAF paints a similar picture for the value of freight shipments, which decreased in 2008 and 2009

TABLE 4-1 Weight and Value of Shipments by Transportation Mode: 2007, 2012, and 2040[1]

Weight

	2007				2012				2040			
Millions of tons	Total	Domestic	Exports[2]	Imports[2]	Total	Domestic	Exports[2]	Imports[2]	Total	Domestic	Exports[2]	Imports[2]
Truck	12,778	12,587	95	97	13,182	12,973	118	92	18,786	18,083	368	335
Rail	1,900	1,745	61	93	2,018	1,855	82	82	2,770	2,182	388	201
Water	950	504	65	381	975	542	95	338	1,070	559	164	347
Air, air & truck	13	3	4	6	15	3	5	7	53	6	20	27
Multiple modes & mail	1,429	433	389	606	1,588	453	540	595	3,575	645	1,546	1,383
Pipeline	1,493	1,314	4	175	1,546	1,421	13	112	1,740	1,257	17	467
Other & unknown	316	266	36	14	338	277	47	14	526	362	130	34
Total	**18,879**	**16,851**	**655**	**1,372**	**19,662**	**17,523**	**901**	**1,238**	**28,520**	**23,095**	**2,632**	**2,794**

Value

	2007				2012				2040			
Billions of 2007 dollars	Total	Domestic	Exports[2]	Imports[2]	Total	Domestic	Exports[2]	Imports[2]	Total	Domestic	Exports[2]	Imports[2]
Truck	10,780	10,225	267	287	11,130	10,531	309	289	21,465	19,315	985	1,166
Rail	512	374	45	93	551	400	55	96	898	555	148	195
Water	340	158	15	167	339	170	21	148	337	138	46	153
Air, air & truck	1,077	151	422	505	1,182	163	470	549	5,043	834	1,997	2,212
Multiple modes & mail	2,884	1,646	394	844	3,023	1,697	478	848	9,925	5,203	1,911	2,811
Pipeline	716	651	4	61	768	699	9	61	776	605	17	154
Other & unknown	341	252	48	41	359	267	51	41	821	482	199	139
Total	**16,651**	**13,457**	**1,196**	**1,997**	**17,352**	**13,927**	**1,392**	**2,033**	**39,265**	**27,131**	**5,303**	**6,831**

[1]Many 2007 and 2040 numbers in this table were revised as a result of Freight Analysis Framework (FAF) database improvements in FAF, version 3.4.

[2]Data do not include imports and exports that pass through the United States from a foreign origin to a foreign destination by any mode.

NOTES: Numbers may not add to totals due to rounding. The 2012 data are provisional estimates that are based on selected modal and economic trend data. All truck, rail, water, and pipeline movements that involve more than one mode, including exports and imports that change mode at international gateways, are included in multiple modes & mail to avoid double counting. As a consequence, rail and water totals in this table are less than other published sources.

SOURCE: U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), Office of Freight Management and Operations, Freight Analysis Framework, version 3.4, 2014 as cited in USDOT, FHWA and Bureau of Transportation Statistics, *2013 Freight Facts and Figures*, Table 2-1 and 2-2. Available at http://ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/ as of August 2014.

before increasing in 2011 to 100.9 percent of the estimated value for 2007 (in 2007 dollars). Table 4-1 shows that the weight and value of freight in 2012 surpassed prerecession levels in all categories (except import tonnage). FAF forecasts that freight weight will grow 1.3 percent annually between 2012 and 2040. The value of goods moved, in real dollars, is expected to increase faster than tonnage and more than double during this time as the value of goods increases [USDOT FHWA BTS 2014]. U.S. exports and imports accounted for 10.9 percent of the weight and 19.7 percent of the value of freight transported throughout the United States in 2012. FAF forecasts that U.S. exports and imports will account for an even greater share of freight movements in 2040, reaching 19.0 percent of the weight and 30.9 percent of the value of goods shipped throughout the country [USDOT FHWA BTS 2014].

Population growth and economic activity are the primary factors that determine freight demand. As population increases or economic activity expands, more goods are produced and used, resulting in additional freight movement. Between 2007 and 2012, the U.S. population increased by 4.2 percent [USDOC CENSUS 2013], and U.S. gross domestic product grew 11.6 percent in terms of current dollars [USDOC BEA 2014]. In addition, changes in the composition of goods demanded had an effect on what goods were moved, what modes were used to transport them, and where they were shipped. Freight traffic, which fluctuates with economic activity, increased in 2013. Freight carried by the for-hire transportation industry rose as the economy rebounded

BOX 4-A The Commodity Flow Survey and the Freight Analysis Framework

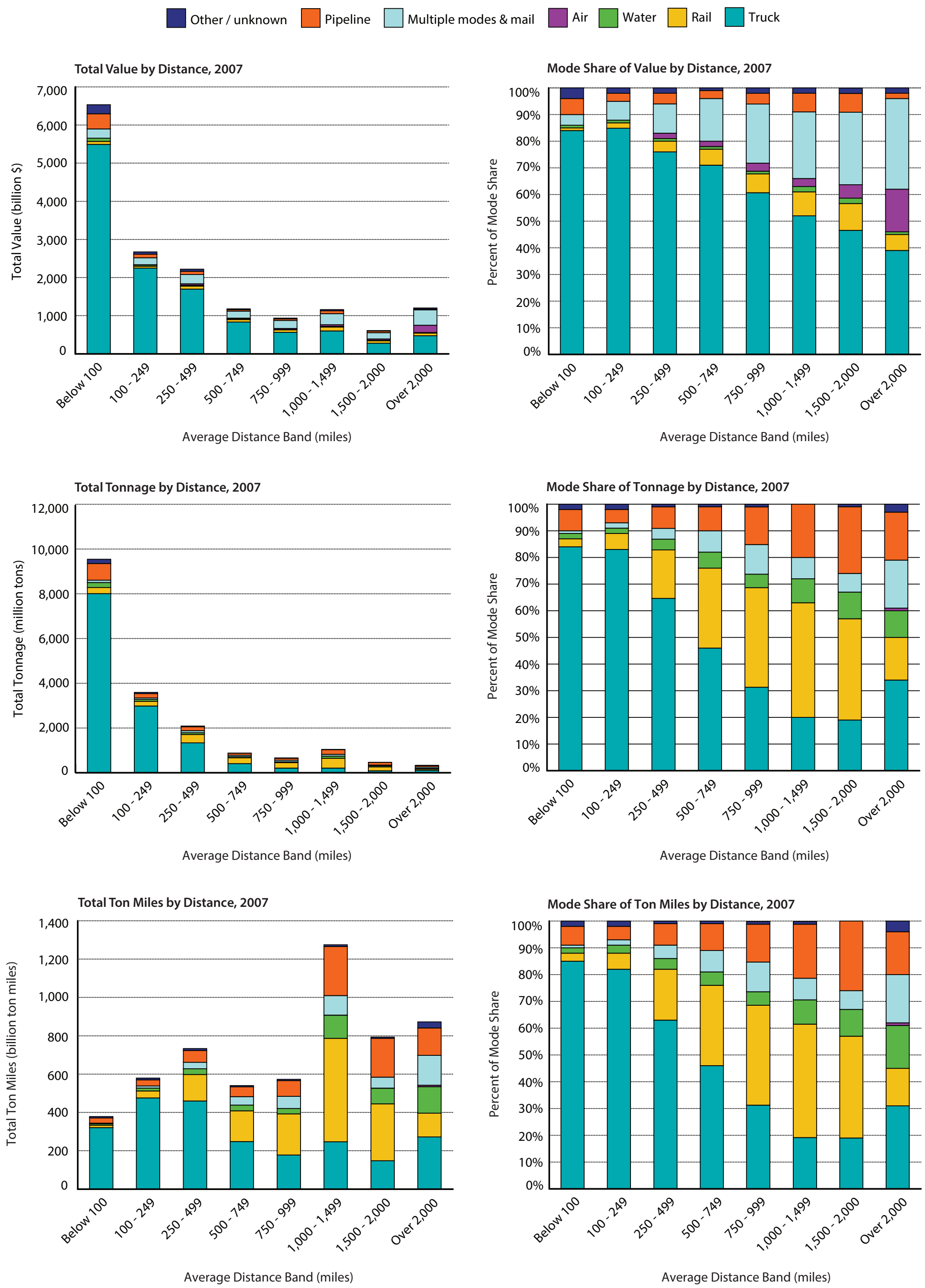
The Commodity Flow Survey (CFS) is conducted every 5 years (specifically in the years ending in 2 and 7) by the Bureau of Transportation Statistics (BTS) in partnership with the U.S. Census Bureau as part of the Economic Census. The CFS provides data for most of the U.S. economy on commodities shipped, their value and weight, mode of transport, and origin and destination within and between all U.S. regions. The survey covers about 75 percent of the tonnage shipped from a domestic origin to a domestic destination. The CFS is the foundation for the Freight Analysis Framework (FAF).

The FAF supplements CFS data with a variety of other sources to estimate total tonnage and value, commodity type, mode, origin, and destination for 1997, 2002, 2007, 2012, and 2040. It also assigns truck flows to the highway network for 2007 and 2040 to provide a picture of freight truck volumes.

While the FAF is more complete, the CFS provides greater commodity detail and additional shipment characteristics, such as hazardous materials class. BTS released preliminary 2012 CFS estimates in December 2013, which are available at https://www.census.gov/econ/cfs/ and will be followed by final estimates in December 2014.

FAF forecasts are based on long-term U.S. economic projections, including real gross domestic product growth, nonfarm business productivity, real oil prices, and the Federal budget deficit. Detailed information on CFS data and methodologies are available at www.bts.gov/publications/commodity_flow_survey/. Information on FAF data and methodologies are available at www.ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm.

FIGURE 4-1 Value, Tonnage, and Ton-Miles of Freight by Distance, 2007



SOURCE: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 3.4, 2013.

from the past recession. According to the Bureau of Transportation Statistics' (BTS) freight Transportation Services Index (TSI), freight shipments were at the highest all-time levels in the last two months of 2013. Freight shipments, as measured by the index, were up 4.4 percent in December 2013 compared to December 2012 (figure 1-7) [USDOT BTS 2014].

How Domestic Freight Moves

In 2012 the freight transportation industry moved goods over a network of truck routes, railroads, waterways, airports, and pipelines. The distance a shipment must travel, either by single mode or during any particular leg of a multimodal journey, plays a major part in determining what mode or modes are used (see figure 4-1).

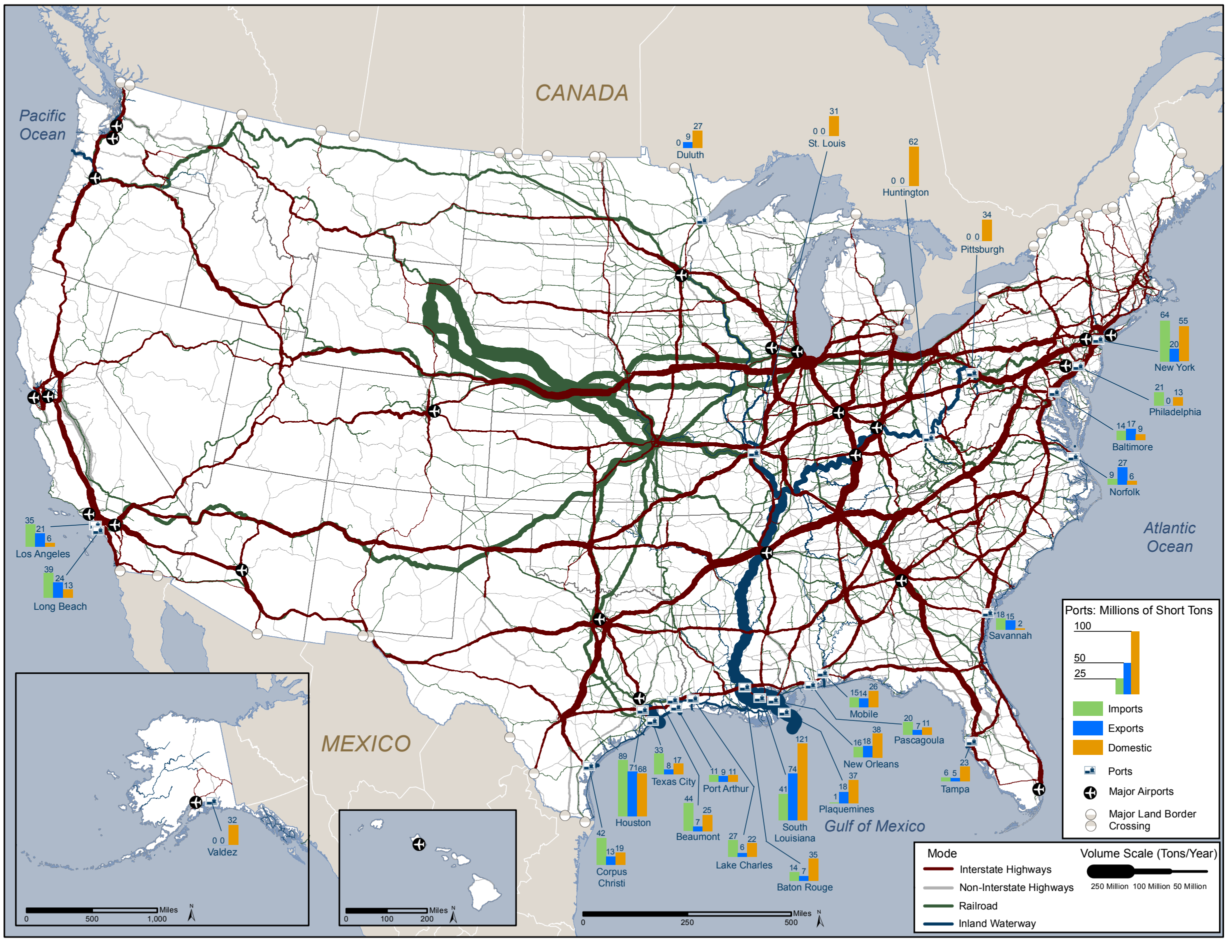
Most goods are moved short distances (less than 250 miles), and accounted for 55.7 percent of the value, 70.7 percent of the weight, and 16.7 percent of the ton-miles for all shipments within the United States in 2007. Although accounting for less than 30 percent of the total weight of all shipments in 2007, shipments of more than 250 miles constituted the bulk of ton-miles logged—83.3 percent. Modal shares of freight vary considerably by distance. While trucks carry the largest shares by value, tons, and ton-miles for shipments moving 750 miles or less, rail is the dominant mode by tons and ton-miles of shipments ranging from 750 to 2,000 miles, and air, multiple, and other/unknown modes account for 51.8 percent of the value of shipments moving more than 2,000 miles [USDOT FHWA BTS 2014].

Trucks carry the highest percentage of the weight and value of goods in the United States. However, figure 4-2 shows that railroads and inland waterways carry large volumes and tonnages of commodities, like coal and petroleum products, over long distances [USACE 2013b]. Rail and water combined accounted for 15.2 percent of the total tonnage and 5.1 percent of the total value of freight moved in the United States in 2012. Air carriers moved high-value, low-weight products. This is underscored by the relatively extreme value-to-weight ratio of air cargo, which is nearly $70,000 per ton. In comparison, the overall value-to-weight ratio of cargo carried by all modes combined is less than $900 per ton. In 2012 pipelines moved 1.5 billion tons of goods valued at $768 billion ($512 per ton), while rail moved more tonnage of lessor value—2.0 billion tons valued at $551 billion ($275 per ton). Rail represented 10.3 percent of the total tonnage and 3.2 percent of the total value of shipments in 2012, about the same shares as reported in 2007. Rail shipments by tonnage are projected to increase by 37.3 percent between 2012 and 2040 [USDOT FHWA BTS 2014].

The water mode typically carries low-value, bulk products similar to rail.[1] While waterborne shipments, by tonnage and value, declined in 2008 and 2009, they have since rebounded. In 2012 the water transportation industry moved 975 million tons worth $339 billion ($348 per ton), representing 5.0 percent

[1] Many shipments arriving in the United States by rail and water are transferred to another mode for delivery to their final destination. These shipments are counted under multiple modes. Thus, the rail and water numbers discussed here may be lower than those in other published sources.

FIGURE 4-2 Freight Flows by Highway, Railroad, and Waterway: 2010



SOURCE: **Highways**: U.S. Department of Transportation, Federal Highway Administration, Freight Analysis Framework, Version 3.4, 2012. **Rail**: Based on Surface Transportation Board, Annual Carload Waybill Sample and rail freight flow assignments done by Oak Ridge National Laboratory. **Inland Waterways**: U.S. Army Corps of Engineers, Institute for Water Resources as of November 2013.

of the tonnage and 2.0 percent of the value of all freight shipments [USDOT FHWA BTS 2014]. In 2012 approximately 565 million short tons of cargo were moved by vessel along the inland waterways, including the Mississippi River—the Nation's busiest waterway [USACE 2013].

In comparison with the rail and water modes, air transport carries high-value products, such as electronics, precision instruments, and pharmaceuticals that require quick delivery. Of all modes, the value of air-freight shipments is projected to increase the fastest from 2011 to 2040, growing by 327 percent [USDOT FHWA BTS 2014]. In 2012 U.S. airlines[2] carried a total of 62,424 million international and domestic revenue freight and mail cargo

[2] In all service classes (scheduled and nonscheduled)

TABLE 4-2 Top Commodities by Weight and Value: 2012

Weight	Millions of Tons	Value	Billions of 2007 Dollars
Gravel	2,319	Machinery	$1,836
Cereal grains	1,595	Electronics	$1,492
Coal	1,527	Motorized vehicles	$1,348
Natural gas, coke, asphalt[1]	1,442	Mixed freight	$1,090
Non-metallic mineral products	1,442	Pharmaceuticals	$909
Waste/scrap	1,368	Miscellaneous manufactured products	$717
Gasoline	1,030	Textiles/leather	$710
Crude petroleum	783	Gasoline	$705
Fuel oils	765	Plastics/rubber	$601
Natural Sands	585	Articles of base metal	$588
Total, all commodities	**19,662**	**Total, all commodities**	**$17,352**

[1]This group includes coal and petroleum products not elsewhere classified such as liquefied natural gas, coke, asphalt, and other products of coal and petroleum refining, excluding gasoline, aviation fuel, and fuel oil.

SOURCE: U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), Office of Freight Management and Operations, Freight Analysis Framework, version 3.4, 2014 as cited in USDOT, FHWA and Bureau of Transportation Statistics, *2013 Freight Facts and Figures*, Table 2-4. Available at http://ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/ as of August 2014.

revenue ton-miles, of which 12,367 million were domestic [USDOT BTS 2014a].

Over the last 20 years, the U.S. transportation system has become increasingly intermodal. Although intermodal services accounted for a relatively small share (8.1 percent) of freight tonnage, they moved 17.4 percent of the value of the goods in 2012. FAF forecasts the value of intermodal shipments to increase significantly between 2012 and 2040 [USDOT FHWA BTS 2014].[3]

The growth in intermodal freight movement is driven, in part, by global supply chain requirements. Between 1990 and 2010, the railroad industry reported an 82 percent increase in trailer and container traffic [AAR 2011]. Preliminary data from the Association of American Railroads show that rail intermodal traffic accounted for 12.6 percent of U.S. Class I railroad revenue in 2011. Only coal along with chemicals and allied products accounted for a larger share of revenue [AAR 2013]. With the growth in container trade and improvements in information and logistics technologies, the stage is set for increased reliance on intermodal transportation to move goods from manufacturers to consumers.

Commodities Moved Domestically

Table 4-2 shows that bulk products, such as gravel, cereal grains, coal, and waste/scrap, comprised a large share of the tonnage moved in 2012, but a comparatively small share of the value of the Nation's freight. In fact, in 2012 the top 10 commodities by weight accounted

[3] The FAF category for multiple modes and mail includes all multimodal movements and is not limited to traditional intermodal services, such as trailer-on-flatcar and container-on-flatcar rail.

BOX 4-B Bakken Formation

The oil-rich Bakken formation stretches across western North Dakota and northeastern Montana and into the Canadian provinces of Manitoba and Saskatchewan. Figure 4-3 shows the U.S. geographic region and the major highways and railroad lines that support exploration in this region. In 2013 total output from this region grew to more than 1 million barrels of oil per day (BPD) from less than 200,000 BPD in 2007. North Dakota accounts for more than 10 percent of total U.S. oil production and is the second largest oil producing state, after Texas [USDOE EIA 2013].

Bakken oil production has broad implications for the transportation system. For example, it has increased large-truck traffic by 40 to 50 percent on rural roads in the region. As a result, the highway network has deteriorated more quickly under the heavy traffic to and from the well-heads, which can require up to 2,300 drilling-related truck trips [UGPTI 2012].

Once drilled, oil from the Bakken formation is transported from the well to a processor via truck to a pipeline or rail transfer facility, while natural gas is moved by gathering pipeline to a trunk connection. In North Dakota, pipelines move roughly three-quarters of the oil harvested from wells [TOLLIVER 2013].

Injuries involving large truck crashes in the region have increased by 1,200 percent from 2008 to 2012. Oil from the Bakken region is a hazardous material and poses a risk, especially as oil is transported through grade crossings and populated and heavily trafficked areas [TOLLIVER 2013].

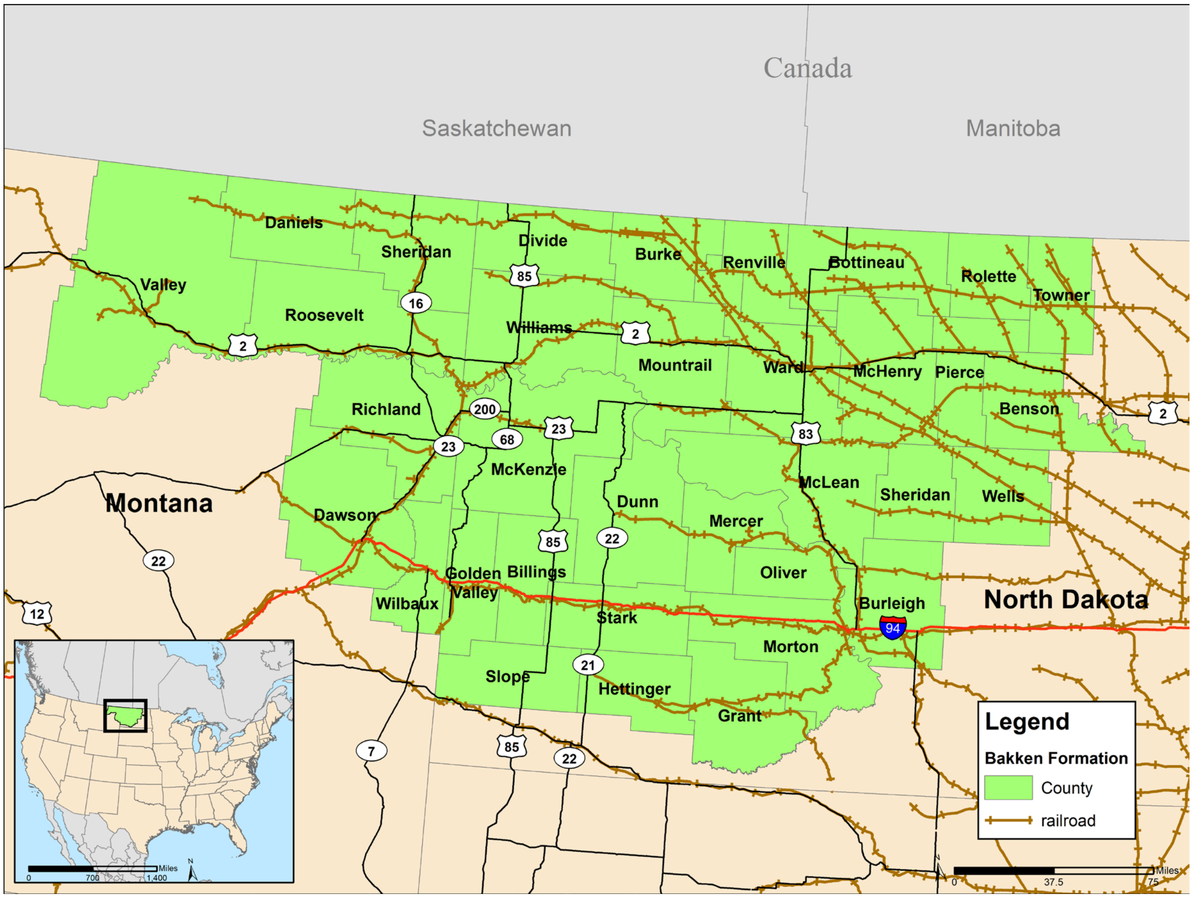
for 65 percent of total tonnage but only 16 percent of the value of goods. Rounding out the top 10 by weight were nonmetallic products, gasoline, fuel oils, crude petroleum, and other foodstuffs [USDOT FHWA BTS 2014]. Box 4-B discusses the Bakken formation, which has experienced significant growth in crude petroleum shipments.

The picture changes significantly when looking at the value of goods shipped. The highest value goods were those that are time-sensitive, including electronics, pharmaceuticals, and textiles/leather. Other top commodities by value are machinery, motorized vehicles, intermodal shipments, gasoline, and plastics/rubber, and other foodstuffs. In 2012 the top 10 commodities by value accounted for 58 percent of total value but only 13 percent of total tonnage [USDOT FHWA BTS 2014]. Chapter 7 covers the safety and environmental issues associated with transportation of hazardous materials.

International Trade

U.S. retailers are increasingly dependent on the U.S. transportation system, especially those that build up their inventories in October in anticipation of holiday sales in November and December. In particular, businesses utilize liner services to move intermodal shipping containers seamlessly through the global transportation system. Container ports represent the link between the global and domestic freight network, utilizing intermodal barge, truck, and rail connections to transport containers to their final destinations [USDOT BTS 2012]. The value of total U.S.-

FIGURE 4-3 Highway and Railroad Network Serving the Bakken Formation



SOURCE: **Highway and Railroad**: U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS), *National Transportation Atlas Databases 2013*. Available at http://www.bts.gov/ as of October 2013. **Bakken Formation**: USDOT/BTS, Special Tabulation.

international merchandise trade increased from $2.6 trillion in 2000 to $3.8 trillion in 2012—a 43.4 percent inflation-adjusted increase[4] [USITC DATAWEB 2014].

Six of the top 15 U.S. trading partners were Asian countries in 2012. Trade with China grew the fastest, from 5.8 percent of the total value of U.S. merchandise trade in 2000 to 14.0 percent in 2012. In 2000 China ranked 10th among U.S. trading partners; today it is second only to Canada while Mexico, Japan, and Germany, respectively, round out the top five [USDOC ITA 2014].

Surface Trade With Canada and Mexico

Our North American Free Trade Agreement partners—Canada and Mexico—accounted for 29.0 percent ($1.11 trillion) of the value of

[4] The 2000 U.S. International Trade Commission trade data was adjusted to current dollars using the Bureau of Labor Statistics' Consumer Price Index (CPI) Inflation Calculator.

U.S. merchandise trade in 2012. Over the 2000 to 2012 period, combined trade adjusted for inflation with Canada and Mexico increased 26.8 percent[5] [USDOC ITA 2014].

Trucks carried 27.9 percent of the tonnage and 59.9 percent of the value of trade with these two countries, while rail carried 21.9 percent of the tonnage and 15.1 percent of the value (table 4-3). U.S. trade with Canada and Mexico was $103.1 billion in October 2013, exceeding $100 billion for the first month on record. Mineral fuels and oils transported by pipeline and vessel accounted for much of the increased trade value [USDOT BTS 2013a].

[5] The percent increase was calculated by adjusting the 2000 trade data using the CPI Inflation Calculator.

In 2012 U.S. imports from Canada and Mexico exceeded exports in terms of merchandise trade value. Motor vehicles were the top commodity category for goods transported by land modes between the United States and Canada. Michigan, which accounts for 13.0 percent of the U.S.-Canada border mileage, was the leading state for trade by land modes with Canada. Michigan has border crossing/entry ports between Detroit, Port Huron, and Sault Ste. Marie and southern Ontario; both Michigan and Ontario have a high concentration of automakers. Texas, which accounts for 64.2 percent of the U.S.-Mexico border mileage and is home to 11 border crossing/entry ports, led all other states in surface trade with Mexico. Electrical

TABLE 4-3 Value and Tonnage of U.S. Merchandise Trade with Canada and Mexico: 2000, 2005, 2011, and 2012

Billions of current U.S. dollars and millions of short tons

	2000		2005		2011		2012	
Mode	**Value**	**Weight**	**Value**	**Weight**	**Value**	**Weight**	**Value**	**Weight**
Truck[1]	429	NA	491	191	626	208	665	196
Rail[1]	94	NA	116	141	152	142	168	154
Air	45	<1	33	<1	46	<1	44	<1
Water	33	194	58	256	108	208	106	196
Pipeline[1]	24	NA	52	86	81	123	77	136
Other[1]	29	NA	39	5	46	13	50	21
Total[1]	**653**	**NA**	**790**	**679**	**1,058**	**675**	**1,110**	**703**

KEY: NA = not available.

[1] The U.S. Department of Transportation, Bureau of Transportation Statistics estimated the weight of exports for truck, rail, pipeline, and other modes using weight-to-value ratios derived from imported commodities.

NOTES: 1 short ton = 2,000 pounds. "Other" includes shipments transported by mail, other and unknown modes, and shipments through Foreign Trade Zones. Totals for the most recent year differ slightly from the Freight Analysis Framework (FAF) due to variations in coverage and FAF conversion of values to constant dollars. Numbers may not add to totals due to rounding.

SOURCES: **Truck, Rail, Pipeline, and Other**: U.S. Department of Transportation, Bureau of Transportation Statistics, North American Transborder Freight Data, available at www.bts.gov/transborder as of October 2013; **Air and Water:** U.S. Department of Commerce, Census Bureau, Foreign Trade Division, *FT920 - U.S. Merchandise Trade: Selected Highlights* (Washington, DC: annual issues).

FIGURE 4-4 Top 25 U.S. International Trade Freight Gateways by Value of Shipments: 2011

SOURCE: **Air**: U.S. Department of Commerce, Census Bureau, Foreign Trade Division, special tabulation, October 2012; **Water**: U.S. Army Corps of Engineers, Navigation Data Center, special tabulation, October 2012; **Land**: U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS), TransBorder Freight Data, special tabulation, available at http://www.bts.gov/programs/international/transborder/ as of October 2012; as cited in USDOT/BTS, *National Transportation Statistics*, available at http://www.bts.gov as of October 2013.

machinery was the top commodity transported between the United States and Mexico [USDOT BTS 2013b]. In total, there are 87 ports-of-entry along the U.S.-Canada border and 25 on the U.S.-Mexico border.

Freight Transportation Gateways

A large volume of U.S.-international merchandise trade passes through a relatively small number of freight gateways—the entry and exit points for trade between the United States and other countries (figure 4-4). In 2012 the Port of Los Angeles was the top water gateway, handling more than $214.6 billion in cargo, mostly imports, while on the Atlantic coast the port of New York and New Jersey ranked second, handling $209.6 billion. That year John F. Kennedy International Airport was the leading air gateway, handling $182.7 billion in exports and imports. Laredo, the top land-border crossing, handled $163.4 billion in trade across the U.S.-Mexico border, followed by Detroit, which handled $130.9 billion across the U.S.-Canada border in 2012 [USDOT BTS 2013a].

Water is the leading transportation mode for U.S.-international trade both in terms of weight and value. Ships accounted for more than 73.5 percent of trade weight and 46.6 percent of trade value in 2012. Air handles less than 1 percent of trade weight but 24.3 percent of trade value, due to its focus on high-value, time-sensitive, and perishable commodities. In 2012 the top U.S.-international air gateways by value were John F. Kennedy International, NY, Chicago O'Hare International, IL, and Los Angeles International, CA [USDOT BTS 2014b]. Memphis International, TN, Louisville International, KY, and Ted Stevens Anchorage International, AK, were the top domestic air gateways by weight in 2012 [USDOT BTS 2014a]. Trucks, which haul a large share of imports and exports between U.S. international gateways and inland locations, carried 17.4 percent of the value of total U.S.-international trade (figure 4-5a) and 10.1 percent of the tonnage in 2012 (figure 4-5b).

Water Trade

As a result of the growth in international trade, the number of container vessels calling at U.S. ports has increased. Between 2006 and 2011, vessel calls at U.S. seaports increased by 7.9 percent. In 2011 tankers accounted for 35.0 percent of the vessel calls, followed closely by containerships with 32.5 percent. The average displacement of container vessels increased 9.9 percent, from 46,602 deadweight tons (dwt) in 2006 to 51,204 dwt in 2011. The new post-Panamax containerships also increased in average capacity by 13.3 percent, as measured in twenty-foot equivalent units (TEU) during this time [USDOT MARAD 2013a].

In 2012 U.S. seaports handled 29.4 million TEU of containerized cargo, which is about the same as 2007 and up by 18.4 percent from 24.9 million TEU in 2009, following the last recession. The ports of Los Angeles and Long Beach on the Pacific coast and the port of New York and New Jersey on the Atlantic coast are the leading container ports [USDOT MARAD 2013b]. As shown in figure 4-6, the geographic distribution of container ports is more concentrated along the Pacific and Atlantic coasts, while large volumes of bulk commodities are transported through gulf coast ports (figure 4-2). In 2011 the Pacific coast accounted for 27.0 percent of all types of vessel calls, followed by the Atlantic coast, including Puerto Rico, with 38.9 percent, and then the gulf coast with 34.1 percent [USDOT MARAD 2013a].

The major increase in trade with China has resulted in a large share of trade moving through Pacific coast ports (figure 4-7). The trend toward larger containerships has led to a concentration of liner service at ports with ample overhead clearance and water draft, intermodal connections such as double stack rail, and room to grow. This trend is expected to continue, especially when the expanded Panama Canal locks open [USDOT BTS 2011a]. U.S.-international trading partners as well as global and domestic freights flows

FIGURE 4-5a U.S. International Merchandise Trade Value by Transportation Mode: 2012

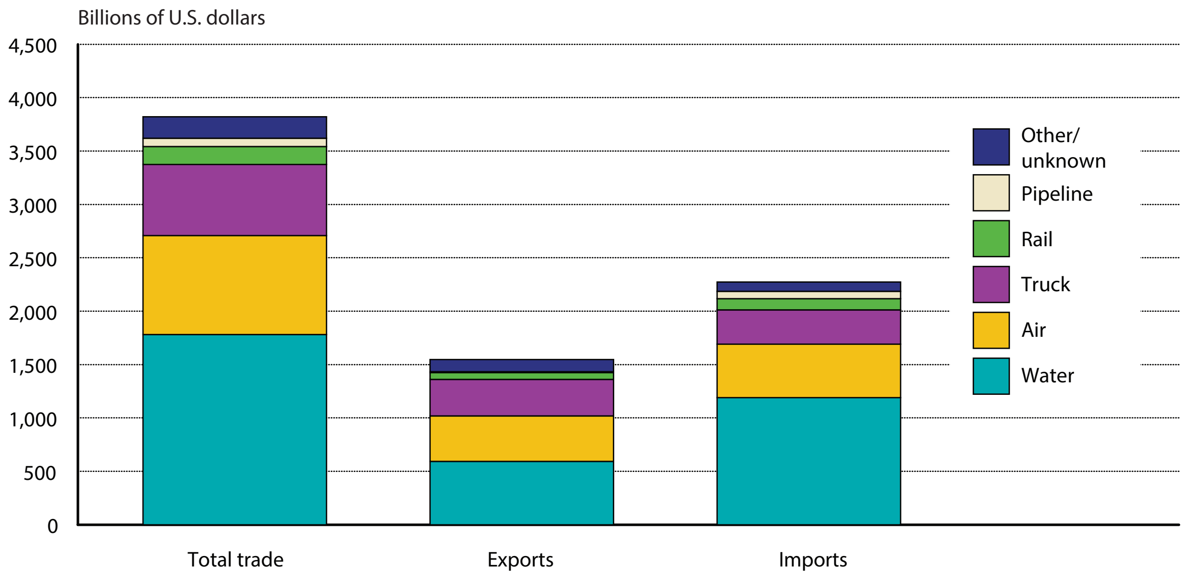
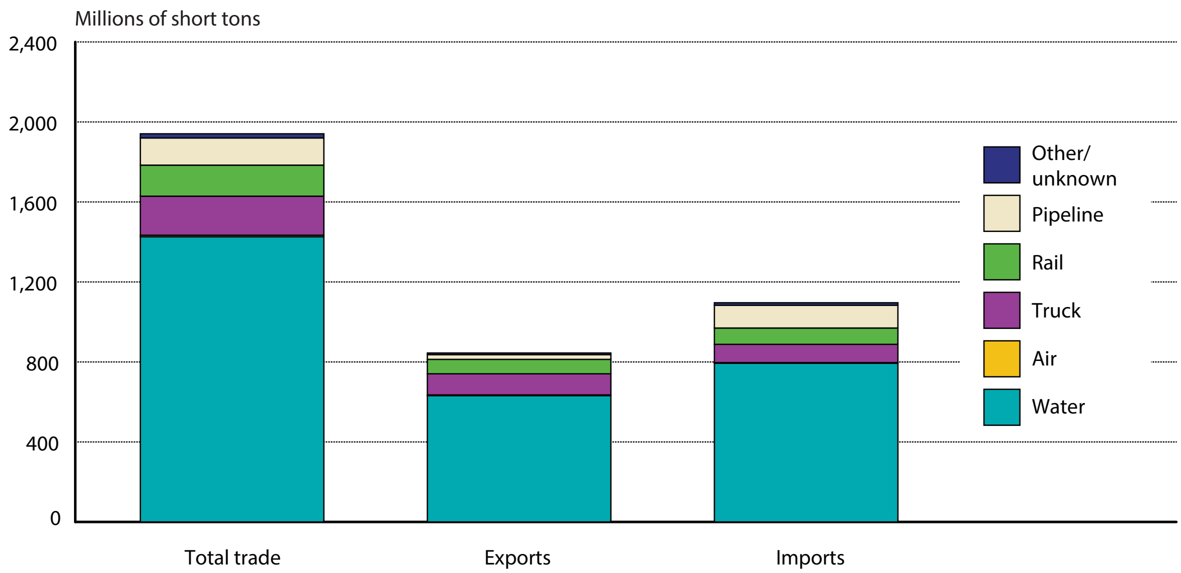


FIGURE 4-5b U.S. International Merchandise Trade Weight by Transportation Mode: 2012



NOTES: 1 short ton = 2,000 pounds. The U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics estimated 2012 weight data for truck, rail, pipeline, and other and unknown modes using value-to-weight ratios derived from imported commodities. Totals for the most recent year differ slightly from the USDOT, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework (FAF) due to variations in coverage and FAF conversion of values to constant dollars. Numbers may not add to totals due to rounding.

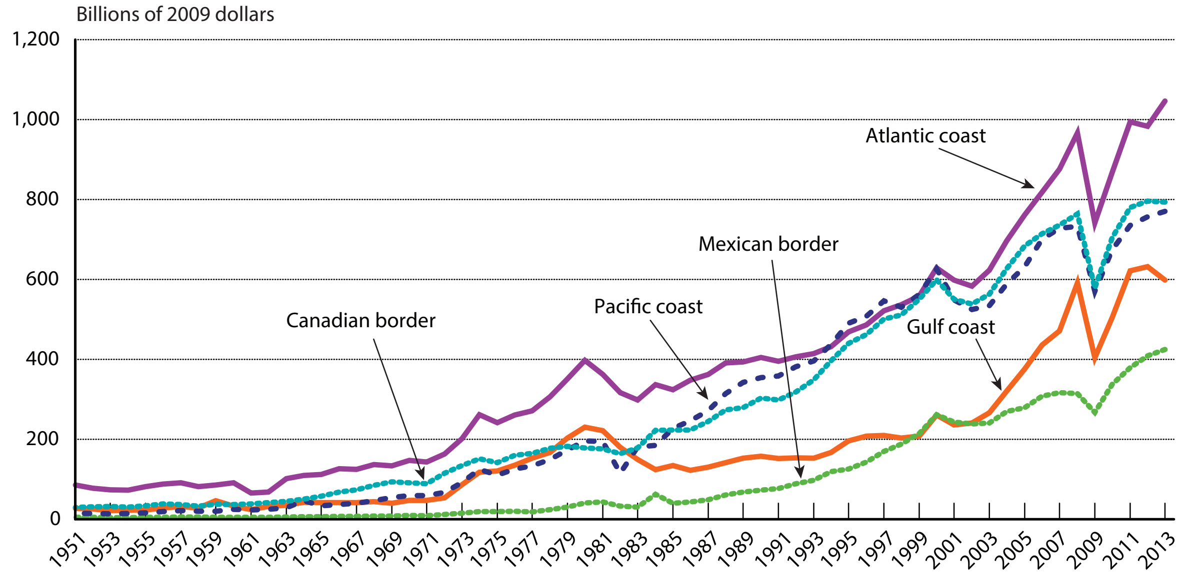
SOURCE: **Total, water and air data**: U.S. Department of Commerce, U.S. Census Bureau, Foreign Trade Division, *FT920 - U.S. Merchandise Trade: Selected Highlights* (Washington, DC: February 2013). **Truck, rail, pipeline, and other and unknown data**: U.S. Department of Transportation, Bureau of Transporation Statistics, North American Transborder Freight Data, available at www.bts.gov/transborder as of October 2013.

FIGURE 4-6 Top 25 Water Ports by Containerized Cargo: 2011 (thousands of TEUs)

SOURCE: U.S. Department of Transportation, Maritime Administration, *U.S. Waterborne Container Trade by U.S. Custom Ports*, available at http://www.marad.dot.gov/ as of September 2013.

have and will continue to evolve. Growth in U.S.-international trade over the past 20 years has increased freight volumes on major freight highway, rail, and waterway routes as international trade competes with domestic freight and passenger traffic for use of the transportation infrastructure. Moreover, trade growth with Canada and Mexico and the tapping of natural resources, such as the Bakken formation (box 4-b), generates increased north-south traffic flows on a domestic transportation infrastructure that was initially developed along east-west corridors during the westward development of the Nation.

FIGURE 4-7 Value of U.S. International Merchandise Trade by Coasts and Borders: 1951–2013



NOTES: The value of coal shipments through Mobile, AL; Charleston, SC; and Norfolk, VA are considered proprietary information and are consolidated. The total value of coal exports for the above three cities are included under the Atlantic Coast Customs District.

SOURCE: **1951-1970**: U.S. Department of Commerce, Census Bureau, *Historical Statistics of the United States, Colonial Times to 1970, Bicentennial Edition* (Washington, DC: 1975); **1971-1999**: U.S. Department of Commerce, Census Bureau, *Statistical Abstract of the United States* (Washington, DC: annual issues); **2000-2013**: U.S. Department of Commerce, Census Bureau, Foreign Trade Division, *FT920 - U.S. Merchandise Trade: Selected Highlights* (Washington, DC: annual issues). **Implicit GDP Deflator**: U.S. Department of Commerce, Bureau of Economic Analysis, *Current-Dollar and Real Gross Domestic Product*, available at www.bea.gov as of June 2014.

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CHAPTER 5

Transportation System Performance

System Performance Defined

As used here, system performance refers to how efficiently and reliably people and freight carriers can travel to destinations on the transportation network. This chapter focuses on measures that can be used to determine whether certain aspects of system performance, such as congestion and accessibility, are improving or declining over time. Other aspects of system performance, such as safety, energy usage, and environmental impacts, are discussed separately in other chapters.

System performance measures often are viewed from the perspectives of both the user and the operator. Users are interested in characteristics, such as travel cost, travel time, and the reliability of successfully completing a trip within a certain time, each of which directly affects their ability to accomplish a trip purpose. Owners and operators are concerned with the level of service provided to users and the ability to respond to service disruptions so as to promote reliable mobility and accessibility.

- The average annual delay per commuter rose from 32 hours in 1990 to 38 hours in 2011—a 19 percent increase. The total number of hours of delay experienced by all commuters across the Nation reached 5.5 billion hours in 2011—more than twice the 1990 total.
- Urban highway congestion cost the economy $121.2 billion in 2011, of which 22 percent, or $27 billion, was due to the effects of congestion on truck movements.
- On average in 2012, travelers in major metropolitan areas had to allow 40 percent more travel time to arrive on time 95 percent of the time.
- While roadway congestion is still worse than it was in 1990, significant progress has been made since 2007.
- In 2012 scheduled maintenance and unexpected delays at inland waterway locks resulted in more than 150 thousand hours of lock shutdowns to traffic. This level of service interruptions was almost twice the level in 2000.
- Almost 20 percent of domestic flights in 2013, or more than one million flights, arrived at the gate more than 15 minutes late. More than 10 percent, or 126 thousand, of those delayed flights, or 2 percent of all flights, arrived at the gate more than 2 hours late.

The U.S. Congress has recognized the importance of system performance by calling for performance-based decision making in MAP-21 (*Moving Ahead for Progress in the 21st Century Act*), signed into law by President Obama in July 2012 [Pub. L. 112–141].

As part of MAP-21, the U.S. Department of Transportation (USDOT) is required to establish performance measures and standards for several program/policy areas, including asset conditions on National Highway System (NHS) roads, safety, mobile source emissions, performance of interstate and noninterstate NHS roads, traffic congestion, and freight movement on the interstate system. These latter three categories—interstate/noninterstate NHS road performance, traffic congestion, and freight movement—relate most directly to the performance of the Nation's transportation system and are thus the focus of this chapter. MAP-21 also requires statewide and metropolitan transportation planning agencies to establish and use performance-based approaches for transportation decision making that support national goals (see box 5-A).

System Accessibility

System accessibility is defined as the ability of travelers and freight shippers and carriers to reach key destinations, such as hospitals, job sites, schools, factories, airports, ports, and community centers. The Nation's transportation infrastructure is comprised of over 4 million miles of roads, about 19,400 public and private use airports, 140,000 miles of freight and passenger railroads, and 25,000 miles of navigable waterways as shown in box

BOX 5-A MAP-21 Emphasis on Performance-Based Decision Making

"The statewide [metropolitan] transportation planning process shall provide for the establishment and use of a performance-based approach to transportation decision making to support the national goals…

- support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency;
- increase the safety of the transportation system for motorized and non-motorized users;
- increase the security of the transportation system for motorized and non-motorized users;
- increase the accessibility and mobility of people and for freight;
- protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development patterns;
- enhance the integration and connectivity of the transportation system, across and between modes, for people and freight;
- promote efficient system management and operation; and
- emphasize the preservation of the existing transportation system."

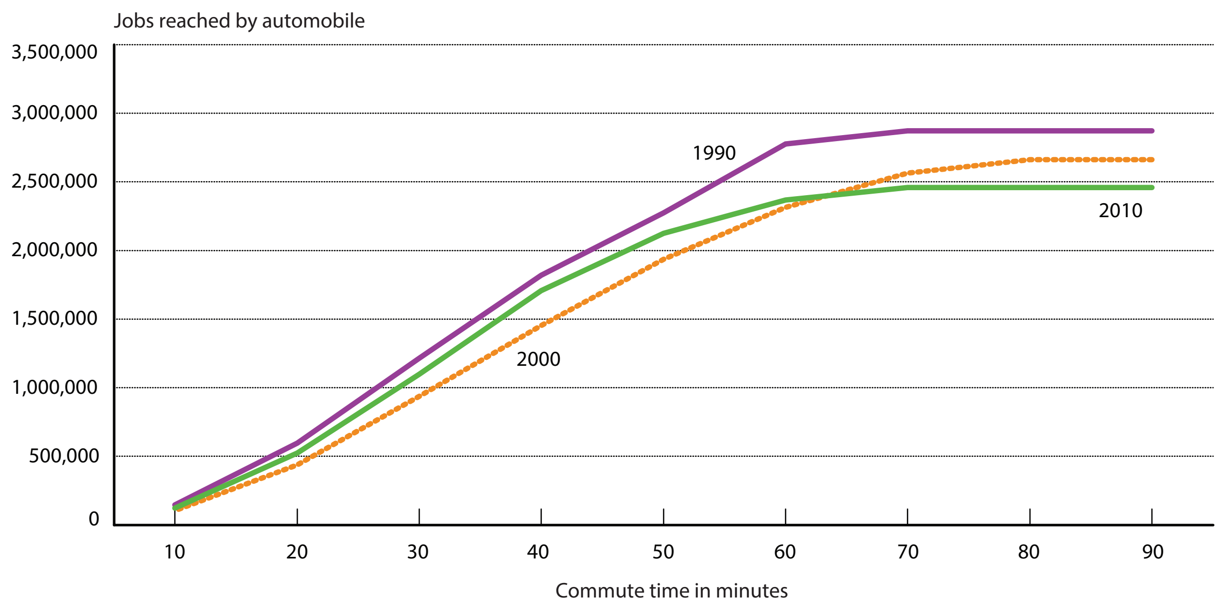
SOURCE: Pub. L. 112–141: *Moving Ahead for Progress in the 21st Century Act* (July 6, 2012). Available at http://www.gpo.gov/ as of December 2013.

1-A. In 2014 the U.S. transportation system served 316.1 million residents as well as millions of businesses and visitors [USDOC CENSUS 2014a]. In today's world, one can accomplish many objectives without ever traveling, such as electronic banking, shopping, and communications. This substitution effect for trip-making has in some cases reduced the number of trips made, but it might increase the number of trips in other categories, such as the number of truck deliveries in response to Internet shopping.

In evaluating system performance, it is important to know how accessibility has changed over time. The measure most often used is the number of destinations reachable within a given travel time, in particular transportation system accessibility to jobs.

The Center for Transportation Studies, at the University of Minnesota, has developed a method for comparing morning peak-period accessibility to jobs by automobile across 51 U.S. metropolitan areas for 1990, 2000, and 2010 [UMN CTS 2013]. Figure 5-1 shows how accessibility to jobs has changed from 1990 to 2010. In 1990, for example, 2 million jobs across 51 metropolitan areas were accessible in an average travel time of 43 minutes by automobile. A decade later, in 2000, the average travel time had increased to 52 minutes. But by 2010 that average travel time had dropped to 46 minutes as travel speeds increased (to about where they were in 1990) [UMN CTS 2013]. The crossing of the 2000 and 2010 lines in figure 5-1 most likely reflects the impact of the December 2007 through June 2009 recession and the subsequent

FIGURE 5-1 Number of Jobs Accessible by Commute Time: 1990, 2000, and 2010



SOURCE: Levinson, D. 2013. *Access Across America*, Center for Transportation Studies, University of Minnesota, *Access Across America*. CTS 13-20. Figure 3.1. Available at http://www.cts.umn.edu/Research/featured/access/ as of December 2013.

slow recovery, that is, not as many jobs were available for access.

The University of Minnesota study concluded that increases in absolute accessibility were found in large (Dallas, San Francisco, and Los Angeles) and smaller (Jacksonville, Las Vegas, and Phoenix) fast-growing metropolitan areas. Decreases in accessibility for the period of 1990 to 2010 tended to be found in older northeastern metropolitan areas that had minimal or negative job growth and faster-growing cities with major congestion problems. Changes in accessibility were attributed to changes in network speeds, network design, and employment density. It is important to emphasize that this accessibility measure focused only on trips by automobile; a complete accessibility measure would include accessibility from transit and other modes.

Congestion

The ability of transportation system users to reach a destination in a cost-effective, safe, and reliable manner is an important aspect of the Nation's transportation system. The characteristics of making such trips, including travel time, costs, and access to facilities/services, are used to indicate the level of mobility afforded to users. Box 5-B describes how system performance measures, such as travel time and congestion, are viewed from two different perspectives—the user's versus the operator's.

Road congestion in urban areas is one of the major causes for travel time delay. The Texas Transportation Institute has monitored congestion levels on the U.S. road network for decades and has reported in a biannual *Urban Mobility Report* on the number of hours of congestion experienced by network users and the associated economic costs [TAMU TTI 2013].

BOX 5-B System Performance User's v. Operator's Perspectives

From the user's standpoint, system performance is based on an individual trip. Travel time to work refers to the total number of minutes it normally takes a person to get from home to work each day, including time spent waiting for public transportation, picking up passengers in carpools, and on other activities related to getting to work [USDOC CENSUS 2014b]. In 2000 average travel time as measured by the decennial census was 25.5 minutes, which was an increase of 3.8 minutes (17.5 percent) from 21.7 minutes in 1980, and an increase of 3.1 minutes (13.8 percent) from 22.4 minutes in 1990 [USDOC CENSUS 2014b]. In 2012, based on the American Communities Survey, the average travel time stood at 25.7 minutes [USDOC CENSUS 2013].

From the operator's perspective, congestion can also be measured by the yearly hours of delay. Table 5-1 shows that annual delay per commuter has increased by 6 hours (18.8 percent from 32 hours in 1990 to 38 hours in 2011). This is extra time spent traveling at congested speeds rather than free-flow speeds by private vehicle drivers and passengers who typically travel in the peak periods [TAMU TTI 2013]. The Travel Time Index (TTI) is another important indicator for system operators and is discussed in detail in this chapter.

TABLE 5-1 Annual Congestion Delay and Costs: 1990, 1995, 2000, & 2005–2011

498 urban area

Year	Travel Time Index	Delay per commuter (hours)	Total delay (billion hours)	Fuel wasted (billion gallons)	Total cost (billion, 2011 U.S. Dollars)
1990	1.14	32.0	2.66	1.36	55.2
1995	1.16	35.4	3.42	1.78	71.0
2000	1.19	38.7	4.50	2.39	94.2
2005	1.23	43.1	5.91	3.17	98.2
2006	1.22	43.1	5.94	3.20	130.8
2007	1.22	42.0	5.88	3.23	131.2
2008	1.18	37.6	5.23	2.76	115.3
2009	1.18	37.6	5.43	2.81	120.0
2010	1.18	37.6	5.46	2.85	120.0
2011	1.18	38.0	5.52	2.88	121.2

NOTES: Includes 15 very large urban areas (population over 3 million), 32 large urban areas (population over 1 million but less than 3 million), 33 medium urban areas (population over 500,000 but less than 1 million), 21 small urban areas (population less than 500,000), and 397 other urban areas.

SOURCE: Texas A&M University, Texas Transportation Institute, *2012 Urban Mobility Report*, available at http://tti.tamu.edu/documents/mobility-report-2012.pdf as of October 2013.

Table 5-1 shows the estimates for annual hours of delay, the number of gallons of wasted fuel due to delay, the dollar value of delay and wasted fuel, and a measure called the Travel Time Index (TTI).[1] For example, a TTI value of 1.18 indicates that a 30 minute trip with congestion will take 18.0 percent longer or just over 35 minutes (1.18 × 30) in the peak period.

Road congestion, in terms of amount and cost, has increased since 1990, although the economic recession that began at the end of 2007 and ran through the middle of 2009 has had a dampening effect on what had been a steady increase. Congestion in the Nation's urban areas in 2011 had an economic cost of $121.2 billion compared to $55.2 billion in 1990 (2011 dollars). The average yearly delay per commuter rose from 32 hours in 1990 to 38 hours in 2011, a 19 percent increase, and the total national hours of delay in 2011 reached 5.5 billion hours—more than twice the 1990 total. The high points of congestion, however, were in 2005, 2006, and into 2007, just before the recession began. The effects of congestion on truck movements accounted for $27 billion (22 percent) of the congestion cost [TAMU TTI 2013]. In addition, the average commuter:

- wasted 19 gallons of fuel per week in 2011 (a week's worth of fuel for the average U.S. driver), up from 8 gallons in 1982;
- experienced an average of 52 hours of delay in 2011 in areas with over three million population; and

[1] The ratio of the travel time during the peak period to the time required to make the same trip at free-flow speeds.

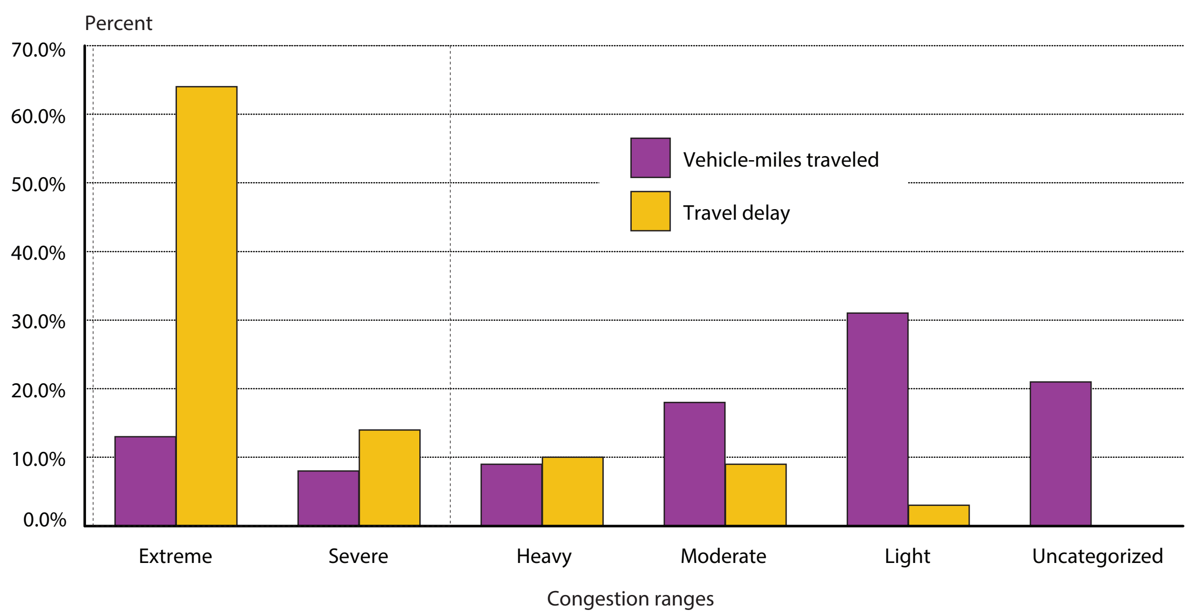
- planned for approximately 3 times as much travel time as in noncongested conditions to arrive at their destination ontime 9 times out of 10 [TAMU TTI 2013].

In all urban areas, the worst congestion levels (defined as "extreme," "severe," or "heavy") affected only one in nine trips in 1982, whereas this proportion increased to almost one in three trips in 2011. In addition, the most congested sections of road (labeled extreme and severe) handled only 21.0 percent of all urban road travel, but accounted for 78.0 percent of peak period delays as shown in figure 5-2. It is important to note that congestion levels have increased over the past 30 years in all urban areas, from the largest to the smallest. Congestion is worse in the afternoon, but it can occur at any time throughout the day (figure 5-3).

Congestion and delay are not limited to roadways. The average length of flight delays is over 50 minutes (table 5-2). Flight delays are caused by a variety of reasons, ranging from extreme weather to disruptions in airline carrier operations (figure 5-4). The combined effects of nonextreme weather conditions, airport operations, heavy traffic volume, and air traffic control contributed to 22.5 percent of delays in 2012, an 11 percentage point improvement from 2005. Flight delays can ripple through the U.S. aviation system as late arriving flights, for whatever reason, delay subsequent flights—the cause of 42.1 percent of delays for the next scheduled flights in 2013.

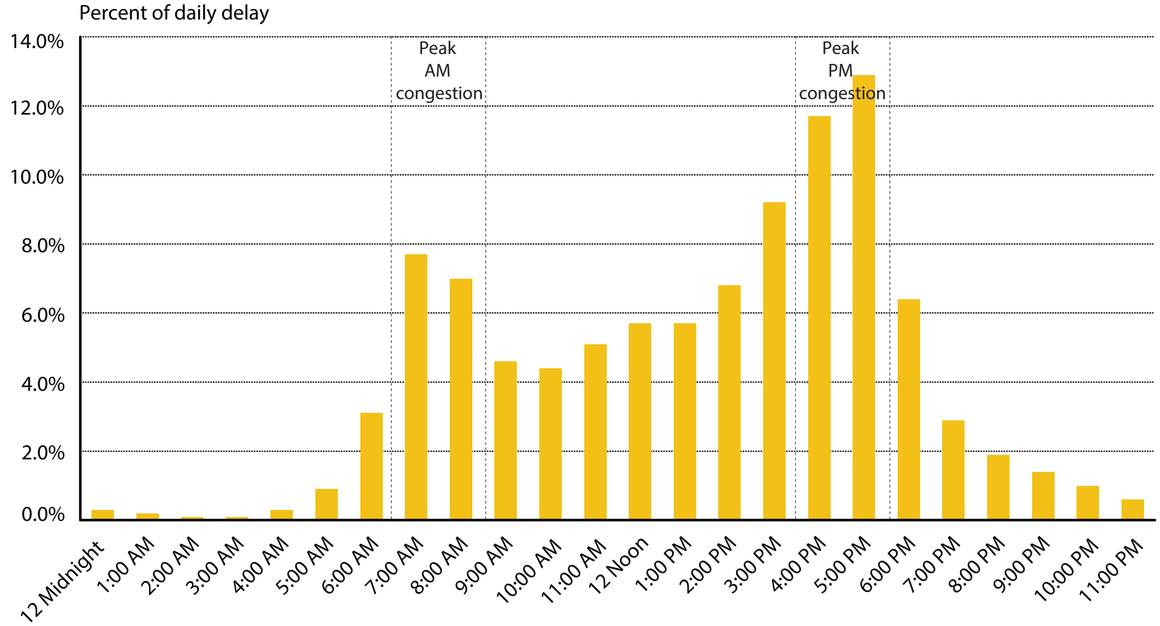
Congestion is especially a problem for time-sensitive freight shipments. Various performance indicators are used to monitor

FIGURE 5-2 Vehicle Travel and Travel Delays in Congestion Ranges: 2011



SOURCE: Texas A&M University, Texas Transportation Institute, *2012 Urban Mobility Report*, available at http://tti.tamu.edu/documents/mobility-report-2012.pdf as of October 2013.

FIGURE 5-3 Percent of Congestion by Time of Day: 2011



SOURCE: Texas A&M University, Texas Transportation Institute, *2012 Urban Mobility Report* (December 2012: full report with exhibits), Exhibit 5. Available at http://tti.tamu.edu/ as of October 2013.

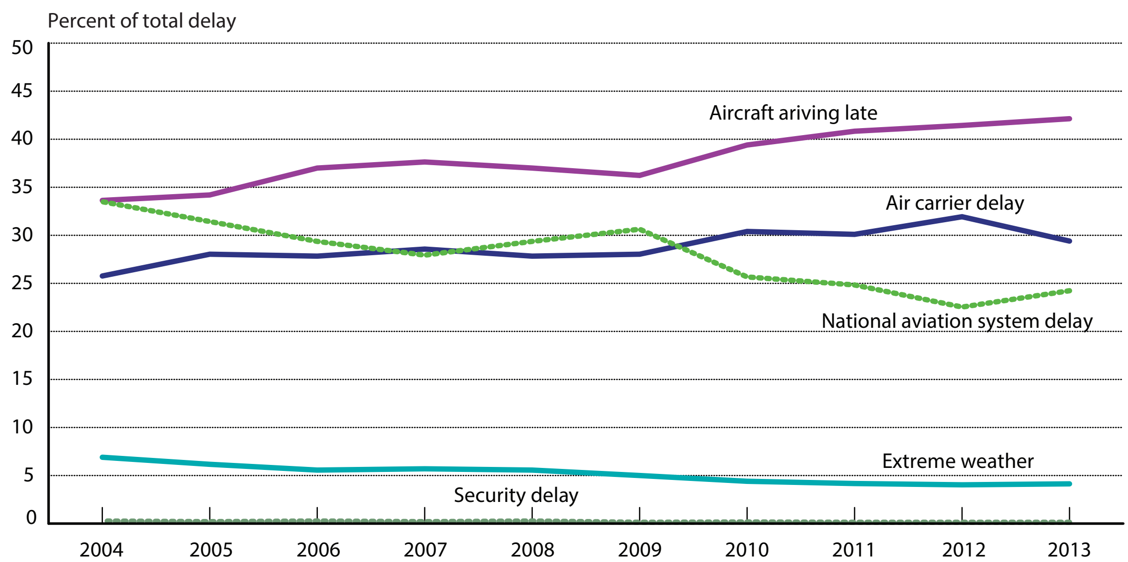
TABLE 5-2 Percentage of All Delayed Flights by Length of Time Delayed: 2004–2013

	Total number of arriving flights	Percentage of arriving flights, delayed	Average length of delay (minutes)	15-29 minutes	30-59 minutes	60-89 minutes	90-119 minutes	More than 120 minutes
2004	7,129,270	19.9	51	42.3	31.3	12.3	6.1	7.8
2005	7,140,596	20.5	52	41.8	31.1	12.4	6.2	8.1
2006	7,141,922	22.6	54	40.3	31.2	12.8	6.5	8.9
2007	7,455,458	24.1	56	39.1	31.0	13.1	6.9	9.7
2008	7,009,726	21.7	57	39.1	30.5	13.0	6.9	10.2
2009	6,450,285	18.8	54	40.7	30.7	12.7	6.6	9.0
2010	6,450,117	18.2	54	41.2	30.7	12.5	6.5	8.9
2011	6,085,281	18.2	56	40.4	30.1	12.8	6.8	9.7
2012	6,096,762	16.6	56	40.6	30.1	12.6	6.7	9.8
2013	6,369,482	19.9	56	39.7	30.4	12.7	6.8	10.1

NOTES: For the monthly number of carriers reporting, please refer to the *Air Travel Consumer Reports* available at http://airconsumer.dot.gov/reports/index.htm. A flight is considered delayed when it arrived *at the gate* 15 or more minutes later than scheduled. Arriving flights consists of scheduled operations less canceled and diverted flights. Average *length of delay* is calculated for delayed flights only. Percents may not add to 100 due to rounding.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Transtats Database, *Airline On-Time Performance*, available at http://www.transtats.bts.gov/ as of December 2013.

FIGURE 5-4 National Flight Delays by Cause, Percent of Total Delay Minutes: 2004–2013



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Transtats Database, *Airline On-Time Performance*, available at http://www.transtats.bts.gov/ as of February 2014.

time-related system performance. The USDOT's Federal Highway Administration (FHWA), in cooperation with the American Transportation Research Institute (ATRI), is working to quantify the impact of traffic congestion on truck-based freight at 250 specific locations. Similar to the TTI, the primary measure is the ratio of noncongested speed to congested speed at key freight locations (often interstate-to-interstate interchanges). For example, a 22.6 mph peak average speed and a 43.4 mph nonpeak average speed in Austin, TX, yields a ratio of 2.10. In 2012 some of the most congested truck bottlenecks on freight-heavy highways could be found in Austin, TX (2.10); Chicago, IL (1.87); Houston, TX (1.51); and Atlanta, GA (1.49) [USDOT FHWA and BTS 2013].

The inland water network is also a key component of the Nation's freight transportation system. The U.S. Army Corps of Engineers (Corps) is responsible for 239 lock chambers on the Nation's inland water system and monitors the movements of barges and other commercial vessels. In 2012 barge tows experienced on average a 2-hour delay navigating a lock, the largest delay since 2000 [USACE 2012]. The average age of locks under jurisdiction of the Corps is 50 years, and it is expected that delays will likely increase given the needed rehabilitation and reconstruction of key locks.

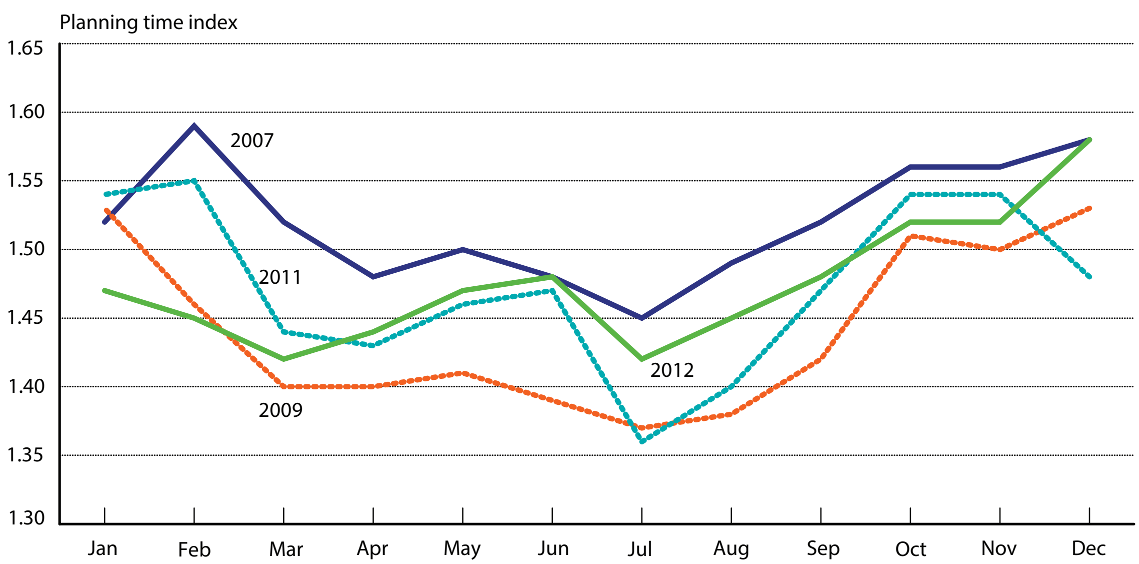
System Reliability

Reliability is defined as the level to which one can make trips with some certainty that the actual trip will occur within an expected range of travel times. More reliability means less uncertainty associated with trips, such as crashes, vehicle breakdowns, and similar incidents; work zones; unannounced road work; weather; and special events that can often lead to widely varying travel times from one day to the next for the same trip.

The Planning Time Index (PTI)[2] is used to estimate the extra time that one should plan for a trip. For example, a PTI of 1.5 means that a traveler wanting to arrive on time 19 out of 20 times should allow 50 percent more time. This means 30 extra minutes should be budgeted for a trip that in free flow conditions would typically take 60 minutes to arrive on time in 19 out of 20 times. The extra time allowed, in this example 30 minutes, is called the buffer index, which is often used to assess system reliability. Based on PTI data collected from 18 cities between 2007 and 2012, travelers would have to plan a minimum of about 40 percent more travel time to arrive "ontime" for 19 out of 20 trips. Significant progress was made to reduce roadway congestion from 2007 to 2012 (figure 5-5) [USDOT FHWA OPS 2013]. Figure 5-5 also shows the impact of weather on travel as the PTI was generally higher in winter than in summer months.

[2] The ratio of travel time on the worst day of the month compared to the time required to make the same trip at free-flow speeds.

FIGURE 5-5 Highway Reliability As Measured by the Planning Time Index in 18 Cities: January-December 2007, 2009, 2011, and 2012



NOTES: Multi-city average is weighted by vehicle-miles traveled in these respective cities: Boston, MA; Chicago, IL; Detroit, MI; Houston, TX; Los Angeles, CA; Minneapolis-St. Paul, MN; Oklahoma City, OK; Orange County, CA; Philadelphia, PA; Pittsburgh, PA; Portland, OR; Providence, RI; Riverside-San Bernardino, CA; Sacramento, CA; St. Louis, MO; Salt Lake City, UT; San Diego, CA; San Francisco, CA; and Tampa, FL. *Planning Time Index*-the ratio of travel time or the worst day of the month compared to the time required to make the same trip at free-flow speeds. A value of 1.8, for example, indicates a 20-minute free-flow trip requires 36 minutes during the worst peak period.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *Urban Congestion Report*, January 2013-March 2013 (FY 2013, Q2), available at http://www.ops.fhwa.dot.gov/perf_measurement/ucr/reports/fy2013_q2.htm as of November 2013.

For nonhighway modes, different measures can be used to assess system reliability. For passenger transportation, for example, ontime performance is often an indicator of service reliability. Amtrak experienced a significant improvement in ontime performance, with a record 83.0 percent ontime performance in 2012 [USDOT BTS NTS 2013], up from 68.6 percent in 2007 (table 5-3). Greater improvement in ontime performance is seen for trips over 400 miles in length, where ontime performance jumped from 39.5 percent in 2007 to 70.7 percent in 2012. The vast majority of passenger train services outside the Northeast Corridor are provided over tracks owned by and shared with the Class I freight railroads. As a result, Amtrak's ontime performance is largely dependent on the condition and performance of the host railroads, with the important exception of Amtrak-owned tracks in the Northeast Corridor.

U.S. airlines reported that nearly 20 percent of all domestic scheduled flights, or more than one million flights, arrived at the gate more than 15 minutes late in 2013. The average length of delay for late arriving flights was almost an hour. More than 10 percent, or nearly 126 thousand flights, arrived at the gate

TABLE 5-3 Amtrak On-Time Performance Trends and Hours of Delay by Cause: 2007–2012

	2007	2008	2009	2010	2011	2012
On-time performance, total percent (weighted)	68.6	71.2	80.4	79.7	78.1	83.0
Short distance (<400 miles), percent	72.2	73.6	81.0	80.3	79.8	84.5
Long distance (>=400 miles), percent	39.5	52.0	75.0	74.7	63.6	70.7
Hours of delay by cause, total[a]	**101,655**	**94,566**	**79,304**	**79,976**	**86,021**	**79,235**
Amtrak[b]	22,902	23,223	21,813	23,404	26,121	21,384
Host railroad[c]	72,565	64,724	46,842	44,090	48,707	46,564
Other[d]	6,187	6,618	10,648	12,482	11,192	11,286

[a] Amtrak changed its method for reporting delays in 2000. Therefore, the data for 2000 and following years are not comparable with prior years.

[b] Includes all delays that occur when operating on Amtrak owned tracks and all delays for equipment or engine failure, passenger handling, holding for connections, train servicing, and mail/baggage handling when on tracks of a host railroad.

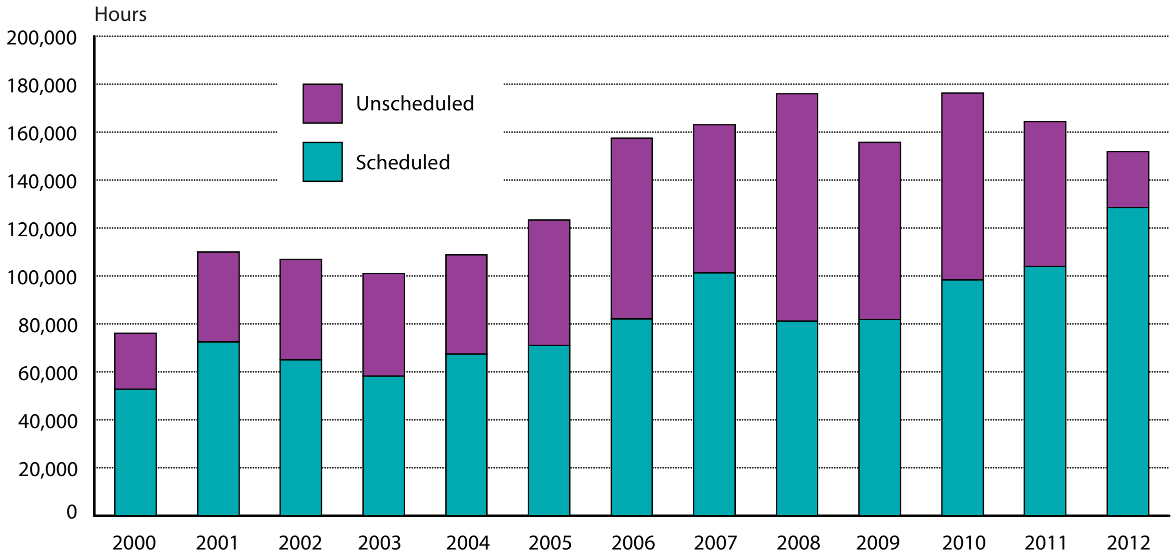
[c] Includes all operating delays not attributable to Amtrak when operating on tracks of a host railroad, such as track and signal related delays, power failures, freight and commuter train interference, routing delays, etc.

[d] Includes delays not attributable to Amtrak or other host railroads, such as customs and immigration, law enforcement action, weather, or waiting for scheduled departure time.

NOTES: Host railroad is a freight or commuter railroad over which Amtrak trains operate for all or part of their trip. Numbers may not add to totals due to rounding. All percentages are based on Amtrak's fiscal year (October 1–September 30). Amtrak trains are considered on time if arrival at the endpoint is within the minutes of scheduled arrival time as shown on the following chart. Trip length is based on the total distance traveled by that train from origin to destination:
Trip length (miles):
0–250
251–350
351–450
451–550
> 551

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics. *National Transportation Statistics*, Table 1-73. Available at http://www.bts.gov/ as of December 2013.

FIGURE 5-6 Total Number of Hours of Lock Closures: 2000–2012



SOURCE: U.S. Army Corps of Engineers, *Navigation Data Center, Lock Performance Monitoring System. Locks by Waterway, Locks Unavailability, Calendar Years 1993-2013* (February 19, 2014). Available at http://www.navigationdatacenter.us/ as of Februrary 2014.

more than 2 hours late (table 5-2). Between 2005 and 2012, late departures decreased from 17.9 (for all carriers and all airports) to 16.3 percent, while late arrivals declined from 20.5 to 16.6 percent [USDOT BTS NTS 2013].

For the U.S. Army Corps of Engineers inland waterway locks, system reliability can be measured as the percent of time a lock is unavailable for use (defined as the cumulative periods over a year during which a lock facility was unable to pass traffic). Locks could be unavailable for a number of reasons, ranging from scheduled maintenance, unexpected stoppages due to operational issues, and weather conditions such as flooding and ice. For example, high water levels and flows shut down 22 locks and stopped cargo movements along the Upper Mississippi River and its confluences in late April 2013 [USACE 2013]. As shown in figure 5-6, the total number of hours of unavailability in 2012 was more than 150 thousand, almost twice the level in 2000. Lock unavailability due to scheduled operations, such as maintenance, showed a marked increase, accounting for 84.7 percent of the total unavailable hours in 2012. As noted earlier, the increase is most likely due to the aging of the locks in the inland water system.

System Resiliency

Many parts of the Nation's transportation system are vulnerable to both natural and man-made disruptions. Because of this vulnerability, transportation firms and agencies have become interested in providing a system that is resilient to disruptive impacts. A resilient transportation system has design-level robustness so that it can withstand severe blows, respond appropriately to threats, and mitigate the consequences of threats through response and recovery operations [USDOT VOLPE 2013]. A resilient transportation system is one that can "take a punch" and recover in a timely way to provide the mobility and accessibility that are critical to the economy and to the quality of life of the Nation's citizens.

The United States has experienced extreme weather events throughout its history. However, with the heavy concentration of the Nation's population in urban areas (many along the coasts) and with a strong reliance on the efficient movement of people and goods, recent weather events have resulted in extensive economic and community costs. For example, the U.S. Department of Commerce (USDOC), National Oceanic and Atmospheric Administration (NOAA) estimated that the United States has experienced 151 weather/climate disasters since 1980, including such events as hurricanes, tornadoes, floods, and droughts/wildfires. The overall damage from each of these events exceeded $1 billion, resulting in more than a $1 trillion cumulative cost to the Nation [USDOC NOAA 2013a]. The year 2012 was the second most costly since 1980 with over $110 billion in damages and 377 deaths due to extreme weather events (dollar wise, the most costly year was 2005 with over $160 billion in damages) [USDOC NOAA 2013b]. Part of the physical recovery costs and overall economic impact were due to the damage and disruption to the transportation system.

Hurricane Sandy and Tropical Storm Irene are two recent examples of extreme weather events that disrupted the transportation system. Hurricane Sandy caused extensive damage in October 2012 along the New Jersey, New York, and Connecticut coasts and record flooding in lower Manhattan. Roads and bridges were damaged throughout the region, and road and rail tunnels were flooded. The region's major airports were closed, and transit service was not restored in many areas until several months after the storm [KAUFMAN, QING, LEVENSON and HANSON 2012].

Tropical Storm Irene, the remnants of what had been Hurricane Irene that hit the U.S. East Coast in 2011, inundated Vermont with high levels of rainfall. Over 225 communities were affected by the storm. Massive flooding closed 146 segments of the state road system with over 200 bridges damaged (34 closed completely), resulting in a repair cost of between $175 million to $200 million. An additional 2,260 municipal road segments and 963 culverts were damaged, with 175 road segments and 90 bridges closed. Moreover, 200 miles of state-owned rail track required repair [USDOC EDA 2012].

Although the New Jersey/New York/Connecticut and Vermont regions suffered huge losses during their respective storms, one of the key lessons from each event was the importance of transportation system resilience. Major transportation facilities—roads, bridges, transit systems, ports, and airports—were in operation within weeks of the hurricane. In most cases, advanced preparations by state and local government agencies (e.g., moving transit vehicles out of vulnerable areas and establishing emergency management centers) can mitigate disruption to transportation systems [MTA 2012]. The existence of redundant paths in the New Jersey/New York/Connecticut and Vermont transportation network provided travel options for both person and freight trips seeking to avoid travel blockages. In both cases, the transportation agencies were able to put the transportation system back into operation in a very short period of time, thus minimizing the economic impact to state and regional economies.

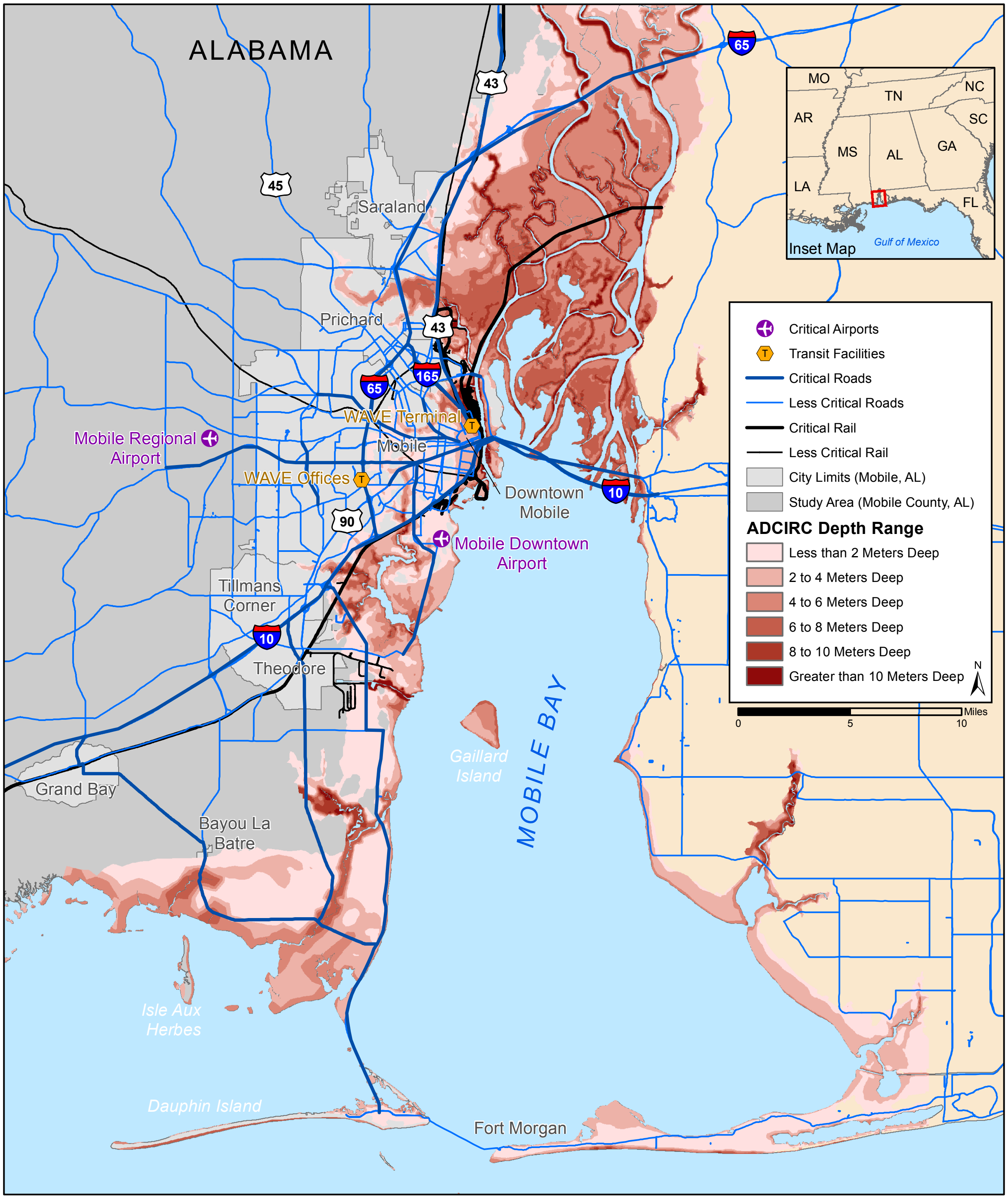
There are economic and other costs associated with such major disruptions, including those resulting from extreme weather events, infrastructure repair, and loss in productivity. For example, the economic impact to New Jersey and New York resulting from Hurricane Sandy was estimated at $63 billion, although some studies have suggested that the impact was less given the economic rebound associated with the recovery from the hurricane [RUTGERS UNIVERSITY 2013]. This cost included the estimated expenditures to replace the roads, bridges, and transit facilities damaged by the storm.

A Washington State DOT study of the economic impact of massive floods that closed I-5 and I-90 during the winter of 2007–2008 estimated a combined cost of almost $75 million, of which some $47 million was associated with the I-5 disruption [PSRC 2008]. The analysis was based on revenue losses incurred by firms that could not deliver products to or receive orders from customers and on additional business costs incurred by both the trucking industry and freight dependent sectors because of delays, detours, and the use of alternative modes of delivery. The additional cost of taking the detours was estimated to be between $500 and $850 per truckload. The Washington State DOT estimated the loss of more than $3.8 million in tax revenues and 460 jobs. In addition to the above business losses, estimated highway damage from the winter storm totaled $18 million for state routes and another $39 million for city and county roads [WSDOT 2008]. The U.S. Department of Transportation, in 2014, projected the potential impacts of changing climatic conditions and associated infrastructure costs on Mobile, AL. Figure 5-7 shows the likely inundation levels in the Mobile region and the critical transportation facilities that would be affected with a Hurricane Katrina-like storm on top of a 0.8 yard (0.75 meter) sea level rise. The areas in various shades of red indicate the water-level elevation over current dry land and the location of critical transportation facilities. As can be seen, a significant amount of the Mobile region would be inundated, along with several key transportation facilities. There is a significant concentration of fuel ports and terminals such as the Louisiana Offshore Oil Port and 33 refineries along gulf coast. Many of these ports and terminals are connected to an aging network of oil and gas pipelines, half of which were built 50 to 60 years ago, that are susceptible to floods and wind damage [USDOT FHWA 2014].

Security Concerns

The Transportation Security Administration (TSA) of the U.S. Department of Homeland Security screens people as they pass through

FIGURE 5-7 Potential Sea Level Rise Impacts on Transportation Infrastructure and Systems in Mobile, AL



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics based upon data provided by the U.S. Department of Transportation, Federal Highway Administration. *Gulf Coast Study*. Available at http://www.fhwa.dot.gov/ as of February 2014.

security checkpoints at 450 airports with Federal screening and other passenger facilities. The TSA confiscated approximately 50 million prohibited items, such as sharp objects, firearms, tools, explosive and flammable material, volatile chemicals, and other dangerous items, over the past decade. In 2011 alone, the TSA prevented more than 1,200 guns from being brought onto passenger aircraft [USDHS TSA 2012].

International piracy incidents and armed robberies at sea are another security concern affecting U.S. citizens traveling overseas, especially in the waters surrounding the horn of Africa. This area has been monitored closely, especially after the hijacking of the U.S.-flagged *Maersk Alabama* on April 8, 2009. In 2013 there were 9 vessels fired upon/attempted boarding in East African waters compared to 7 vessels hijacked, 1 boarding, and 24 vessels fired upon/attempted boarding in 2012 [USN ONI 2014].

Cost Associated With Poor System Performance

The following discussion focuses on the economic costs associated with poor transportation system performance, costs associated with system disruptions, and expected benefits from strategies that will improve system performance.

The *Urban Mobility Report* includes an estimate of the cost to system users of about $121 billion in delay and fuel wasted in congestion costs in 2011. The report also estimated the beneficial effects of public transportation and roadway operational improvements to these costs. For public transportation, the analysis examined what would happen if transit services were eliminated in the 498 urban areas that were part of the study. The additional system cost (or the cost foregone given transit service) is thus considered the benefit of transit investment. For 2011 the benefit includes 865 million hours of delay eliminated and 450 million gallons of fuel saved, resulting in an estimated $20.8 billion in cost savings [TAMU TTI 2013]. For road operational improvements, the report estimated 364 million hours of delay eliminated and 194 million gallons of fuel saved, resulting in an estimated $8.5 billion in cost savings [TAMU TTI 2013].

With respect to businesses, three critical aspects of operations can be affected directly by congestion:

1. direct travel (user) cost, including vehicle operating costs and value of time for drivers and passengers, for all business-related travel;
2. logistics and scheduling costs, including costs of stocking, perishability, and just-in-time processing; and
3. market accessibility and scale, including loss of market-scale economies and reduced access to specialized labor and materials because of congestion.

With a new emphasis on performance-based decision making from MAP-21, it is likely that state transportation planning agencies throughout the Nation will be collecting more data on system performance. This data, and the information it produces, could be useful to decision makers in identifying targeted opportunities for improving transportation system performance, with its attendant economic and quality of life benefits.

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CHAPTER 6

Transportation Economics

The Nation's transportation system makes possible the efficient movement of both people and goods throughout the country and internationally. As discussed in chapter 1, transportation assets, totaling $7.7 trillion in 2012, are a major underpinning of the Nation's wealth and prosperity. Besides facilitating activity in all segments of the economy, the for-hire transportation sector (services for which one pays a fee or buys a ticket) directly employs over 4.4 million people (in 2012), generates revenues through taxes and user fees through their payments for fuel, and invests in infrastructure and equipment needed to move people and goods. Beyond its contribution toward the development of the U.S. gross domestic product (GDP), transportation is also an important element in both household and government budgets. The average household spends about $9,000 per year on transportation, while the government spends about $800 per capita on transportation expenditures.

- Personal, business, and government purchases of transportation goods and services accounted for nearly 8.6 percent of U.S. Gross Domestic Product in 2012.
- Transportation and related sectors employed over 11.7 million workers in 2012, representing 8.8 percent of the Nation's labor force.
- American households spent, on average, nearly $9,000 per year on transportation in 2012, representing 17.5 percent of household expenditures. Transportation expenditure is the second largest household spending category, next to housing.
- In total, the public and private sectors spent $119 billion on transportation construction in 2012, two-thirds of which was on highway infrastructure.
- The transportation revenues of Federal, state, and local governments totaled $156 billion in 2009, while government transportation expenditures totaled $243 billion—a deficit of $87 billion, up from $50 billion in 1995.

Transportation and U.S. Gross Domestic Product

Transportation is both a part of the economic output of the economy and a contributor to that economic output. The Nation's economic output, measured as U.S. GDP by the Bureau of Economic Analysis, included nearly $1.3 trillion in personal consumption, private domestic investment, government purchases, and exports related to transportation goods and services in 2012 (measured in chained 2009 dollars). After subtracting $394 billion in transportation-related imports, transportation accounted for 8.6 percent of U.S. GDP (table 6-1).

When the effects of inflation are removed, spending on transportation in 2012 as a part of final demand has almost fully recovered from the economic recession, which began in December 2007 and continued through June 2009 [NBER 2013]. Many of these changes are due to personal consumption of transportation and private domestic investment

TABLE 6-1 U.S. Gross Domestic Product (GDP) Attributed to Transportation-Related Final Demand: 2000, 2007–2012

Billions of chained 2009 dollars

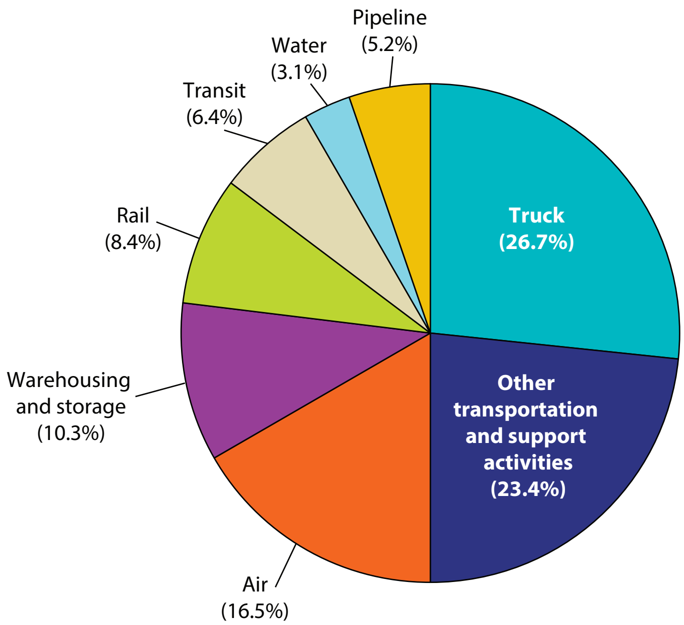
	2000	2007	2008	2009	2010	2011	2012
Gross Domestic Product	$12,565	$14,877	$14,834	$14,418	$14,779	$15,052	$15,471
Total transportation in GDP (percent)	10.6%	9.3%	8.7%	8.4%	8.4%	8.6%	8.6%
Total transportation-related final demand	**$1,332**	**$1,388**	**$1,295**	**$1,208**	**$1,239**	**$1,288**	**$1,331**
Personal consumption of transportation, total	**$945**	**$1,005**	**$925**	**$867**	**$870**	**$889**	**$916**
Motor vehicles and parts	$346	$393	$341	$317	$323	$339	$364
Motor vehicle fuels, lubricants, and fluids	$266	$273	$262	$260	$260	$255	$254
Transportation services	$333	$339	$321	$290	$287	$294	$298
Gross private domestic investment, total	**$213**	**$213**	**$167**	**$80**	**$147**	**$190**	**$232**
Transportation structures	$9	$9	$10	$9	$10	$9	$11
Transportation equipment	$204	$204	$157	$71	$137	$181	$221
Exports (+), total	**$218**	**$270**	**$269**	**$219**	**$248**	**$273**	**$295**
Imports (-), total	**$328**	**$391**	**$355**	**$258**	**$326**	**$353**	**$394**
Net exports of transportation-related goods and services	-$109	-$121	-$86	-$39	-$79	-$81	-$99
Government transportation-related purchases, total	**$283**	**$291**	**$290**	**$300**	**$300**	**$289**	**$283**
Federal purchases	$25	$35	$38	$39	$40	$41	$42
State and local purchases	$246	$236	$233	$239	$236	$226	$225
Defense-related purchases	$12	$21	$20	$23	$24	$21	$16

NOTES: *Total transportation-related final demand* is the sum of total Personal consumption of transportation, total Gross private domestic investment, Net exports of transportation-related goods and services and total Government transportation-related purchases. *Net exports* is exports minus Imports. *Federal purchases* and *State and local purchases* are the sum of consumption expenditures and gross investment. *Defense-related purchases* are the sum of transportation of material and travel. The Bureau Economic Analysis has changed the reference year for chained dollar estimates from 1999 onward as part of the comprehensive revision of the national income and product accounts in 2014. Chained 2005 dollars estimates for earlier years can be found in the 2013 edition of NTS, table 3-4.

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts Tables, tables 1.1.6, 2.3.6, 2.4.6, 3.11.6, 3.15.6, 4.2.6, 5.4.6, and 5.5.6, available at http://www.bea.gov/ as of March 11, 2014 as reported in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, table 3-4, available at http://www.bts.gov/ as of August 2014.

FIGURE 6-1 Percent of For-Hire Transportation Services Contribution to U.S. Gross Domestic Product: 2012

Total for-hire transportation = $471.6 billion



SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, Industry Economic Accounts, as cited in the U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, table 3-1, available at http://www.bts.gov/ as of August 2014.

in transportation equipment, both of which suffered significant declines during the recent recession. While personal consumption has not completely rebounded, private domestic investment has nearly doubled since bottoming out in 2009 (table 6-1).

Transportation is also a contributor to economic output, making possible the production and sale of nearly everything made in the Nation. For-hire transportation contributes $472 billion (3.0 percent) to U.S. GDP when the goods and services consumed by for-hire transportation are netted out to avoid double counting. Of this contribution, 26.7 percent is made by for-hire trucking, with the next largest modal share (16.5 percent) coming from commercial aviation (figure 6-1).

Many nontransportation industries provide transportation services for their own use, called in-house transportation (e.g., trucks operated by grocery chains). The contribution of in-house transportation services to the economy had not been separately broken out until the Transportation Satellite Accounts were developed jointly by the Bureau of Transportation Statistics (BTS) and the Bureau of Economic Analysis (BEA) in 1997. In 2006, the latest year for which estimates are available, in-house transportation accounted for nearly half (45 percent) of the total value added by both for-hire and in-house transportation services in the trucking, rail, water, and air modes to the U.S. economy [USDOT BTS 2011]. Applying this ratio to 2012 data, the total value of in-house plus for-hire transportation for all modes is estimated at $588 billion for 2012, compared to $514 billion for 2006.

Transportation and Trade

An efficient and reliable domestic transportation system with good connections to the international transportation network allows U.S. businesses to compete for customers in the global marketplace and to connect domestic manufacturers with distant sources of raw materials and other inputs to produce goods.

The transportation industry moves trade goods and provides international transportation services. U.S.-international trade grew faster than the economy as a whole. Between 2000 and 2010, the real value of U.S- international trade increased by 47.1 percent and GDP increased by 22.4 percent, while at the same time the real value of household income decreased by 8.9 percent. As a share of GDP, U.S. merchandise trade in terms of current dollars, which includes goods but not services, grew from about 19.6 percent in 2000 to 23.9 percent in 2012 [USDOC BEA NIPA 2014, USDOC CENSUS 2012, FTD 2013 and Annual Issues]. Canada, China, and Mexico are the top trading partners in merchandise trade for the United States, as discussed in chapter 4.

The growth in international trade is driven, in large part, by U.S. demand for imported goods. Since the 1970s, the United States has annually imported more goods than it has exported. In 2012 the goods deficit was $741 billion, while services had a surplus of $204 billion, which was the highest on record [USDOC CENSUS FTD 2014]. In 2012 the U.S. imported $415 billion worth of petroleum products compared to only $124 billion in U.S. exports. Also the imports of automobiles ($282 billion) outpaced automobile exports ($141 billion) in 2012 [USDOC CENSUS FTD Annual Issues].

Transportation-Related Employment and Productivity

Beyond the direct and indirect value provided by the transportation sector, it is a significant employer in the United States. In 2012 about 4.4 million people worked in for-hire transportation and warehousing, with trucking accounting for 30.6 percent of that total (table 6-2). The total transportation-related labor force decreased 15.6 percent between 2000 and 2012 [USDOL BLS CES 2014]. The employment decline in the air and truck transportation industries is due partly to productivity improvements (figure 6-2). Mergers and discontinuance of unprofitable routes and services contributed to the airline industry's productivity improvement.

Employment in transportation is not limited to transportation service providers and warehousing. Millions more work in vehicle sales and repairs, vehicle and equipment manufacturing, and a host of other businesses with transportation-related functions [USDOL BLS OES 2014]. Including jobs from these

TABLE 6-2 Employment in For-Hire Transportation and Selected Transportation-Related Industries: 2000, 2007–2012

Thousands

Industry	2000	2007	2008	2009	2010	2011	2012
TOTAL U.S. labor force	**131,881**	**137,645**	**136,852**	**130,876**	**129,917**	**131,497**	**133,739**
	10.5%	9.8%	9.7%	9.3%	9.3%	9.4%	8.8%
Total transportation-related labor force	**13,907**	**13,516**	**13,212**	**12,234**	**12,086**	**12,305**	**11,734**
Transportation and warehousing	4,410	4,541	4,508	4,236	4,191	4,302	4,415
Air transportation	614	492	491	463	458	457	458
Rail transportation	232	234	231	218	216	228	230
Water transportation	56	66	67	63	62	61	63
Truck transportation	1,406	1,439	1,389	1,268	1,250	1,301	1,351
Transit and ground passenger transportation	372	412	423	422	430	440	448
Pipeline transportation	46	40	42	43	42	43	44
Scenic and sightseeing transportation	28	29	28	28	27	28	27
Support activities for transportation	537	584	592	549	543	562	578
Couriers and messengers	605	581	573	546	528	529	533
Warehousing and storage	514	665	672	637	633	653	682
Transportation related manufacturing	2,180	1,826	1,725	1,463	1,447	1,493	1,569
Petroleum and coal products manufacturing	123	115	117	115	114	112	113
Transportation equipment manufacturing	2,057	1,712	1,608	1,348	1,333	1,382	1,456
Other transportation related industries	2,783	2,770	2,674	2,463	2,449	2,522	2,573
Motor vehicle parts dealers	1,847	1,908	1,831	1,638	1,629	1,691	1,732
Gasoline stations	936	862	842	826	819	831	841
Postal service	880	769	747	703	659	631	611
Government employment, total	873	890	895	902	911	892	U
U.S. DOT	64	54	56	58	58	58	57
State and local	809	835	839	845	853	834	U

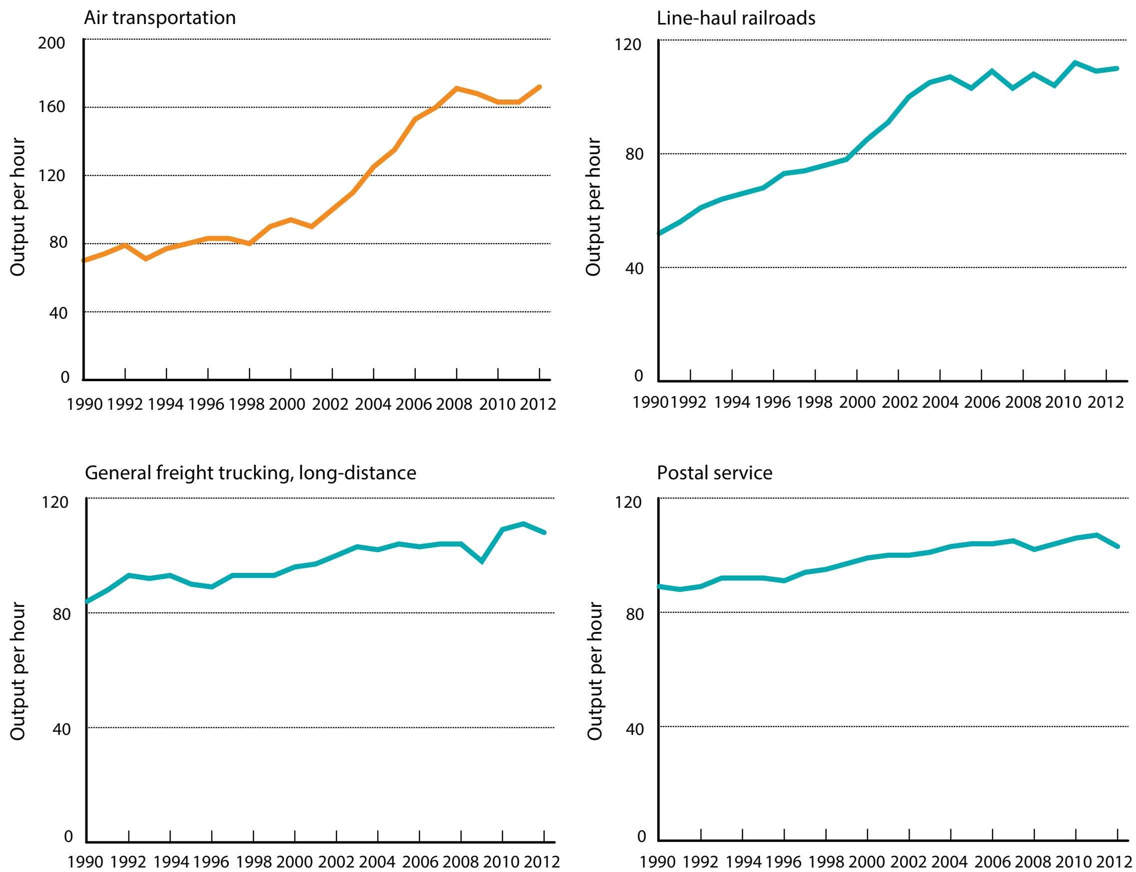
KEY: U = unavailable.

NOTES: *Totals* are annual averages. *For-Hire Transportation and warehousing* includes transportation equipment; petroleum products; tires; rubber; plastics; search, detection, navigation, guidance, aeronautical, and nautical systems; and instrument manufacturing. Fiscal year data. *Government employment* includes USDOT and state and local personnel. State and local component of government employment includes highway, air, transit, and water modes. Details may not add to totals due to independent rounding.

SOURCES: U.S. Department of Labor, Bureau of Labor Statistics; U.S. Census Bureau; and U.S. Department of Transportation, as cited in the U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, table 3-23, available at http://www.bts.gov as of August 2014.

FIGURE 6-2 Labor Productivity Indices for Selected Transportation Industries: 1990–2012

Index, 2002 = 100



NOTES: Graphs with identical scales have same color trendlines. Bureau of Labor Statistics developed labor productivity indexes for all manufacturing and retail trade of the North American Industry Classification System (NAICS) industries as well as selected mining, transportation, communications and services industries. Data in this table are not comparable to the data published in previous editions of the report due to change in base year of the index from 1997 to 2002.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Industry Productivity and Costs, available at http://www.bls.gov/lpc/ as of August 2014.

various industries, transportation-related employment accounted for about 8.8 percent of the U.S. labor force in 2012, down from 10.5 percent in 2000 (see table 6-2).

Workers in transportation occupations are also found in other industries. In 2012 there were approximately 2.9 million people employed as truck drivers in the United States, many of them working for companies whose business focus is nontransportation related, but nevertheless rely on transportation to function, such as grocery chains with in-house truck fleets (table 6-3).

Productivity, measured by output per hour worked, is an important indicator of economic growth and health. Improvements in productivity

TABLE 6-3 Employment in Selected Freight Transportation and Freight Transportation-Related Occupations: 2000, 2007–2012

Thousands

Occupation (SOC code)	2000	2007	2008	2009	2010	2011	2012
Vehicle operators, pipeline operators, and primary support	**3,158**	**3,202**	**3,159**	**2,956**	**2,818**	**2,871**	**2,922**
Driver/sales worker (53-3031)	374	382	373	363	372	388	394
Truck drivers, heavy and tractor-trailer (53-3032)	1,577	1,694	1,673	1,551	1,467	1,509	1,557
Truck drivers, light or delivery services (53-3033)	1,033	923	909	835	780	771	769
Locomotive engineers (53-4011)	29	42	43	44	41	39	37
Rail yard engineers, dinkey operators, and hostlers (53-4013)	4	5	5	5	6	5	5
Railroad brake, signal, and switch operators (53-4021)	17	23	25	24	23	24	24
Railroad conductors and yardmasters (53-4031)	40	38	40	42	43	44	43
Sailors and marine oilers (53-5011)	30	33	32	32	32	31	32
Captains, mates, and pilots of water vessels (53-5021)	21	31	31	30	29	30	31
Ship engineers (53-5031)	7	14	11	11	9	10	11
Bridge and lock tenders (53-6011)	5	5	4	4	3	3	3
Gas compressor and gas pumping station operators (53-7071)	7	4	4	4	4	4	4
Pump operators, except wellhead pumpers (53-7072)	14	10	9	10	9	12	12
Transportation equipment manufacturing and maintenance occupations	**269**	**286**	**269**	**254**	**242**	**242**	**230**
Bus and truck mechanics and diesel engine specialists (49-3031)	259	250	249	233	223	223	19
Rail car repairers (49-3043)	11		21	21	19	19	17
Transportation infrastructure construction and maintenance occupations	**19**	**22**	**24**	**23**	**25**	**25**	**27**
Rail-track laying and maintenance equipment operators (47-4061)	10	14	15	15	16	16	17
Signal and track switch repairers (49-9097)	6	6	7	6	7	8	9
Dredge operators (53-7031)	3	2	2	2	2	2	2
Secondary support service occupations	**1,431**	**1,333**	**1,346**	**1,275**	**1,228**	**1,221**	**1,218**
Dispatchers, except police, fire, and ambulance (43-5032)	167	190	193	185	181	182	185
Postal service mail carriers (43-5052)	355	348	355	339	325	315	305
Shipping, receiving, and traffic clerks (43-5071)	865	756	761	715	688	688	691
Transportation inspectors (53-6051)	27	24	25	24	24	25	24
Tank car, truck, and ship loaders (53-7121)	17	15	12	12	10	11	12

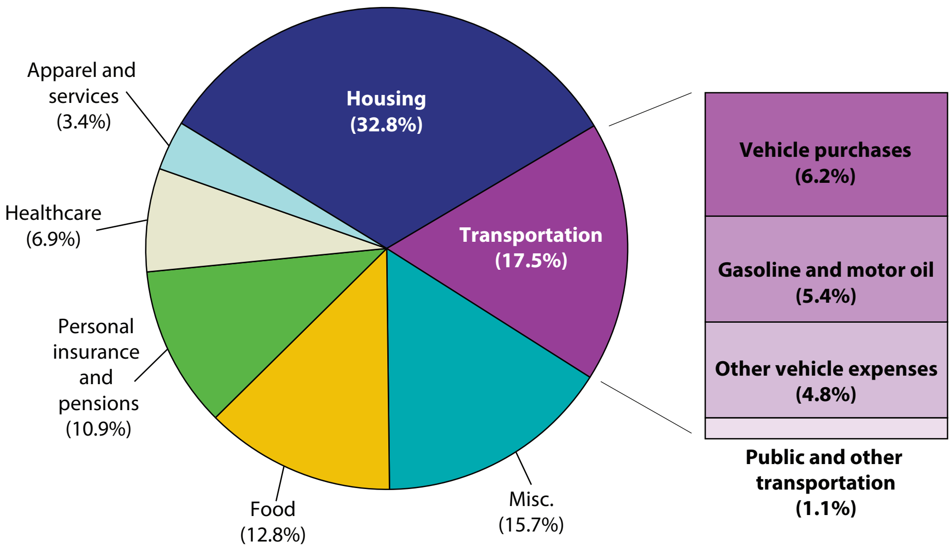
KEY: *SOC* = Standard Occupational Classification.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, *Occupational Employment and Wages*, available at http://www.bls.gov/oes/ as of August 2014.

helps the United States maintain its international competitiveness despite high wages, fuel costs, and other transportation expenditures. Although labor productivity for the transportation sector as a whole is not available, the Bureau of Labor Statistics (BLS) reports labor productivity for several for-hire transportation industries: air, line-haul railroads, general (long distance) freight trucking, and postal services (figure 6-2). Air transportation and line-haul railroads increased productivity by 82.7 and 29.6 percent, respectively, between 2000 and 2012 through divestiture of unprofitable lines and other efficiency improvements. Air carriers improved productivity, as measured by the number of available seat-miles flown per gallon of fuel, and

FIGURE 6-3 Average Household Expenditures by Major Spending Category: 2012

Percent of average annual household expenses



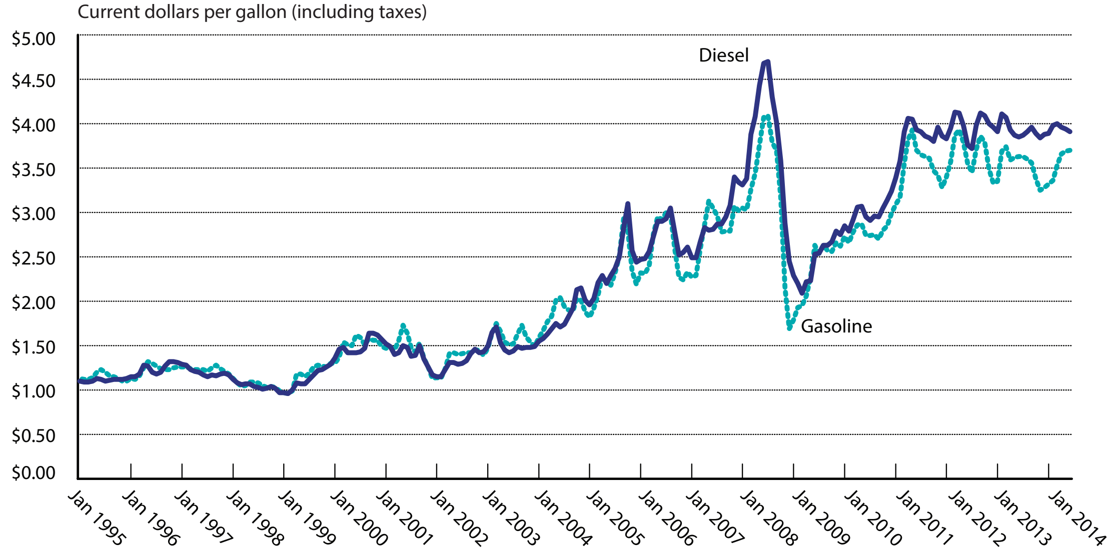
Category	Dollars	Percent
Housing	$16,887	32.8
Transportation	$8,998	17.5
Vehicle purchases	$3,210	
Gasoline and motor oil	$2,756	
Other vehicle expenses	$2,490	
Public and other transportation	$542	
Misc. [a]	$8,075	15.7
Food	$6,599	12.8
Personal insurance and pensions	$5,591	10.9
Healthcare	$3,556	6.9
Apparel and services	$1,736	3.4
Total	**$51,442**	

[a]Includes alcoholic beverages, cash contributions, education, entertainment, personal care products and services, reading, tobacco products and smoking supplies, and other items.

NOTE: Percents may not add to 100 due to rounding.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, *Consumer Expenditure Survey*, available at www.bls.gov/cex as of August 2014.

FIGURE 6-4 Gasoline and Diesel Retail Prices: January 1995–June 2014



NOTES: *Gasoline* includes Unleaded Regular Gasoline, U.S. City Average Retail Price. *Diesel* includes On-Highway Diesel Fuel Price.

SOURCE: U.S. Department of Energy, Energy Information Agency, *Retail Motor Gasoline and On-Highway Diesel Fuel Prices*, available at http://www.eia.gov/totalenergy/data/monthly/#prices as of August 2014.

fuel efficiency, as measured by the number of gallons consumed per block hour [USDOT BTS 2012b]. Over the same period, postal service productivity improved by 3.7 percent and general freight trucking by 13.2 percent. The relatively low increase for freight trucking may be due to increasing quality-of-service demands by shippers and the public. In comparison, overall business sector productivity increased by 30.5 percent [USDOL BLS LPC 2014].

Household Expenditures on Transportation

In 2012 the average household expenditure on transportation was nearly $9,000. This translates to almost 17.5 percent of average household expenditures, second only to housing—about $17,000 per year (figure 6-3). The majority of household transportation expenditures went to the purchase and upkeep of vehicles (94.0 percent), including the cost of gasoline. Some portion of these expenditures represents consumer costs that could be avoided if there were reductions in congestion. Spending on all modes of for-hire and public transportation accounted for the remaining 6.0 percent of household transportation spending in 2012. Airline fares were the largest purchased transportation expenditure (among those who fly), followed by mass transit, a distant second [USDOT BTS NTS 2014]. However, only about one-third of all individuals fly in a one-year period.

On average, rural households spent more on transportation ($9,775) than urban households

($8,804) in 2012. This difference is mostly driven by greater expenditures on motor vehicles and gasoline in rural areas. Gasoline and motor oil expenditures were 29.1 percent higher for rural households. Urban households spent about twice as much on public transportation as did their rural counterparts [USDOL BLS CEX 2014].

In 2011 the Bureau of Labor Statistics' Consumer Expenditure Survey estimated that transportation expenditures accounted for 44.0 percent (about $603) of the $1,372 in total annual consumer expenditures on travel for pleasure. These transportation expenditures show the effect of the economic recession ($538 in 2005, $643 in 2007, $543 in 2009) and subsequent recovery (rising to $570 in 2010 and to $603 in 2011). Airfares accounted for 24.9 percent and "other transportation," including recreational vehicles, accounted for 19.1 percent. Pleasure-related transportation expenditures (excluding business-related travel) included an average of $342 on airfares; $62 on bus, train, and ship fares; $141 on gasoline and motor oil; and $23 for car and truck rental in 2011 [PAULIN 2012].

After generally holding steady in the late 1990s, the annual average prices of gasoline and diesel increased 133.5 and 163.0 percent, respectively, since 2000. As shown in figure 6-4, prices increased from $1.30/gallon for regular gasoline in January 2000 to a monthly average price of $3.70/gallon in 2012 [USDOE EIA 2014].

At the national level, the Bureau of Labor Statistics estimates a consumer price index for urban consumers (CPI-U) that represents the average change in the price of a bundle of market goods at any particular point in time. Transportation costs are part of the CPI-U calculation and represent the second most important contributor after housing costs. Since 2001 the CPI-U has steadily increased with transportation costs ranging from 15.3 to 17.7 percent of the CPI-U. Contrary to the decade-long upward trend, a large reduction in this percentage occurred from late 2007 to early 2008 as the economic recession was first beginning. Fuel prices fluctuated dramatically during this period, first surging to new price levels and later plummeting as the demand for fuel decreased. [USDOL BLS CPI 2012].

Annual average transportation prices have increased more than the 33.3 percent increase in the Consumer Price Index (CPI) between 2000 and 2012. According to the CPI, total transportation prices[1] grew by 41.8 percent during this period. However, new and used motor vehicles prices have been flat. As components of owning a car, automobile insurance increased 56.8 percent, maintenance costs increased 45.3 percent, and the cost of parts increase 46.4 percent between 2000 and 2012. In addition, the CPI shows the costs of public transportation were below the overall price increase, given that public transportation costs increased 29.5 percent during the 2000-2012 period [USDOL BLS CPI 2014].[2]

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[1] Transportation price is less motor fuel.

[2] Public transportation costs include fares for airlines, intercity bus, intercity train, ship, and intracity transportation (intracity mass transit) in the Consumer Price Index.

TABLE 6-4 Government Transportation Expenditures: 1995, 2000, 2007–2009

Millions of current dollars

	1995	2000	2007	2008	2009
All modes, total	**143,278**	**186,913**	**279,989**	**295,830**	**242,950**
Federal	19,955	21,826	36,948	40,575	42,755
State and local	123,323	165,087	243,041	255,255	200,194
Highway, total	**90,099**	**119,932**	**175,510**	**182,057**	**123,649**
Federal	1,708	2,211	2,986	3,853	5,843
State and local	88,391	117,720	172,524	178,204	117,806
Transit, total	**25,460**	**35,417**	**45,753**	**50,893**	**54,341**
Federal	1,277	4,390	98	90	92
State and local	24,183	31,027	45,655	50,803	54,249
Rail, total	**1,049**	**778**	**1,528**	**1,528**	**1,880**
Federal	1,023	765	1,523	1,527	1,880
State and local	26	13	5	1	0
Air, total	**19,204**	**22,445**	**43,806**	**46,593**	**47,831**
Federal	10,807	9,285	23,745	25,329	24,970
State and local	8,397	13,160	20,061	21,264	22,861
Water, total	**6,666**	**7,634**	**12,075**	**13,396**	**13,766**
Federal	4,357	4,493	7,314	8,456	8,547
State and local	2,309	3,141	4,761	4,940	5,219
Pipeline, total	**26**	**55**	**89**	**92**	**99**
Federal	14	37	66	61	55
State and local	12	18	23	31	44
General Support, total	**775**	**653**	**1,229**	**1,271**	**1,384**
Federal	769	645	1,216	1,259	1,368
State and local	6	8	13	12	16

NOTES: Federal expenditures include direct Federal spending, excluding grants to state and local governments. State and local expenditures include outlays from all sources of funds, including federal grants, except rail and pipeline modes. Rail and pipeline modes include outlays funded by Federal grants only. The part of expenditures that may be funded by other state and local government funding sources are not covered due to lack of data. Outlays for U.S. Army Corps of Engineers' civilian transportation-related activities, such as construction, operation, and maintenance of channels, harbors, locks and dams, are not included.

SOURCE: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics. *Government Transportation Financial Statistics 2012*. Available at http://apps.bts.gov/publications/government_transportation_financial_statistics/2012/ as of January 2013.

Public- and Private-Sector Expenditures on Transportation

Federal, state, and local governments spent approximately 4 percent ($243 billion) of their expenditures on transportation in 2009, according to the *Government Transportation Financial Statistics 2012* report produced by BTS. The same report calculates per capita government spending on transportation at about $800 per year [USDOT BTS 2012a]. These expenditures are used, among other things, to build, operate, and maintain publicly owned transportation facilities, implement public policy in such areas as safety and security, and undertake many other activities.

In 2009, the latest year for which comprehensive data have been published, governments spent $243 billion on transportation, with state and local governments spending 82.4 percent of that total, including Federal grants (table 6-4). Government transportation expenditures increased by 69.6 percent between 1995 and 2009. Nearly 50.8 percent of government expenditures went to highways, followed by transit (22.4 percent), air (19.7 percent), and water (5.7 percent).

The public sector is the major funding source for transportation infrastructure construction in the United States. In 2012 the value of government-funded construction underway was about $107 billion, which accounted for 90.0 percent of the total spending. That year government spending on transportation construction was slightly down from a peak of $110 billion in 2010, but up 2.4 percent from 2011. Approximately three-fourths of this public investment was for highways;[3] the remainder supported such construction as airport terminals and runways, transit facilities, water transportation facilities, and pedestrian and bicycling infrastructure [USDOC CENSUS 2012b].

The private sector increased spending on transportation construction by 19.2 percent from 2011 to 2012. In 2012 the value put in place by private construction was $11 billion. The majority of this outlay was for rail projects, followed by air transportation. In total, the public and private sectors spent $119 billion on transportation construction in 2012 [USDOC CENSUS 2012b].

Public-Sector Revenues From Transportation

Public dollars spent on transportation come from user taxes and fees, such as gasoline taxes and tolls, air ticket taxes and fees, and general revenues. In 2009, the latest year for which data from all levels of government have been assembled, government transportation revenues from all sources totaled $156 billion (current dollars). State and local governments collected 67.9 percent of all transportation-related revenues, while the Federal Government collected the balance. As shown in table 6-5, the highway sector generated the greatest revenues (mainly from gas taxes), accounting for $104 billion (67.0 percent), followed by air, a distant second at $30 billion (mainly from air ticket taxes and fees).

[3] Includes pavement, lighting, retaining walls, tunnels, bridges, toll/weight stations, maintenance facilities, and rest stops.

TABLE 6-5 Government Transportation Revenues: 1995, 2000, 2007–2009

Millions of current dollars

	1995	2000	2007	2008	2009
Total, All Modes	**93,698**	**127,295**	**162,821**	**162,385**	**155,729**
Federal	30,478	47,138	54,456	52,053	49,954
State and local	63,220	80,157	108,365	110,332	105,775
Highway, total	**66,716**	**90,275**	**113,297**	**110,464**	**104,379**
Federal[a]	22,200	34,986	40,061	37,080	35,144
State and local	44,516	55,289	73,236	73,384	69,235
Transit, total[b]	**8,575**	**10,670**	**13,874**	**14,591**	**15,292**
Railroad, total[c]	**36**	**1**	**0**	**0**	**0**
Air, total[d]	**14,497**	**22,235**	**29,384**	**30,702**	**29,818**
Federal	6,291	10,544	11,994	12,484	12,491
State and local	8,206	11,691	17,390	18,218	17,327
Water, total	**3,832**	**4,058**	**6,191**	**6,551**	**6,142**
Federal[e]	1,909	1,551	2,325	2,412	2,221
State and local	1,923	2,507	3,866	4,139	3,921
Pipeline, total[c]	**35**	**30**	**60**	**63**	**78**

[a]Includes both Highway and Transit Accounts of the Highway Trust Fund (HTF) and other receipts from motor fuel and motor vehicle taxes not deposited in the HTF.

[b]Includes state and local government only.

[c]Includes Federal only.

[d]Receipts from aviation user and aviation security fees also included.

[e]Includes Harbor Maintenance Trust Fund, St. Lawrence Seaway tolls, Inland Waterway Trust Fund, Panama Canal receipts through 2000, Oil Spill Liability Trust Fund, Offshore Oil Pollution Fund, Deep Water Port Liability Fund, and excise taxes of the Boat Safety Program.

NOTES: Government transportation revenue consists of money collected by govenrments from transportation user charges and taxes to finance transportation program. The revenue of a transportation mode includes all transportation revenues designated to that mode regardless of the sources or instruments from which the revenues are collected. Tolls from highways, bridges, and tunnels, etc., designated for transit use are counted as transit revenue.

SOURCE: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics. *Government Transportation Financial Statistics 2012*. Available at http://apps.bts.gov/publications/government_transportation_financial_statistics/2012/ as of January 2013.

Total transportation revenues increased (without adjusting for inflation) by about 66.2 percent, from $94 billion in 1995 to $156 billion in 2009, while government transportation expenditures increased from $143 billion in 1995 to $243 billion in 2009. Over the same period, highway revenues rose by 56.5 percent. In 2009 transportation revenues covered only about 64.1 percent of expenditures. When revenues from transportation user taxes and fees do not cover expenditures, general tax receipts (e.g., from sales and property taxes), trust fund balances, and borrowing are needed to cover shortages. This gap between transportation expenditures and revenues has widened from $49.6 billion in 1995 to $87.2 billion in 2009.

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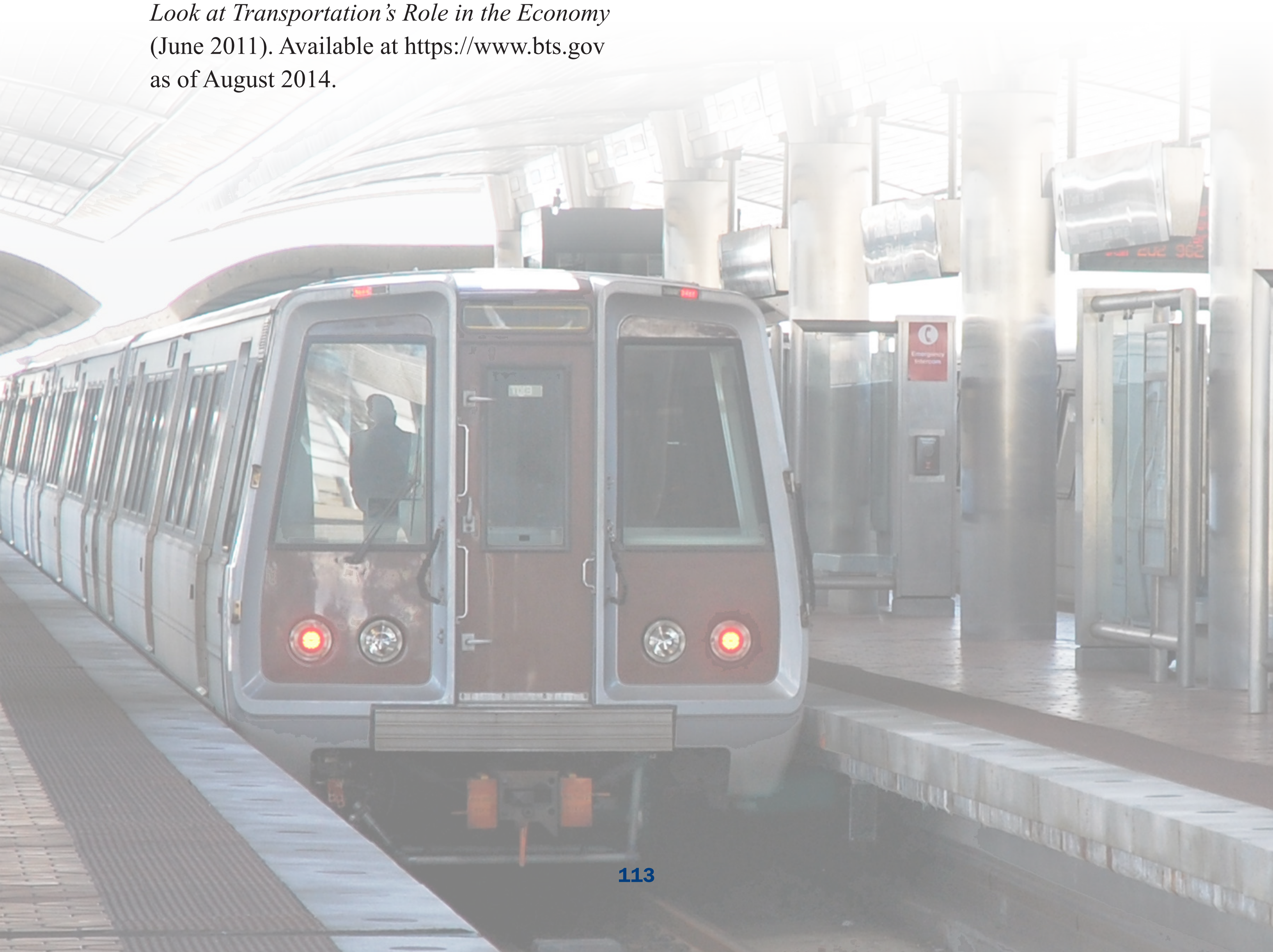


CHAPTER 7

Transportation Safety

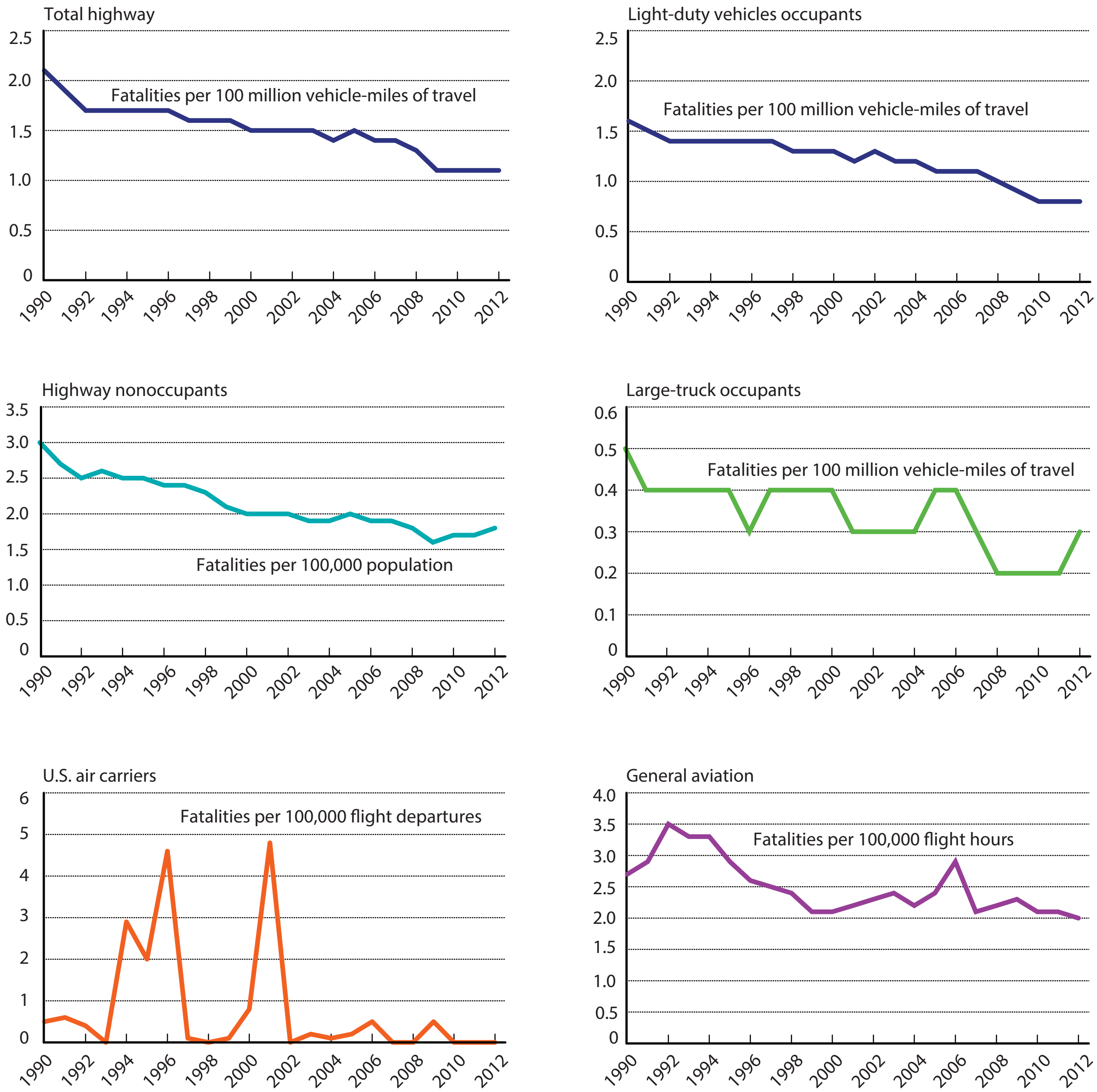
There were nearly 34,400 transportation-related deaths and over 2.2 million transportation-related injuries in 2011—20.0 percent of total deaths resulting from injury in 2011 [USDHHS CDC VITALITY 2014]. Motor vehicle occupants accounted for the majority, followed by motorcyclists and then pedestrians.

In recent decades transportation safety has improved, resulting in a significant decline in fatalities and injuries. In 2011, despite growth in the U.S. population and an increase in the number of licensed drivers, boaters, and general aviation pilots, transportation-related fatalities were down by 27.4 percent over 1990 totals and by 22.5 percent over 2000 totals. Highways, which carry the bulk of U.S. freight and passenger traffic, accounted for 94.4 percent of all transportation-related fatalities and 99.1 percent of injuries in 2011. On average, 92 people per day died in motor vehicle crashes in 2012 [USDOT NHTSA 2014c].

From 1990 through 2012, the overall rate of highway fatalities per vehicle-mile of travel (VMT) declined by 45.2 percent as the

- Transportation safety has been improving in recent decades, averaging 36 fewer fatalities and 2,830 fewer injuries per day in 2011 than in 1990.
- Over 94 percent of transportation fatalities and more than 99 percent of transportation injuries involved highway motor vehicles in 2011. In 2012, on average, 92 people were killed and 6,471 injured every day in crashes involving motor vehicles.
- Recreational boating incidents had the second highest number of fatalities in 2012, with 651 people killed, followed by general aviation with 432 fatalities. Nearly 500 people died while crossing railroad tracks or trespassing on railroad property.
- For the second consecutive year, there were no U.S. commercial airline passenger fatalities in 2012.
- Human factors, such as operating a vehicle while under the influence of alcohol or while distracted, are the most common contributing factors to transportation fatalities. Many people also fail to use safety equipment, such as seat belts or DOT-compliant motorcycle helmets.

FIGURE 7-1 Fatality Rates for Select Modes: 1990–2012



NOTES: Graphs with same color trend lines have identical scales. *Air carrier* fatalities resulting from the Sept. 11, 2001 terrorist acts include only onboard fatalities. *Light-duty vehicles* includes passenger car and light truck occupants.

SOURCE: Calculated by U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS) based upon multiple sources as cited in USDOT, BTS, *National Transportation Statistics*. Tables 2-9, 2-14, 2-17, 2-19, 2-21, and 2-23. Available at www.bts.gov as of June 2014.

highway modes, except for motorcyclists, showed across-the-board reductions. Fatalities per VMT for light-duty vehicle occupants (passenger cars and light trucks) decreased 50.7 percent, followed by decreases in the rates of large-truck occupants and highway nonoccupants (pedestrians and bicyclist) of 46.1 and 39.5 percent, respectively. Human factors, advanced vehicle design, and improved road design all contributed to these improvements [USDOT NHTSA 2012c].

While reductions in fatalities and injuries have been the greatest on the highway, other modes (air travel, including general aviation; railway; and recreational boating), also have improved safety records. Figure 7-1 shows that the safety record of air carriers (as measured by fatalities per departure) has remained stable and low. But despite the fact that the general aviation fatality rate (as measured by fatalities per flight hour) decreased by 26.3 percent from 1990 to 2012, 432 people died in general aviation crashes in 2012.

Between 2000 and 2011, transportation-related fatalities decreased by 9,980 (22.5 percent) (table 7-1). Transportation-related injuries also declined by 1 million (30.5 percent) in 2011 over 2000 totals (table 7-4). Despite these improvements, nearly 34,400 people died and 2.2 million were injured in transportation-related incidents in 2011. Highway modes, particularly light-duty vehicles, accounted for 99.1 percent of 2011 transportation injuries. Almost all modes of transportation showed a decline in injuries between 2000 and 2011 with the exception of motorcycles, which increased by more than 23,000. Many preventive measures, such as child safety seats, graduated driver licensing, increased seat belt use, and increased drunk driving education, contributed to declines in highway vehicles deaths and injuries [USDHHS CDC INJURY 2010b].

Fatalities by Mode

The timeframe used to attribute a fatality to a transportation crash or accident differs among modes according to their data collection methods, reporting periods, and information management systems. For example, a death that occurs within 30 days of an incident involving highway vehicles is considered a highway fatality, while a death that occurs within 24 hours of a rail incident is considered a rail fatality. Such definitional differences pose challenges when comparing safety records across modes of transportation. Table 7-2 shows fatality reporting requirements codified under the *Code of Federal Regulations* for several modes.

TABLE 7-1 Transportation Fatalities by Mode: 1990, 2000, and 2005–2012

	1990	2000	2005	2006	2007	2008	2009	2010	2011	2012
TOTAL fatalities	**47,379**	**44,376**	**45,645**	**45,018**	**43,314**	**39,478**	**35,900**	**34,924**	**34,399**	**U**
Air, total	**866**	**764**	**603**	**774**	**540**	**567**	**548**	**476**	**489**	**447**
U.S. air carrier[a]	39	92	22	50	1	3	52	2	0	0
Commuter carrier[b]	6	5	0	2	0	0	0	0	0	0
On-demand air taxi[c]	51	71	18	16	43	69	17	17	41	15
General aviation[d]	770	596	563	706	496	495	479	457	448	432
Highway, total	**44,599**	**41,945**	**43,510**	**42,708**	**41,259**	**37,423**	**33,883**	**32,999**	**32,479**	**33,561**
Passenger car occupants	24,092	20,699	18,512	17,925	16,614	14,646	13,135	12,491	12,014	12,271
Motorcyclists	3,244	2,897	4,576	4,837	5,174	5,312	4,469	4,518	4,630	4,957
Truck occupants[e], light	8,601	11,526	13,037	12,761	12,458	10,816	10,312	9,782	9,302	9,396
Truck occupants[e], large	705	754	804	805	805	682	499	530	640	697
Bus occupants	32	22	58	27	36	67	26	44	55	39
Pedestrians	6,482	4,763	4,892	4,795	4,699	4,414	4,109	4,302	4,457	4,743
Pedalcyclists	859	693	786	772	701	718	628	623	682	726
Other [f]	584	591	845	786	772	768	705	709	699	732
Railroad, total[g]	**729**	**631**	**626**	**636**	**624**	**605**	**534**	**598**	**552**	**557**
Trespassers	543	463	458	511	470	457	416	439	406	425
Highway-rail grade crossing[h]	130	119	101	102	112	91	87	125	111	98
Employees, Contractors, and Passengers	56	49	67	23	42	57	31	34	35	34
Transit, total[i]	**125**	**110**	**57**	**40**	**65**	**48**	**83**	**64**	**49**	**U**
Highway-rail grade crossing[j]	N	20	23	21	27	10	15	9	7	U
Transit[k]	N	90	34	19	38	38	68	55	42	U
Waterborne, total[l]	**1,051**	**888**	**835**	**839**	**811**	**827**	**839**	**765**	**816**	**714**
Vessel-related[l]	85	53	78	73	67	51	50	41	31	33
Not related to vessel casualties[m]	101	134	60	56	59	67	53	52	27	30
Recreational boating[n]	865	701	697	710	685	709	736	672	758	651
Pipeline, total	**9**	**38**	**14**	**21**	**15**	**8**	**13**	**22**	**14**	**12**
Hazardous liquid pipeline	3	1	2	0	4	2	4	1	1	3
Gas pipeline	6	37	12	21	11	6	9	21	13	9

KEY: N = data do not exist; U = data are unavailable.

[a] Carriers operating under 14 CFR 121, all scheduled and nonscheduled service.

[b] All scheduled service operating under 14 CFR 135 (*Commuter air carriers*).

[c] Nonscheduled service operating under 14 CFR 135 (*On-demand air taxis*).

[d] All operations other than those operating under 14 CFR 121 and 14 CFR 135. 2006 includes the 154 persons killed aboard a foreign registered aircraft operated by Gol Airlines in a collision with another aircraft over Brazil.

[e] *Light trucks* are defined as trucks of 10,000 pounds gross vehicle weight rating or less, including pickups, vans, truck-based station wagons, and utility vehicles. *Large trucks* are defined as trucks over 10,000 pounds gross vehicle weight rating, including single-unit trucks and truck tractors.

[f] Includes occupants of other vehicle types, other nonmotorists, and unknown.

[g] Includes Amtrak. Fatalities include those resulting from train accidents, train incidents, and nontrain incidents. Train and commuter rail occupant and nonoccupant fatalities, excluding public highway-rail grade crossing fatalities involving motor vehicles.

[h] Fatalities involving motor vehicles at private highway-rail grade crossings and fatalities not involving motor vehicles at all highway-rail grade crossings resulting from freight and passenger rail operations including commuter rail. Highway-rail grade crossing fatalities involving motor vehicles at public highway-rail grade crossings are counted under Highway.

[i] All reportable fatalities (excluding suicides) for heavy rail, light rail, and automated guideway.

[j] Includes heavy rail, light rail, and automated guideway. Data for fatalities at light rail grade crossings are: 2000 (12); 2005 (8); 2006 (7); 2007 (5); 2008 (10); 2009 (15); 2010 (9), and 2011(7). Since 2008, the data has included both directly operated (DO) and purchased transportation (PT) modes.

[k] Transit total subtract highway-rail grade crossing.

[l] Vessel-related casualties include those involving damage to vessels such as collisions or groundings. Fatalities not related to vessel casualties include deaths from falling overboard or from accidents involving onboard equipment.

[m] Between 1998 and 2001, data come from combining entries in the Marine Safety Management Information System with entries in the Marine Information for Safety and Law Enforcement System.

[n] Data are based on information provided by the States, the District of Columbia and the five U.S. Territories to the Coast Guard Boating Accident Report Database (BARD) system.

SOURCES: **Air**—National Transportation Safety Board. **Highway**—National Highway Traffic Safety Administration. **Railroad**—Federal Railroad Administration. **Transit**—Federal Transit Administration and personal communication. **Waterborne**—U.S. Coast Guard. **Recreational boating**—U.S. Coast Guard, Office of Boating Safety. **Pipeline**—Pipeline and Hazardous Materials Safety Administration as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, table 2-1, available at http://www.bts.gov/ as of October 2014.

TABLE 7-2 Fatality Definition/Reporting by Mode (as of July 2014)

Mode	Definition	Citation
Air	Requires any injury that results in death within thirty (30) days of the accident.	49 CFR 830.2
Hazardous Material	Requires a written report for certain types of hazardous materials incidents within 30 days, and a follow-up written report within one year of the incident, based on certain circumstances [such as] A death results from injury caused by a hazardous material.	49 CFR 171.16
Highway	Requires any injury which results in the death of a person at the time of the motor vehicle accident or within 30 days of the accident.	49 CFR 390.5
Railroad	Requires the death of a person either at the time an accident occurs or within 24 hours thereafter.	49 CFR 840.2
Rail transit	Requires a fatality at the scene; or where an individual is confirmed dead within thirty (30) days of a rail transit-related incident.	49 CFR 659.33
Recreational Boating	Requires within 48 hours of the occurrence if a person dies within 24 hours of the occurrence.	33 CFR 173

SOURCE: Government Printing Office. Electronic Code of Federal Regulations (e-CFR). Available at http://www.ecfr.gov/ as of July 2014.

Highway

In 2011 passenger car and light truck (e.g., sport utility vehicle, minivan, and pickup truck) occupants combined accounted for 61.9 percent of all transportation fatalities and 65.6 percent of highway fatalities. Passenger car fatalities were down 4,600 and light-truck fatalities were down 3,200 from 2007 to 2011. Combined passenger car and light-truck fatalities accounted for 87.6 percent of the 20.4 percent decline in total transportation fatalities and 88.3 percent of the decline in highway-related fatalities. In 2007 passenger car and light-truck fatalities were 67.7 percent of all transportation fatalities and 70.5 percent of highway fatalities. Large-truck crashes accounted for 3,921 of total highway fatalities in 2012 (about 11 percent), of which 82 percent were occupants of other vehicles or bystanders (table 7-3).

In 2011, 4,630 motorcyclists died. While the miles logged by motorcycles represented less than 1 percent of total highway use, motorcycle fatalities accounted for 13.5 percent of total transportation-related fatalities. Fatalities involving motorcycles increased in 2011, which coincides with a 2.8 percent increase in motorcyclist use that year. The rise in the percentage share of motorcyclist fatalities also reflects a larger improvement in other highway and nonhighway modes.

In 2011 more than 5,100 pedestrians and bicyclists were struck and killed by motor vehicles, down from 5,400 fatalities in 2007. However, pedestrian and bicyclist fatalities accounted for a larger share of deaths in 2011 (12.9 and 2.0 percent respectively) as total transportation-related fatalities decreased.

TABLE 7-3 Distribution of Transportation Fatalities by Mode: 2007 and 2012

	2007		2012	
	Number	Percent	Number	Percent
TOTAL of all modes[a]	**43,314**	**100.0**	**35,372**	**100.0**
Passenger car occupants	16,614	38.4	12,271	34.7
Light-truck occupants	12,458	28.8	9,396	26.6
Motorcyclists	5,174	11.9	4,957	14.0
Pedestrians struck by motor vehicles	4,699	10.8	4,743	13.4
Pedalcyclists struck by motor vehicles	701	1.6	726	2.1
Large-truck occupants	805	1.9	697	2.0
Recreational boating	685	1.6	651	1.8
Other and unknown motor vehicle occupants	614	1.4	509	1.4
General aviation	496	1.1	432	1.2
Railroad trespassers[b] (excluding grade crossings)	470	1.1	425	1.2
Other nonoccupants struck by motor vehicles[c]	158	0.4	223	0.6
Highway-rail grade crossings, not involving motor vehicles[d]	74	0.2	69	0.2
Heavy rail transit (subway)	32	0.1	52	0.1
Bus occupants (school, intercity, and transit)	36	0.1	39	0.1
Waterborne transportation (vessel-related)	67	0.2	33	0.1
Waterborne transportation (nonvessel-related)	59	0.1	30	0.1
Private highway-rail grade crossings, with motor vehicles	38	0.1	29	0.1
Light rail transit	32	0.1	29	0.1
Air taxi	43	0.1	15	0.0
Railroad employees, contractors, and volunteers on duty (excluding grade crossings)	16	0.0	15	0.0
Railroad-related, not otherwise specified (excluding grade crossings)	21	0.0	14	0.0
Gas distribution pipelines	9	0.0	9	0.0
Passengers on railroad trains (excluding grade crossings)	5	0.0	5	0.0
Hazardous liquid pipelines	4	0.0	3	0.0
Commuter air	0	0.0	0	0.0
Air carriers[e]	1	0.0	0	0.0
Automated guideway	1	0.0	0	0.0
Gas transmission pipelines	2	0.0	0	0.0
Other counts, redundant with above[f]				
Large-truck occupants and nonoccupants	4,822	11.1	3,921	11.1
Public grade crossings, with motor vehicles	227	0.5	134	0.4
Commuter rail	124	0.3	80	0.2

[a] Includes fatalities outside the vehicle, unless otherwise specified.

[b] Includes fatalities outside trains, except at grade crossings.

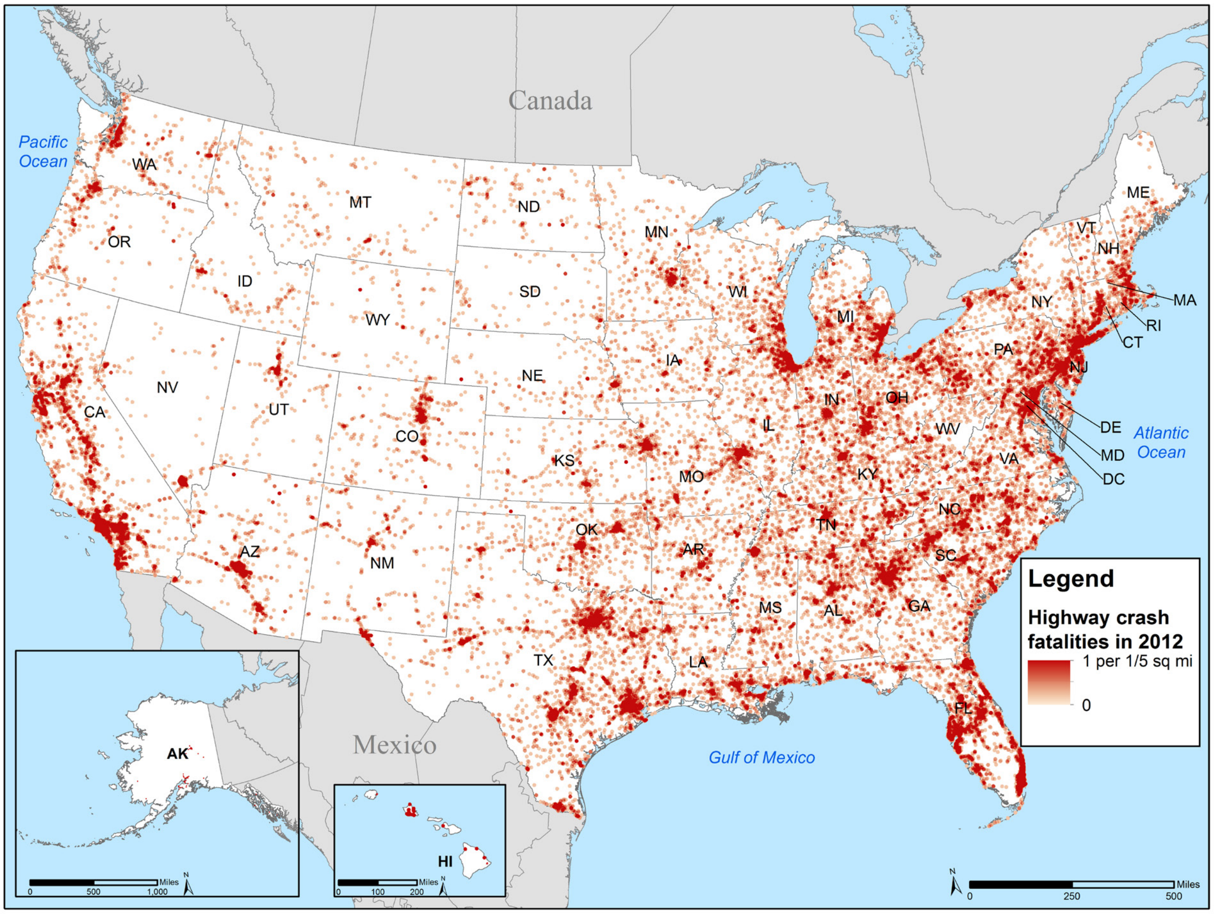
[c] Includes all nonoccupant fatalities, except pedalcyclists and pedestrians.

[d] Public grade-crossing fatalities involving motor vehicles are excluded in counts for motor vehicles.

[e] Fatalities at grade crossings with motor vehicles are included under relevant motor vehicle modes. Commuter rail fatalities are counted under railroad. For Transit bus and Demand responsive transit accidents, occupant fatalities are counted under "bus" and nonoccupant fatalities are counted under "Pedestrians," "Pedalcyclists," or other motor vehicle categories.

SOURCES: **Air**—National Transportation Safety Board. **Highway**—National Highway Traffic Safety Administration. **Railroad**—Federal Railroad Administration. **Transit**—Federal Transit Administration and personal communication. **Waterborne**—U.S. Coast Guard. **Recreational boating**—U.S. Coast Guard, Office of Boating Safety. **Pipeline**—Pipeline and Hazardous Materials Safety Administration as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, table 2-4, available at http://www.bts.gov/ as of October 2014

FIGURE 7-2 Highway Crash Fatalities: 2012



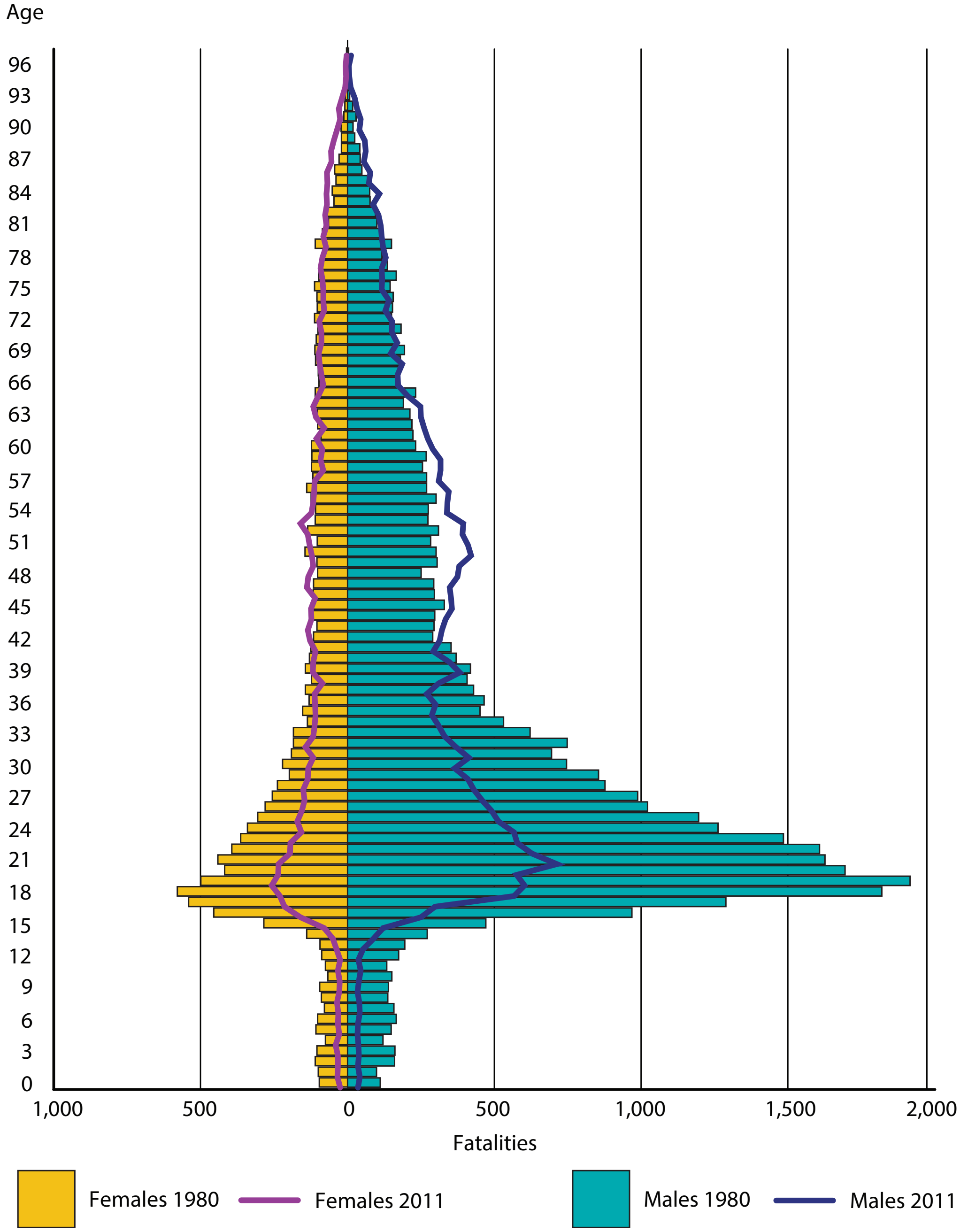
SOURCE: U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration, *Fatality Analysis Reporting System* (FARS) 2012. Available at http://www-fars.nhtsa.dot.gov/ as of January 2014.

Highway fatalities in 2012 were concentrated along the major corridors in the populated areas of California, Florida, Illinois, Texas, and throughout the populous Northeast region from New England near Boston, MA, down to the Middle Atlantic near Washington, DC. In addition, they were also concentrated along the highway corridors and around the urban areas (e.g., Atlanta, GA) in the South Atlantic (figure 7-2).

The number of males killed on the highway exceeded the number of females killed for most age groups in 1980 and 2011 (figure 7-3). This difference is partially due to the fact that males have a higher exposure rate than females as measured by amount of driving. Persons under the age of 30 continued to have the highest fatality numbers in 2011, although deaths for that age group declined substantially from 1980. Males comprised 70.6 percent of 2011 highway fatalities, down from 73.2 percent in 1980. The greatest numbers of highway fatalities by age and gender in 2011 were among 21-year-old males and 19-year-old females. Graduated driver licensing (GDL) programs were established to reduce newly licensed, young driver error by limiting night driving and teen passengers during early months of licensure [GHSA 2013]. GDL programs along with other factors have contributed to this decline and are linked to a significant reduction in fatal and nonfatal injury crashes [USDHHS CDC INJURY 2010].

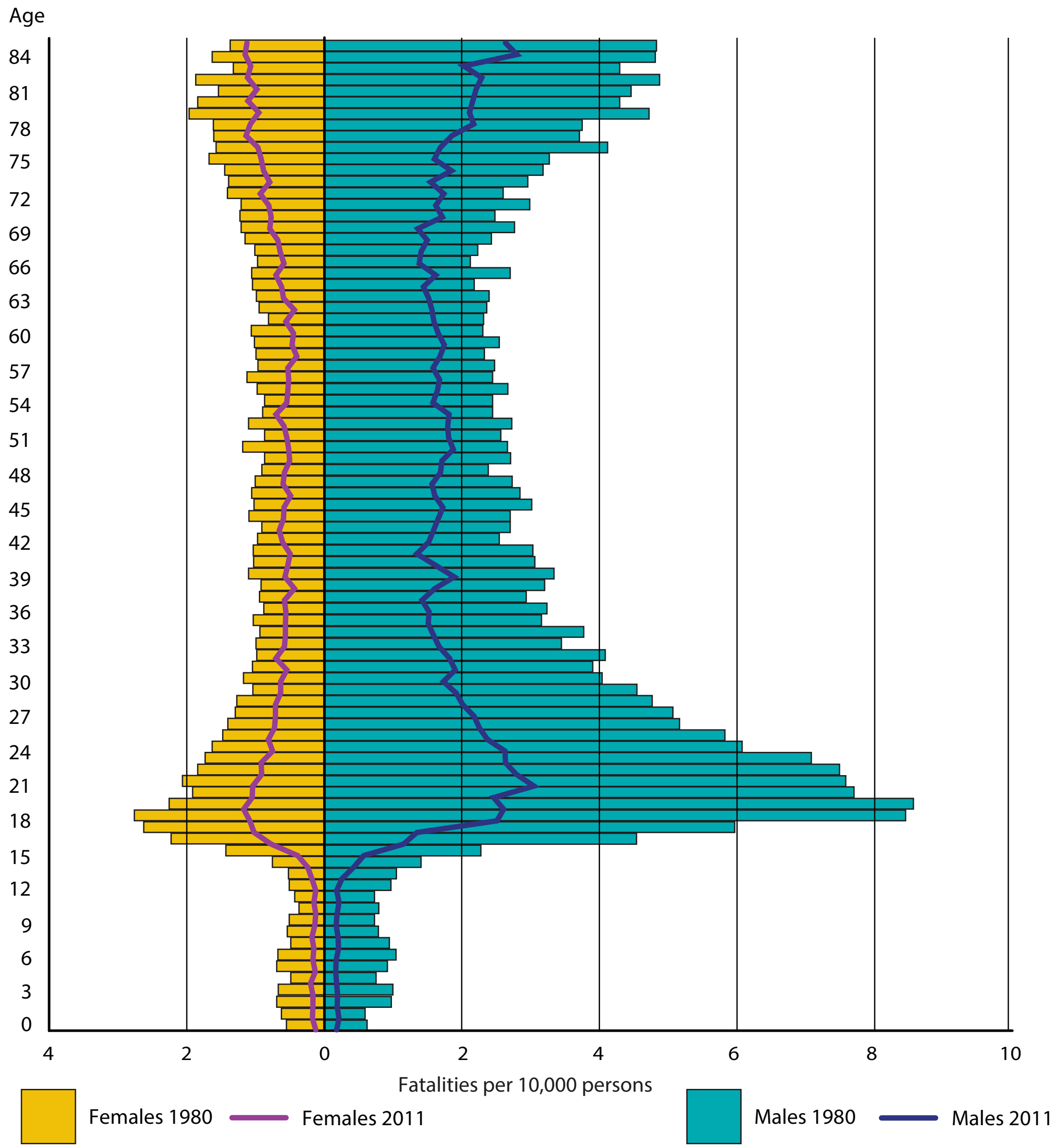
Since 1980 there has been a considerable decrease in fatalities per capita across all age groups for both genders. The greatest numbers of fatalities per capita in both 2011 and 1980 were among males aged 15 to 29 and 78 to 84; however, the 1980 rates were higher. Female fatalities per capita in both 2011 and 1980 peaked between the ages of 15 and 23 and again between the ages of 70 and 84; however, the 1980 rates were again higher (figure 7-4).

FIGURE 7-3 Number of Highway Fatalities by Age and Gender: 1980 and 2011



SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, Fatality Analysis Reporting System (FARS), available at: http://www.nhtsa.gov/FARS as of September 2013 as cited in U.S. Department of Transportation, Bureau of Transportation Statistics. *Passenger Travel Facts and Figures 2014* (July 2014). Table 5-2. Available at http://www.bts.gov as of July 2014.

FIGURE 7-4 Rate of Highway Fatalities by Age and Gender: 1980 and 2011



SOURCE: **Fatality Data** - U.S. Department of Transportation, National Highway Traffic Safety Administration, Fatality Analysis Reporting System (FARS), available at: http://www.nhtsa.gov/FARS as of September 2013. **Population Data** - U.S. Department of Commerce, United States Census Bureau, 1980 and 2011 population estimates available at http://www.census.gov/popest.data/state/asrh/2011/index.html as of September 2013 as cited in U.S. Department of Transportation, Bureau of Transportation Statistics. *Passenger Travel Facts and Figures 2014* (July 2014). Table 5-2. Available at http://www.bts.gov as of July 2014.

Recreational Boating

Recreational boating accounted for 651 of total transportation-related fatalities in 2012, second to highway in the number of fatalities. According to the U.S. Coast Guard, many boating fatalities occurred on calm waters, in light winds, or with good visibility. Alcohol use, failure to wear a lifejacket, and insufficient training play key roles in recreational boating accidents [USDHS USCG OABS 2013a].

Aviation

Unlike the large and commuter U.S. air carriers that had no fatal accidents in scheduled passenger service in 2012, general aviation has accounted for at least 400 fatalities annually over the last 10 years. In 2012, 432 were killed in general aviation accidents. That said, the safety record of the relatively small private and business aircraft that comprise general aviation has improved in recent decades. Most general aviation accidents involved single-engine, piston-powered airplanes. The loss of control inflight accounted for the majority of fatalities, whereas loss of control on the ground accounted for the majority of nonfatal accidents [NTSB 2014a].

Injured People By Mode

All transportation-related injuries declined nearly 980,700 (30.5 percent) in 2011 (the latest year for which all modal data are available) from 2000 (table 7-4). This decline was largely due to a 972,000 (30.5 percent) reduction in injured people on highway over that time period. The National Highway Traffic Safety Administration (NHTSA) estimates that there were almost 2.4 million injured people in highway crashes in 2012. NHTSA estimates the total number of people injured because an exact number is impracticable to tally. The estimated number means that nearly 6,500 people per day are injured in motor vehicle crashes.

In addition to the injured people on the Nation's highways, about 18,300 people were injured in 2011 in nonhighway related incidents. The rail mode reported the greatest number of injuries (approximately 7,600), followed by transit (5,400), and water (3,800)—mostly from recreational boating.

The injury rate for highway crashes in 2012 was 68.5 percent of that in 2000. Comparing injury rates, crash victims in light-duty vehicles were eight times more likely to be injured than crash victims in large trucks (figure 7-5). The air carrier injury rate (measured by the number of injuries per departure) remained relatively low and stable, including the general aviation injury rate (measured by the number of injuries per flight hour) between 2000 and 2011.

TABLE 7-4 Injured Persons by Transportation Mode: 1990, 2000, and 2005–2012

	1990	2000	2005	2006	2007	2008	2009	2010	2011	2012
TOTAL injuries	**3,269,465**	**3,217,117**	**2,716,557**	**2,592,862**	**2,510,227**	**2,366,668**	**2,237,186**	**2,259,122**	**2,236,468**	**U**
Air,[a] total	**485**	**359**	**305**	**286**	**291**	**296**	**301**	**277**	**362**	**276**
U.S. air carrier[b]	29	31	14	9	16	23	23	16	20	18
Commuter carrier[c]	11	7	0	1	0	2	1	2	0	0
On-demand air taxi[d]	36	12	20	11	20	12	4	3	15	10
General aviation[e]	409	309	271	265	255	259	273	256	327	248
Highway, total	**3,230,666**	**3,188,750**	**2,699,000**	**2,575,000**	**2,491,000**	**2,346,000**	**2,217,000**	**2,239,000**	**2,217,000**	**2,362,000**
Passenger car occupants	2,376,439	2,051,609	1,573,396	1,474,536	1,379,181	1,304,006	1,216,000	1,253,000	1,240,000	1,328,000
Motorcyclists	84,285	57,723	87,335	88,652	102,994	95,986	90,000	82,000	81,000	93,000
Truck occupants[f], light	505,144	886,566	872,137	856,896	841,451	768,410	759,000	733,000	728,000	762,000
Truck occupants[f], large	41,822	30,832	27,284	23,815	23,314	22,947	17,000	20,000	23,000	25,000
Bus occupants	32,691	17,769	11,133	9,839	12,141	15,149	12,000	17,000	13,000	12,000
Pedestrians	104,805	77,625	64,446	60,924	70,286	68,832	59,000	70,000	69,000	76,000
Pedalcyclists	74,903	51,160	45,439	44,012	43,481	52,395	51,000	52,000	48,000	49,000
Other[g]	10,578	15,466	17,806	17,989	17,685	18,011	14,000	13,000	15,000	16,000
Railroad, total[h]	**22,957**	**10,614**	**8,675**	**7,896**	**8,826**	**8,221**	**7,420**	**7,661**	**7,593**	**7,622**
Trespassers	560	414	420	481	407	432	344	390	367	410
Highway-rail grade crossing[i]	221	190	180	171	220	152	141	170	218	208
Employees, Contractors, and Passengers	22,176	10,010	8,075	7,244	8,199	7,637	6,935	7,101	7,008	7,004
Transit, total[j]	**11,284**	**12,201**	**4,434**	**5,399**	**5,638**	**8,147**	**8,470**	**8,208**	**7,626**	**U**
Highway-rail grade crossing[k]	N	123	194	172	224	155	229	295	269	U
Transit[l]	N	12,078	4,240	5,227	5,414	7,992	8,241	7,913	7,357	U
Waterborne, total	**3,997**	**5,112**	**4,095**	**4,245**	**4,422**	**3,947**	**3,931**	**3,867**	**3,831**	**3,688**
Vessel-related[m]	175	150	140	177	190	152	196	172	131	141
Not related to vessel casualties[n]	U	607	504	594	559	464	377	542	619	547
Recreational boating	3,822	4,355	3,451	3,474	3,673	3,331	3,358	3,153	3,081	3,000
Pipeline, total	**76**	**81**	**48**	**36**	**50**	**57**	**64**	**109**	**56**	**58**
Hazardous liquid pipeline	7	4	2	2	10	2	4	4	2	4
Gas pipeline	69	77	46	34	40	55	60	105	54	54

KEY: N = data do not exist; U = data are unavailable.

[a] Injuries classified as serious. See definitions of injuries in the glossary.

[b] All scheduled and nonscheduled service operating under 14 CFR 121.

[c] All scheduled service operating under 14 CFR 135 (commuter air carriers).

[d] Nonscheduled service operating under 14 CFR 135 (on-demand air taxis).

[e] All operations other than those operating under 14 CFR 121 and 14 CFR 135.

[f] Large trucks are defined as trucks over 10,000 pounds gross vehicle weight rating, including single-unit trucks and truck tractors. Light trucks are defined as trucks of 10,000 pounds gross vehicle weight rating or less, including pickups, vans, truck-based station wagons, and utility vehicles.

[g] Includes occupants of other unknown vehicle types and other nonmotorists.

[h] Includes Amtrak. Figures include those injuries resulting from train accidents, train incidents, and nontrain incidents. Injury figures also include occupational illness.

[i] Injuries occurring at highway-rail crossings resulting from freight and passenger rail operations including commuter rail. Highway-rail grade crossing injuries, except train occupants, are also counted under highway. Injuries involved with motor vehicles at public highway-rail grade crossings are excluded.

[j] All reportable injuries (excluding attempted suicides) for heavy rail, light rail, and automated guideway.

[k] Includes heavy rail, light rail, and automated guideway. Injuries occurring at highway-rail crossings resulting from operations of public transit rail modes, excluding commuter rail. Data for injuries at light rail crossings are: 2000 (111);2005 (138); 2006 (44); 2007 (139); 2008 (155); 2009 (229); 2010 (295); and 2011 (269). Since 2008, the data has included both directly operated (DO) and purchased transportation (PT) modes.

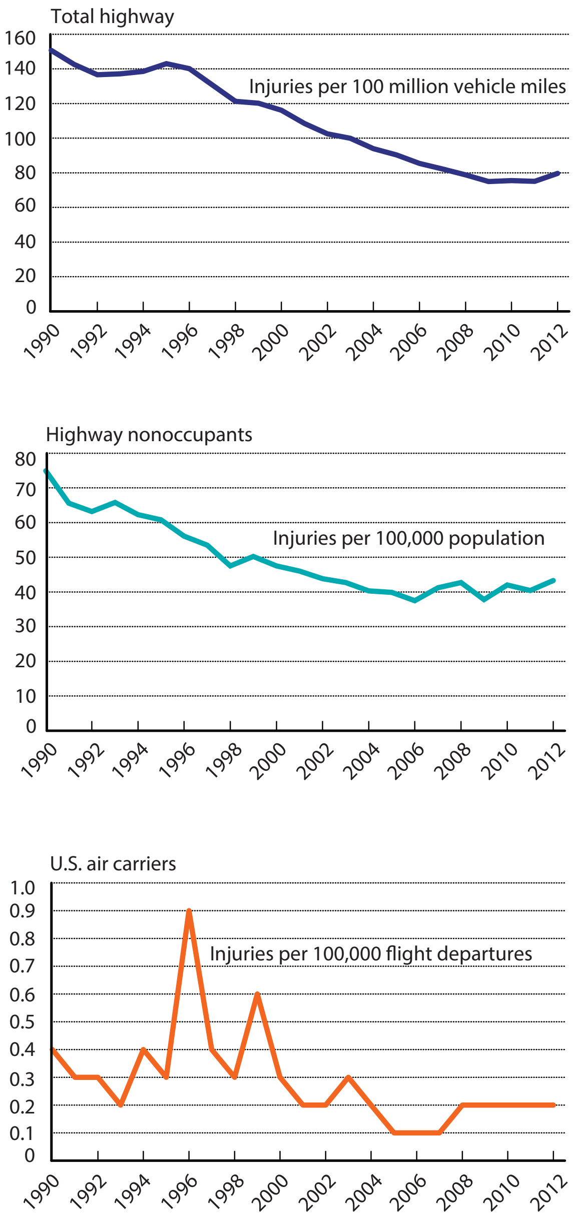
[l] Transit total subtract highway-rail grade crossing.

[m] Vessel-related injuries include those involving damage to vessels, such as collisions or groundings. Injuries not related to vessel casualties include those from falls overboard or from accidents involving onboard equipment.

[n] Between 1998 and 2001, data come from combining entries in the Marine Safety Management Information System with entries in the Marine Information for Safety and Law Enforcement System.

SOURCES: **Air**—National Transportation Safety Board. **Highway**—National Highway Traffic Safety Administration. **Railroad**—Federal Railroad Administration. **Transit**—Federal Transit Administration and personal communication. **Waterborne**—U.S. Coast Guard. **Recreational boating**—U.S. Coast Guard, Office of Boating Safety. **Pipeline**—Pipeline and Hazardous Materials Safety Administration as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, table 2-2, available at http://www.bts.gov/ as of October 2014.

FIGURE 7-5 Injury Rates for Select Modes: 1990–2012



NOTES: Graphs with same color trend lines have identical scales. *Light-duty vehicles* includes passenger car and light truck occupants. *Air* includes serious injuries only. *Nonoccupant* includes pedestrians and riders of nonmotorized bicycles and other pedal-powered vehicles.

SOURCE: Calculated by U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS) based upon multiple sources as cited in USDOT, BTS, National Transportation Statistics. Tables 1-35, 2-2, 2-9, and 2-14. Available at www.bts.gov as of June 2014.

Costs of Motor Vehicle Crashes

Motor vehicle crashes caused an estimated $277 billion in economic costs in 2010, up by more than $45 billion over the nearly $231 billion estimated for 2000. However, this increase is largely attributable to inflation, which accounted for 27 percent of the overall rise. The $277 billion in economic costs can be broken down as follows:

- lost productivity accounted for $93.1 billion (33.6 percent);
- property damage losses totaled $76.1 billion (27.5 percent);
- medical expenses amounted to $34.9 billion (12.6 percent);
- congestion impacts reached $28 billion (10.1 percent); and
- other crash-related costs, such as insurance administration and legal fees, accounted for the remaining $45 billion (16.2 percent) [USDOT NHTSA 2014a].

Motor vehicle crashes cost nearly $900 per U.S. resident in 2010, equivalent to 1.9 percent of the $14.96 trillion U.S. Gross Domestic Product. When factoring in the $594 billion in comprehensive costs from the loss of life, pain, and injuries, the cost of 2010 motor vehicle crashes totaled about $871 billion. Private insurers paid approximately 52.2 percent of these economic costs, while individual crash victims paid approximately 25.1 percent. Third parties, such as uninvolved motorists delayed in traffic, charities, and health care providers, bore about 14.0 percent of these costs; while Federal, state, and local governments accounted for the remaining 8.7 percent [USDOT NHTSA 2014a].

Motorcycles accounted for less than 1 percent of the vehicle-miles traveled but 14 percent of highway fatalities in 2010, largely due to the lack of protection afforded to other highway vehicles. In 2010 motorcycle crashes cost $13.5 billion in economic impacts and $66 billion in societal harm, as measured by comprehensive costs. Compared to other motor vehicle crashes, these costs are disproportionately caused by fatalities and serious injuries [USDOT NHTSA 2014a].

Selected Contributing Factors

Human, environmental, and vehicle factors contribute to transportation crashes. Human factors are the most common cause and involve driver errors or risky behaviors, such as driving while under the influence, distracted driving, or fatigue. Environmental factors include roadway design (e.g., narrow lanes, no shoulders), roadway hazards (e.g., utility poles, overgrowth), and operating conditions (e.g., wet roads). Vehicle factors include equipment- and maintenance-related failures (e.g., tire separations and worn out parts) [GAO 2003].

One or more human factors were recorded for 72 percent of the drivers of passenger vehicles (cars, vans, pickup trucks, and sport utility vehicles) involved in single-vehicle crashes and 51 percent of the passenger vehicle drivers in multivehicle crashes. For comparison, one or more human factors were recorded for 55 percent of the drivers of large trucks involved in single-vehicle fatal crashes and for 27 percent of the drivers of large trucks involved in multivehicle fatal crashes. More specifically, speeding was the most often coded driver-related factor for both vehicle types, while distracted/inattentive driving was the second most common factor for large-truck drivers, while impairment (fatigue, alcohol, illness, etc.) was the second most common factor for passenger vehicle drivers in 2012 [USDOT FMCSA 2014].

Alcohol Use

All 50 states and the District of Columbia now limit Blood Alcohol Concentration (BAC) to 0.08 percent while operating a highway vehicle [USDHHS NIH NIAAA 2012]. Table 7-5 shows 10,322 people were killed in alcohol-impaired motor vehicle crashes in 2012. A combination of awareness, educational, and enforcement efforts (e.g., the *Drive Sober or Get Pulled Over* campaign and sobriety checkpoints) has helped to raise awareness [USDOT NHTSA 2012b].

All 50 states and the District of Columbia have also adopted the legal drinking age of 21 years [USDHHS NIH NIAAA 2012]. Yet motor vehicle crashes continued to be the leading cause of death for teens aged 16 to 19 years old, and alcohol-impaired driving was a contributing factor in 18.0 percent of fatal crashes involving drivers age 16 to 20 in 2012. In 2011, 11.3

TABLE 7-5 Fatalities by Highest Blood Alcohol Concentration (BAC) in Highway Crashes: 2005–2012

	2005	2006	2007	2008	2009	2010	2011	2012
Total fatalities	**43,510**	**42,708**	**41,259**	**37,423**	**33,883**	**32,999**	**32,479**	**33,561**
Fatalities in alcohol-related crashes (BAC = .01+)	**15,985**	**15,970**	**15,534**	**13,826**	**12,731**	**11,906**	**11,527**	**12,041**
Percent	36.7	37.4	37.6	36.9	37.6	36.1	35.5	35.9
BAC = 0.00								
Number	27,423	26,633	25,611	23,499	21,051	21,005	20,848	21,411
Percent	63.0	62.4	62.1	62.8	62.1	63.7	64.2	63.8
BAC = 0.01 - 0.07								
Number	2,404	2,479	2,494	2,115	1,972	1,771	1,662	1,719
Percent	5.5	5.8	6.0	5.7	5.8	5.4	5.1	5.1
BAC = 0.08+								
Number	13,582	13,491	13,041	11,711	10,759	10,136	9,865	10,322
Percent	31.2	31.6	31.6	31.3	31.8	30.7	30.4	30.8

KEY: BAC = blood alcohol concentration.

NOTES: Total fatalities include those in which there was no driver or motorcycle rider present. BAC values have been assigned by U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA) when alcohol test results are unknown. *Alcohol-related crashes* pertain to the BAC of the driver and nonoccupants struck by motor vehicles. For some years, numbers for *Fatalities* in alcohol-related crashes (BAC = .01+) may not add to totals due to rounding.

SOURCE: U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration, National Center for Statistics and Analysis, *Traffic Safety Facts* (Washington, DC: Annual Issues), available at http://www-nrd.nhtsa.dot.gov/ as of May 2014 (Revised), as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*, table 2-26, available at http://www.bts.gov as of June 2014.

percent of students aged 16 years and older self-reported driving after drinking during the prior 30 days [USDHHS CDC INJURY 2012]. In 2012, 758 drivers age 16 to 20 with a BAC of 0.08 or higher were killed in alcohol-impaired crashes [USDOT NHTSA 2013c]. Alcohol involvement either by the driver or the pedestrian was reported in 48 percent of all fatal pedestrian crashes in 2012 [USDOT NHTSA 2014f].

In 2012 alcohol-impairment was listed as a contributing factor in 280 boating accidents, 109 fatalities, and 227 injuries; it was listed as the primary factor in 16.7 percent of deaths [USDHS USCG OABS 2013a]. As of January 1, 2013, 45 states and the District of Columbia limit BAC to 0.08 percent for operators of recreational boats. The remaining five states, Georgia, Michigan, North Dakota, South Carolina, and Wyoming, all have 0.10 percent standards [USDHHS NIH NIAAA 2012].

Distraction

Between 2010 and 2012, total distraction-affected crashes were up 0.9 percent. In 2012 more than 3,000 people were killed and an estimated 421,000 injured in motor vehicle crashes involving distracted drivers. Specifically, distracted driving accounted for

TABLE 7-6 Motor Vehicle Traffic Crashes and Distraction-Affected Crashes: 2010–2012

Year	Total	Distraction-affected	Percent	Distraction-affected involving cell phone use	Percent
Fatal crashes					
2010	30,296	2,993	9.9%	366	12.2%
2011	29,867	3,047	10.2%	354	11.6%
2012	30,800	3,050	9.9%	378	12.4%
Injury crashes					
2010	1,542,000	279,000	18.1%	16,000	5.7%
2011	1,530,000	260,000	17.0%	15,000	5.8%
2012	1,634,000	286,000	17.5%	21,000	7.3%
Property damage only crashes					
2010	3,847,000	618,000	16.1%	30,000	4.9%
2011	3,778,000	563,000	14.9%	35,000	6.2%
2012	3,950,000	619,000	15.7%	39,000	6.3%
Total motor vehicles crashes					
2010	5,419,000	900,000	16.6%	47,000	5.2%
2011	5,338,000	826,000	15.5%	50,000	6.1%
2012	5,615,000	908,000	16.2%	60,000	6.6%

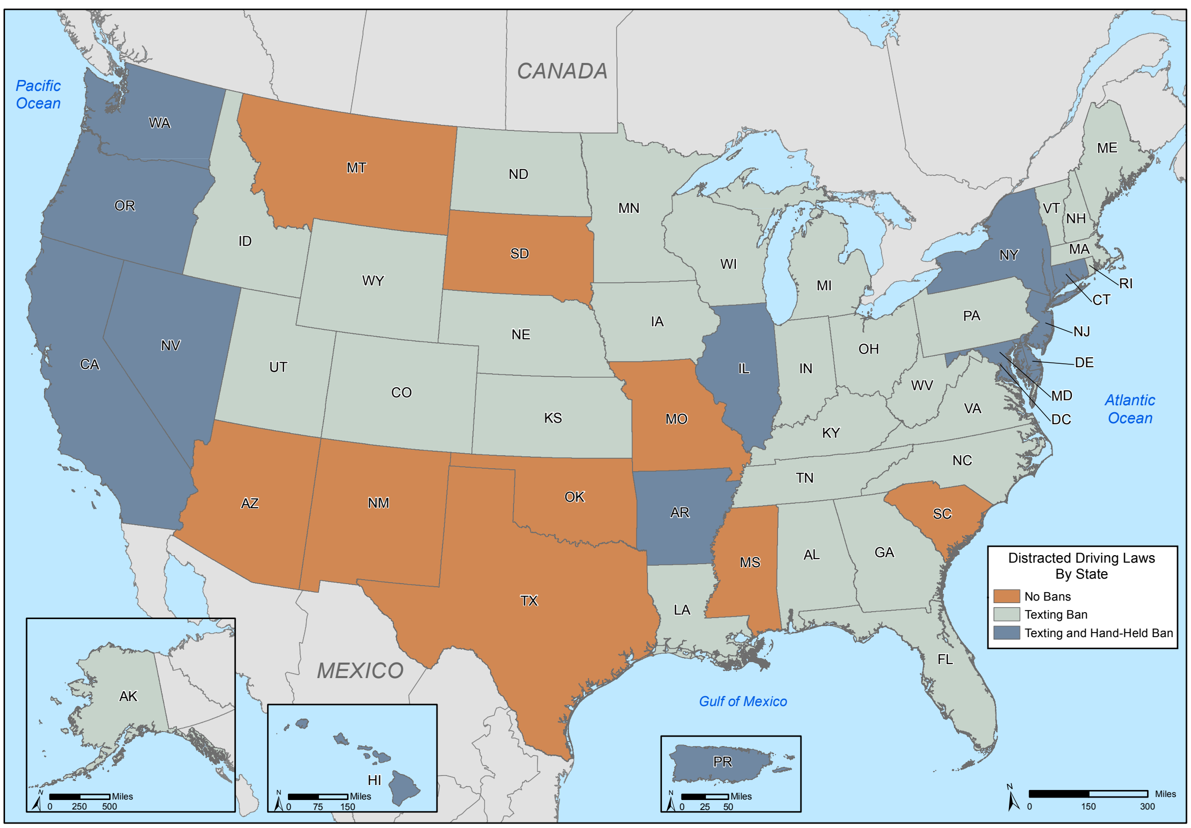
SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, *Distracted Driving 2012* (April 2014), Table 6, available at http://www-nrd.nhtsa.dot.gov/ as of July 2014.

9.9 percent of fatal crashes, 17.5 percent of injury crashes, and 15.7 percent of all property damage only crashes involving a motor vehicle in 2012 (table 7-6). Those 20 to 29 years old accounted for most (27 percent) of distracted driving crashes [USDOT NHTSA 2014b].

Although many activities are distracting while operating a motor vehicle or crossing a street, cell phone useage and texting have received the most attention as these devices have attained nearly universal usage in the last few years. Distraction-affected crashes involving cell phones increased from 5.2 percent in 2011 to 6.6 percent in 2012.

According to a 2012 AAA Foundation for Traffic Safety survey, 88.5 percent of licensed drivers reported that they considered drivers talking on cell phones to be a "somewhat" or "very" serious risk to their personal safety. In addition, 95.7 percent of respondents considered text messaging or emailing behind the wheel risky. Further, 90.3 percent of respondents

FIGURE 7-6 State Laws on Distracted Driving—Ban on Hand-Held Devices and Texting While Driving (as of April 2014)



SOURCE: U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration as cited in the USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*. Table 2-25. Available at http://www.bts.gov/ as of July 2014.

believe that distracted drivers are somewhat or a much bigger problem compared responses attained three years earlier [AAA 2013]. Figure 7-6 shows the 14 states and the District of Columbia that prohibit drivers' use of handheld cell phones, and the 43 states and the District of Columbia that ban texting while driving.

Distracted driving by commercial motor vehicle drivers was a contributing factor in 6.4 percent of the fatal crashes involving large trucks in 2012 [USDOT FMCSA 2014]. Distracted driving is not just limited to motor vehicles, distracted vehicle operators are found in all modes of transportation, including airline pilots, bus drivers, train engineers, and tugboat operators [NTSB 2014b]. Operator inattention is first among the primary contributing factors in recreational boating accidents, contributing to 14.0 percent of recreational boating accidents, 10.2 percent of related fatalities, and 14.2 percent of injuries [USDHS USCG OABS 2013a].

Driver Fatigue

In 2012 drowsy and fatigued driving were a factor for 2.8 percent of drivers and motorcycle riders involved in fatal crashes [USDOT NHTSA 2014c]. Steps have been taken to reduce the risk. In addition, commercial motor vehicle driver fatigue contributed to 1.7 percent and distraction or inattention to another 6.4 percent of fatal crashes involving large trucks in 2012 [USDOT FMCSA 2014]. For instance, the Federal Motor Carrier Safety Administration implemented new Federal regulations to reduce truck driver fatigue on July 1, 2013. The new hours-of-service final rule limits the current maximum average work week to 70 hours, a decrease of 12 hours from the previous maximum of 82 hours [USDOT FMCSA 2013b].

Occupant Protection Equipment

When properly used, safety devices appreciably reduce the risk of death or serious injury. NHTSA estimated that over 16,300 lives were saved on highways in 2012 by occupant protection devices, including safety belts, air bags, child restraints, and motorcycle helmets [USDOT NHTSA 2013b]. Specifically, safety belts saved almost 12,200 lives, air bags 2,200 lives, child restraints almost 300, and motorcycle helmets nearly 1,700 lives in 2012 (table 7-7). Many more lives could have been saved had these devices been used universally—an estimated 3,000 more lives could have been saved if seats belts were used 100 percent of the time and about 800 more from full use of DOT-compliant motorcycle helmets.

Despite such estimates, many people choose not to use seat belts or helmets [USDOT NHTSA 2013e]. In 2012, 79 percent of passenger vehicle occupants who were ejected from the vehicle were killed [USDOT NHTSA 2014d]. Eighty-seven percent of occupants of cars, vans, and sport utility vehicles (SUVs) used safety belts in 2013, up from 82 percent in 2005 (table 7-8).

DOT-compliant helmets are an effective safeguard, reducing the risk of dying in a motorcycle crash by 37 percent. Moreover, wearing a helmet reduces the need for

TABLE 7-7 Estimated Lives Saved by Occupant Protection, Motorcycle Helmets, and Drinking Age Laws: 2005–2012

	2005	2006	2007	2008	2009	2010	2011	2012
Safety belts[a]	15,688	15,458	15,223	13,312	12,763	12,582	11,983	12,174
Air bags	2,752	2,824	2,800	2,557	2,387	2,315	2,210	2,213
Motorcycle helmets	1,554	1,667	1,788	1,836	1,486	1,556	1,622	1,699
Age 21 minimum legal drinking age	882	888	831	716	626	552	535	525
Child restraints	424	427	388	286	307	303	265	263

[a] Represents all adults and children age 5 and older. Data are for passenger vehicles, which include cars, light trucks, vans, pickups, and utility vehicles. Excludes medium and heavy trucks.

SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, Traffic Safety Facts, Final Edition, (Washington, DC: Annual Issues), available at http://www-nrd.nhtsa.dot.gov/ as of June 10, 2014 as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*, table 2-31, available at http://www.bts.gov as of June 2014.

TABLE 7-8 Safety Belt and Motorcycle Helmet Use: 2005–2013

Percent

	2005	2006	2007	2008	2009	2010	2011	2012	2013
Overall Safety Belt Use	82	81	82	83	84	85	84	86	87
Drivers	83	82	83	84	85	86	84	87	88
Passengers	78	78	81	81	82	83	82	84	85
Passenger cars	83	82	84	84	86	86	85	87	88
Vans and sport utility vehicles	85	84	86	86	87	88	87	89	90
Pickup trucks	73	74	72	74	74	75	74	77	78
Motorcycle Helmet Use[b]	48	51	58	63	67	54	66	60	60
Operators	56	57	59	64	69	55	67	63	62
Passengers	29	33	56	54	55	51	64	46	50

[a] Seat belt use is as of the Fall each year except in 2005 (June). Motorcycle helmet use is as of the Fall each year except in 2005 (June).

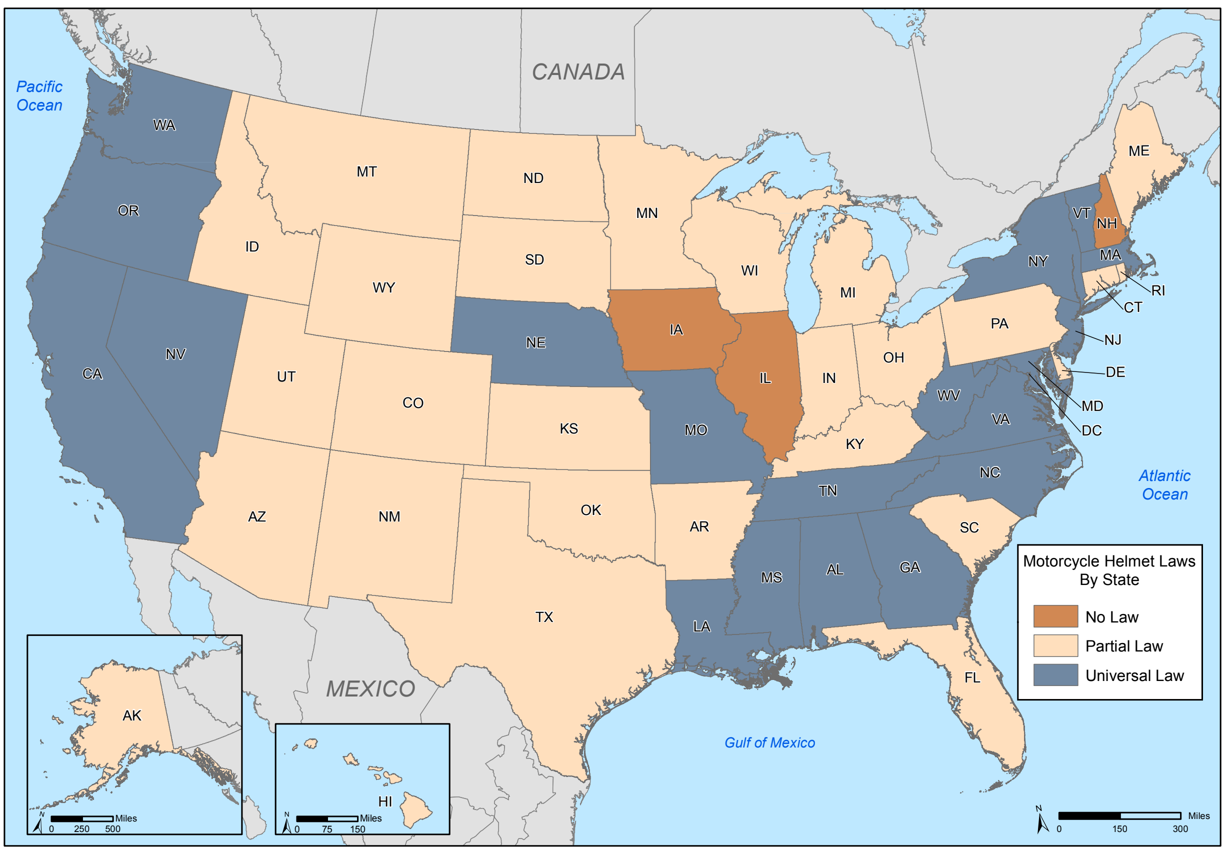
[b] Only those operators and riders wearing safety helmets that met U.S. Department of Transportation (DOT) standards are counted. Those safety helmets that do not meet DOT standards are treated as if the operator/rider were not wearing a helmet.

NOTE: Occupants of commercial and emergency vehicles are excluded.

SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, Traffic Safety Facts: Research Notes, *Seat Belt Use* (Annual issues); and *Motorcycle Helmet Use—Overall Results* (Annual issues), available at http://www-nrd.nhtsa.dot.gov as of June 2014 as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*, table 2-30, available at http://www.bts.gov as of June 2014.

emergency medical care, hospitalization, intensive care, rehabilitation, and long-term care in crashes involving a motorcycle [NTSB 2010]. Overall usage of DOT-compliant helmets by motorcyclists stood at 60 percent in 2012, up from 48 percent in 2005 but down from a peak of 67 percent in 2009 (table 7-8). Only 19 states and the District of Columbia have a universal helmet law, 28 states have a partial law covering certain riders and passengers (e.g., those under the age of 18), and 3 states (Illinois, Iowa, and New Hampshire) have no motorcycle helmet law (figure 7-7). In 2012, 89 percent of riders wore helmets in states that required helmet use while 49 percent of riders wore helmets in states that do not require their use [USDOT NHTSA 2013a]. By 1975, 47 states and the District of Columbia had adopted universal helmet use laws, which required motorcycle helmets for all riders. However, many states repealed such laws in the following years after the adoption of helmet laws as a prerequisite for attaining Federal highway construction funds was withdrawn in 1975 [COSGROVE 2007].

FIGURE 7-7 State Laws on Motorcycle Helmet Use (as of June 2014)



SOURCE: Insurance Institute for Highway Safety, Highway Loss Data Institute as cited in the U.S. Department of Transportation, Bureau of Transportation Statistics, *State Transportation Statistics*. Table 2-5. Available at http://www.bts.gov/ as of July 2014.

Most states require mandatory recreational boating education and safety training courses, but eight states do not (Alaska, Arizona, California, Idaho, Maine, South Dakota, Utah, and Wyoming). Boater education helps reduce the risk of boating accidents and death [NTSB 2013], and about 42.6 percent of U.S. boat owners have taken a boating safety course [USDHS USCG OABS 2013b]. In 2012 only 14 percent of deaths occurred on boats operated by someone who had received boating safety instruction [USDHS USCG OABS 2013a].

Drowning accounted for 71 percent of all fatal boating accidents in 2012, and almost 85 percent of those victims were not wearing a life jacket [USDHS USCG OABS 2013a]. As of January 2013, 48 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands have enacted laws or regulations requiring children to wear life jackets [NTSB 2013].

Traffic Safety Enforcement

Traffic safety enforcement promotes good driving habits (e.g., wearing a safety belt) and discourages unsafe behaviors (e.g., impaired driving) [USDOT NHTSA 2014]. According to the Bureau of Justice Statistics, about 10.2 percent of the Nation's 212.3 million drivers were stopped while operating a motor vehicle, 5.3 percent of drivers were ticketed, 3.4 percent were given a verbal or written warning, and 1.4 percent were allowed to proceed with no enforcement action taken in 2011 [USDOJ BJS 2013].

Males were more likely to be stopped and ticketed than females, accounting for 58.5 percent of ticketed drivers. The difference could be attributed to the fact that male drivers, as a whole, drive more than female drivers. Drivers who were 25 to 34 years of age accounted for about 22.4 percent of stopped drivers, which is the highest percentage among all age groups [USDOJ BJS 2013]. However, this age group accounts for only 13.7 percent of the vehicle-miles traveled [USDOT FHWA NHTS 2009].

In 2012, according to the Federal Bureau of Investigation, law enforcement agencies across the country made an estimated 1.2 million arrests for driving under the influence [FBI 2013]. Studies have shown sobriety checkpoints are an effective countermeasure to reduce alcohol-impaired driving; they may have reduced alcohol-related crashes by 20 percent [USDHHS CDC INJURY 2011].

The Federal Motor Carrier Safety Administration (FMCSA) has a mission to reduce crashes, injuries, and fatalities involving the Nation's approximately 504,000 interstate freight carriers, 12,000 interstate buses, and 16,000 interstate hazmat carriers. [USDOT FMCSA 2013a]. FMCSA issued over 24,000 warning letters in 2012 to commercial motor carriers whose safety data showed a lack of compliance with motor carrier safety regulations and whose safety performance had fallen to an unacceptable level [USDOT FMCSA 2013a]. Nearly 3.6 million roadside inspections were conducted in fiscal year 2012, a 46.0 percent increase from fiscal year 2000 (table 7-9), and 61.0 percent of these

TABLE 7-9 Activity Summary of Roadside Safety Inspection by Motor Carrier Inspection Type: 2000 and 2012

	2000		2012	
	Number	Percent	Number	Percent
All inspections				
Number of inspections	2,453,776	100.0	3,582,221	100.0
With no violations	639,593	26.1	1,395,748	39.0
With violations	1,814,183	73.9	2,186,473	61.0
Driver inspections				
Number of inspections	2,396,688	100.0	3,464,458	100.0
With no violations	1,459,538	60.9	2,463,117	71.1
With violations	937,150	39.1	1,001,341	28.9
With OOS violations	191,031	8.0	170,015	4.9
Vehicle inspections				
Number of inspections	1,908,300	100.0	2,442,853	100.0
With no violations	584,389	30.6	928,661	38.0
With violations	1,323,911	69.4	1,514,192	62.0
With OOS violations	452,850	23.7	491,541	20.1

KEY: OOS = out-of-service.

NOTES: There are six levels of inspection, including a Level I - North American Standard (NAS) Inspection, Level II - Walk-Around Driver/Vehicle Inspection, Level III - Driver-Only Inspection, Level IV - Special Inspections, Level V - Vehicle-Only Inspection, and Level VI - Enhanced NAS Inspection for Radioactive Shipments. For additional information on what each level entails, please see http://www.fmcsa.dot.gov/safety-security/safety-initiatives/mcsap/insplevels.htm. A roadside inspection is an examination of individual commercial motor vehicles and drivers to determine if they are in compliance with the Federal Motor Carrier Safety Regulations and/or Hazardous Materials Regulations. Serious violations result in the issuance of driver or vehicle out-of-service orders. Serious violations include operating a vehicle in a hazardous condition, hazardous materials onboard, or lack of required operating authority. These violations must be corrected before the driver or vehicle can return to service. Moving violations also may be recorded in conjunction with a roadside inspection.

SOURCE: U.S. Department of Transportation (USDOT), Federal Motor Carrier Safety Administration, Motor Carrier Management Information System (MCMIS), *Roadside Inspection Activity Summary for Fiscal Years*, special tabulation, October 2013 as cited in USDOT, Federal Highway Administration (FHWA) and the Bureau of Transportation Statistics (BTS). *Freight Facts and Figures 2013* (January 2014). Table 5-6. Available at http://www.bts.gov/ as of July 2014.

inspections resulted in violations. Vehicle violations put 20.1 percent of vehicles out-of-service, while driver violations, which commonly include hours-of-service noncompliance, put 4.9 percent of drivers out-of-service. Vehicle violations (e.g., worn tires, oil leaks) outnumbered driver violations 1.5 to 1. Such violations must be corrected before the driver or vehicle can return to service.

Hazardous Material Transportation

Transporting hazardous materials requires special precautions, handling, and reporting. There are separate safety regulatory systems in place for pipelines, rail, and vehicles that transport hazardous materials. These special requirements recognize that incidents involving the transportation of hazardous materials can affect the environment in addition to potentially risking injury and death. Table 7-10 shows the nearly 16,000 hazardous materials incidents in 2013, excluding pipeline. A very small share of hazardous materials transportation incidents are the result of a vehicular crash or train derailment (referred to as “accident-related”) as seen in table 7-10. Ninety percent of incidents related to the movement of hazardous materials occur on highways or in truck terminals. In 2013, 2.1 percent of accident-related incidents were attributable to vehicle crashes or train derailments, which accounted for the majority of property damage. Most hazardous materials incidents occur because of human error or package failure, particularly during loading and unloading. Table 7-11 provides a summary of the over 600 hazardous liquid- and gas-related incidents reported in 2013, which resulted in 10 fatalities, 46 injuries, and nearly $276 million in property damage.

Statistics show that the U.S. transportation system has become safer over the past few decades, even as use increases. This improvement is true across all modes. However, despite this progress, transportation remains a leading cause of death and injury each year. To continue the reduction in the number of deaths and injuries, USDOT has established safety improvement as its top priority. As part of these efforts, several agencies within the department have established data programs to gauge the safety performance of the transportation system, and new data programs to identify potential risk factors (boxes 7-A and 7-B).

TABLE 7-10 Hazardous Materials Transportation Incidents: 1990, 2000, and 2010–2013

	1990	2000	2010	2011	2012	2013
Total incidents	**8,879**	**17,557**	**14,802**	**15,026**	**15,439**	**15,766**
Total accident-related incidents	**297**	**394**	**359**	**376**	**398**	**329**
Air	297	1,419	1,295	1,400	1,460	1,438
Accident-related	0	3	2	2	2	3
Highway	7,296	15,063	12,653	12,810	13,247	13,604
Accident-related	249	329	321	334	363	296
Rail	1,279	1,058	749	745	662	661
Accident-related	48	62	35	40	33	30
Water[1]	7	17	105	71	70	63
Accident-related	0	0	1	0	0	0
Other[2]	0	0	NA	NA	NA	NA
Accident-related	0	0	NA	NA	NA	NA

KEY: NA = not available.

[1] Water category includes only packaged (nonbulk) marine. Non-packaged (bulk) marine hazardous materials incidents are reported to the U.S. Coast Guard and are not included.

[2] Other category includes freight forwarders and modes not otherwise specified.

NOTES: Hazardous materials transportation incidents required to be reported are defined in the Code of Federal Regulations (CFR), 49 CFR 171.15, 171.16 (Form F 5800.1). Hazardous materials deaths and injuries are caused by the hazardous material in commerce. Each modal total also includes fatalities caused by human error, package failure, and causes not elsewhere classified. As of 2005, the Other data are no longer included in the hazardous materials information system report. *Accident-related* means resulting from a vehicular crash or accident damage (e.g., a train derailment).

SOURCE: U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, Hazardous Materials Information System Database, available at www.phmsa.dot.gov/hazmat/library/data-stats as of February 2014.

TABLE 7-11 All Reported Hazardous Liquid and Gas Incidents: 2013

	Incidents Reported	Fatalities	Injuries	Property Damage	Gross Barrels Spilled (Haz Liq)	Net Barrels Lost (Haz Liq)
Hazardous Liquid	400	1	5	$215,234,460	120,411	90,555
Gas Transmission	105	0	2	$41,467,761		
Gas Gathering	8	0	0	$1,296,828		
Gas Distribution	110	9	39	$17,783,774		
TOTAL	**623**	**10**	**46**	**$275,782,823**	**120,411**	**90,555**

KEY: *Haz Liq* = Hazardous Liquid

SOURCE: U.S. Department of Transportation, Pipeline and Hazardous Material Safety. *All Reported Pipeline Incident: 2013*. Available at http://primis.phmsa.dot.gov as of February 2014.

BOX 7-A

Confidential Close Call Reporting System

The Confidential Close Call Reporting System (C3RS) is intended to improve rail and transit safety by studying near-miss incidents and unsafe situations, identifying their root causes, and developing preventative measures or corrective actions. It is hoped that this reporting program will help foster a safety culture without the threat of administrative discipline.

The program is operated by the Bureau of Transportation Statistics (BTS) under agreements with Union Pacific Railroad, Canadian Pacific Railway, New Jersey Transit, and the Washington Metropolitan Area Transit Authority to allow their employees to voluntarily report close call events without threat of disciplinary action. BTS protects data and information collected for statistical purposes under the *Confidential Information Protection and Statistical Efficiency Act* of 2002, which established uniform confidentiality protections over the disclosure and use. Preliminary results show a significant reduction in minor derailments in yard operations.

BOX 7-B

Position, Navigation, and Timing Technology

Global Positioning Systems (GPSs) provides positioning, navigation, and timing services that are widely used in all modes of transportation. GPS helps prevent transportation accidents, aids search and rescue efforts, and speeds the dispatch of emergency services [NCO 2013]. Satellite-based technologies, such as GPS, are an integral component to the efficiency and effectiveness across modes of transportation. For example, the Next Generation Air Transportation System (NextGen) integrates GPS to help increase operational safety and situational awareness for aviation system users, especially during approaches and departures, and while taxiing on the ground [NCO 2013]. Another example is Positive Train Control (PTC). PTC works in conjunction with GPS technologies to track train location and speed—data that can be used to stop trains from going too fast and to prevent fatal accidents (especially head-on collisions) due to fatigue, sleepiness, and distractions [NTSB 2014c]. On waterways and especially in port, GPS helps vessels maneuver around navigational hazards and traffic [NCO 2013]. GPS technologies can help track vehicles and their valuable cargo's location, which may help to reduce the loss of $15 to $30 billion annually in cargo theft and pilferage from commercial motor vehicles [FMCSA 2011].

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—2013b. *Lives Saved in 2012 by Restraint Use and Minimum Drinking Age Laws* (November 2013). Available at http://www.nhtsa.gov/ as of July 2014.

—2013c. *Traffic Safety Facts 2012 Data: Alcohol-Impaired Driving* (December 2013). Available at http://www.nhtsa.gov/ as of September 2014.

—2012a. *New NHTSA Analysis Shows 2011 Traffic Fatalities Declined by Nearly Two Percent* (December 2012). Available at http://www.nhtsa.gov/ as of October 2013.

—2012b. *Impaired Driving* (December 2012). Available at http://www.nhtsa.gov/ as of October 2013.

—2012c. *An Analysis of Recent Improvements to Vehicle Safety* (June 2012). Available at http://www.nhtsa.gov/ as of March 2014.

CHAPTER 8

Energy and Environment

This chapter reviews the patterns and trends in transportation use of energy and impacts on the environment. These aspects of the transportation system are also important measures of performance to be taken into account along with such primary measures as system reliability, efficiency, and safety.

Recent trends show reduced U.S. petroleum dependence as a result of nearly constant domestic consumption and increased domestic production. U.S. dependence on imported oil peaked at 60.3 percent in 2006, but has since decreased from 51.5 percent in 2009 to 39.9 percent in 2012 [USDOE EIA 2013f].

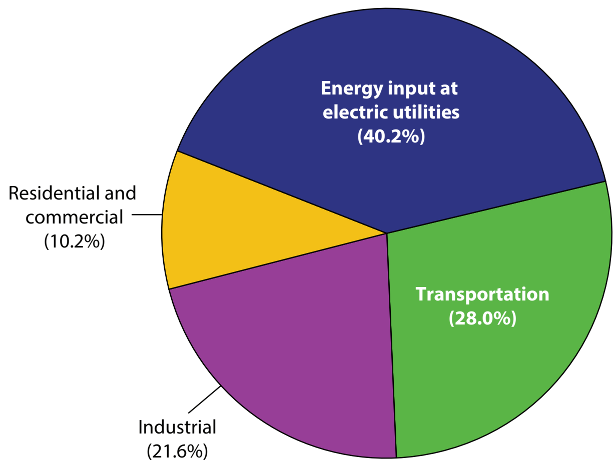
In 2012 the U.S. transportation sector used 27 quadrillion Btu (British thermal unit) of energy, second only to electricity generation but down from the peak of 29 quadrillion Btu in 2007 (figure 8-1 and 8-2).[1] Transportation

[1] Total transportation energy use reported here is almost 2 quads higher than the detailed modal breakdown shown in table 8-1. This is due to differences in definitions, data sources, and estimation methods. For example, table 8-1 excludes some off-highway used of gasoline and diesel fuel as well as energy for international air transport and shipping.

- Transportation relies almost entirely on petroleum to move people and goods. Recent trends, however, show decreasing transportation dependence on imported oil, primarily due to the introduction of domestically produced ethanol in gasoline and increased domestic oil production.
- The highway mode dominates transportation energy use, accounting for 83.5 percent of the total in 2011. Personal vehicles, such as passenger cars, sport utility vehicles, minivans, and pick-up trucks, accounted for 73.7 percent of highway energy use and 61.5 percent of total transportation energy use.
- Transportation is the second largest producer of greenhouse gas emissions, accounting for 27.3 percent of the U.S. total in 2011. Since 2005 transportation-produced greenhouse gases have been decreasing because of improved energy efficiency, less vehicle travel, and increased use of biofuels.
- All transportation-related air pollutant emissions are lower than they were in 1990, resulting in improved air quality in many urban areas. The number of days that resulted in the nonattainment of at least one national air quality standard in an urban area decreased from 4,091 in 1990 to 1,012 in 2010.

FIGURE 8-1 U.S. Energy Use by Sector: 2012

Total = 95.1 quadrillion Btu



KEY: Btu = British thermal unit.

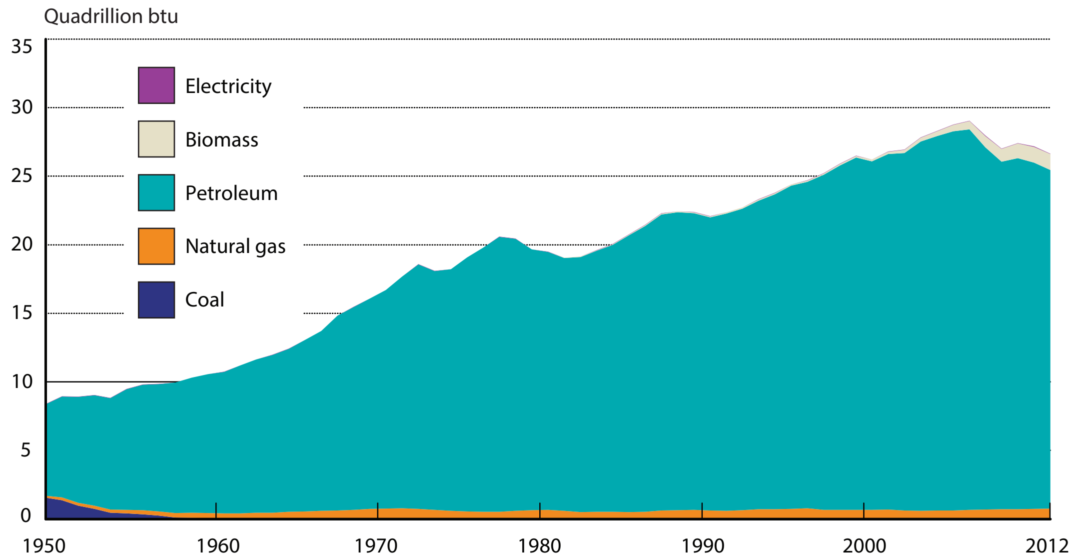
NOTES: The data for *Residential, Commercial, and Industrial* sectors include only fossil fuels consumed directly. Most renewable fuels are not included. The data for the *Transportation* sector includes only fossil and renewable fuels consumed directly. The data for *Electric utilities* includes all fuels (fossil, nuclear, geothermal, hydro, and other renewables) used by electric utilities.

SOURCE: U.S. Department of Energy, Energy Information Administration as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*. Table 4-2. Available at http://www.bts.gov as of November 2013.

relied on petroleum for 92.7 percent of the energy it used in 2012, down from a peak of 97.3 percent in 1978 (figure 8-2). The United States consumes nearly 18.5 million barrels of oil per day (nearly twice as much as China's 10.3 million barrels), of which 13.0 million barrels (70.1 percent) are consumed by the U.S. transportation system. Despite transportation's dependence on petroleum, recent trends show decreasing dependence on imported petroleum, sharply reduced emissions of air pollutants, and small reductions in greenhouse gas emissions.

Aggregate national emissions of the six common air pollutants (carbon monoxide, lead, nitrogen dioxide, volatile organic compounds, particulate matter, and sulfur dioxide) dropped an average of 61.9 percent between 1990 and 2012 [USEPA 2014]. Greenhouse gas (GHG) emissions (carbon dioxide, hydrofluorocarbons, methane, and nitrous oxide) closely parallel transportation energy use and, as a result, were 17.9 percent higher in 2012 than in 1990. Since 2005, however, transportation GHG emissions have been decreasing as a result of less vehicle travel, improved energy efficiency, and increased use

FIGURE 8-2 Transportation Energy Use by Energy Source: 1950–2012



KEY: Btu = British thermal unit.

SOURCE: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review*, table 2.1e, *Monthly Energy Review*, table 2.5. Available at http://www.eia.gov as of September 2013.

of biofuels. Tighter fuel economy and emission standards are expected to further reduce air pollutant emissions.

Energy Use Patterns and Trends

After four decades of oil price shocks and a variety of incentives for alternative fuels, the U.S. transportation sector remains heavily dependent on petroleum (figure 8-2). Transportation's petroleum dependence decreased from 96.7 percent in 2004 to 92.7 percent in 2012, chiefly due to increased blending of domestically produced ethanol from biomass in gasoline [USDOE EIA 2013a]. Today almost all gasoline sold in the United States contains 10 percent ethanol (E10).

Nearly all transportation-related natural gas consumption, shown in figure 8-2, is used to fuel pipeline compressors. Natural gas use by motor vehicles remains a small fraction of total transportation energy use. Recently lower prices and abundant domestic supplies have increased interest in natural gas as a motor fuel.

Transportation's petroleum use is expected to remain at about 13.5 million barrels per day through 2020 and beyond, chiefly due to decreases in personal vehicle gasoline use as a consequence of tightened fuel economy standards [USDOE EIA 2013d]. However, declining personal vehicle petroleum use is projected to be offset by growth in petroleum demand by other modes, particularly medium and heavy-duty trucks. According to the Freight Analysis Framework, freight tonnage is forecast to grow annually by 1.3 percent during this period (table 4-1).

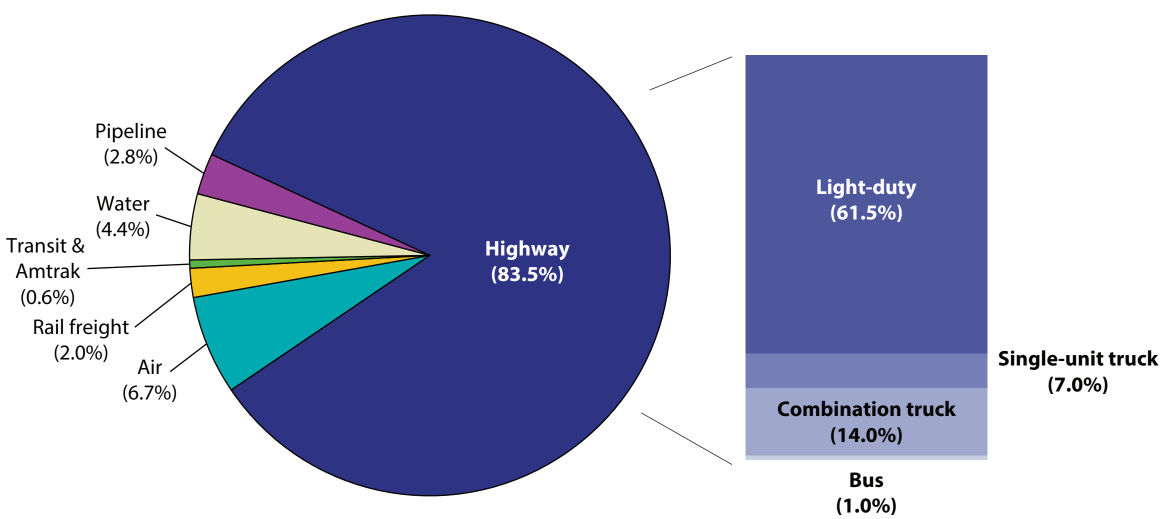
Alternative fuels use (excluding gasohol) by motor vehicles is increasing. Total alternative fuel use exceeded 500 million gasoline-equivalent gallons in 2011, up 12.7 percent over 2010 levels [USDOE EIA 2013b]. In comparison, about 138 billion gallons of gasoline were consumed[2] in the United States [USDOE EIA 2014]. Compressed and liquefied natural gas accounted for almost one-half of the total, followed by E85, propane, electricity, and hydrogen. E85 is a blend of between 51 percent and 85 percent denatured ethanol and gasoline and can be used safely by approximately 10 million flex-fuel vehicles operating on U.S. roads.

The highway mode dominates transportation energy use. Highway vehicles were responsible for 83.5 percent of total transportation energy use in 2011 (figure 8-3). Light-duty vehicles (passenger cars, sport utility vehicles, minivans, and pick-up trucks) accounted for three-fourths of highway energy use and 61.5 percent of total transportation energy use.

[2] EIA uses *product supplied* to approximately represent consumption of petroleum products. It measures the disappearance of these products from primary sources, such as refineries, natural gas processing plants, blending plants, pipelines, and bulk terminals.

FIGURE 8-3 Energy Use by Mode of Transportation: 2011

Total = 25 quadrillion Btu



KEY: Btu = British thermal unit

SOURCE: Various sources as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 4-6, Available at http://www.bts.gov as of November 2013.

TABLE 8-1 Transportation Energy Use by Mode: 2011

Energy and Physical Units of Measure

	Trillion Btu	Percent of total	Units	Physical units
Air				
Certificated carriers[a]				
Jet fuel	1,467	5.8	(million gallons)	10,864
General aviation[b]				
Aviation gasoline	26	0.1	(million gallons)	216
Jet fuel	201	0.8	(million gallons)	1,491
Highway				
Gasoline, diesel and other fuels				
Light-duty vehicle, short wheel base and motorcycle[c]	11,120	44.0	(million gallons)	88,962
Light-duty vehicle, long wheel base[c]	4,416	17.5	(million gallons)	35,326
Single-unit 2-axle 6-tire or more truck	1,773	7.0	(million gallons)	14,183
Combination truck	3,524	14.0	(million gallons)	28,193
Bus	242	1.0	(million gallons)	1,933
Transit				
Electricity	22	0.1	(million kWh)	6,534
Motor fuel				
Diesel[d]	80	0.3	(million gallons)	625
Gasoline and other nondiesel fuels[e]	19	0.1	(million gallons)	101
Compressed natural gas	18	0.1	(million gallons)	128
Rail, Class I (in freight service)				
Distillate / diesel fuel	511	2.0	(million gallons)	3,685
Amtrak				
Electricity	2	0.01	(million kWh)	555
Distillate / diesel fuel	9	0.03	(million gallons)	63
Water				
Residual fuel oil	683	2.7	(million gallons)	4,560
Distillate / diesel fuel oil	295	1.2	(million gallons)	2,128
Gasoline	138	0.5	(million gallons)	1,104
Pipeline				
Natural gas	705	2.8	(million cubic feet)	683,715
TOTAL	**25,250**			

KEY: Btu = British thermal unit.

[a] Domestic operations only.

[b] Includes fuel used in air taxi operations, but not commuter operations.

[c] *Light-duty vehicle, short wheel base* includes passenger cars, light trucks, vans and sport utility vehicles with a wheelbase (WB) equal to or less than 121 inches. *Light-duty vehicle, long wheel base* includes large passenger cars, vans, pickup trucks, and sport/utility vehicles with wheelbases (WB) larger than 121 inches.

[d] *Diesel* includes Diesel and Bio-Diesel.

[e] *Gasoline and all other nondiesel fuels* include gasoline, liquefied petroleum gas, liquefied natural gas, methane, ethanol, bunker fuel, kerosene, grain additive, and other fuel.

NOTES: The following conversion rates were used:

Jet fuel = 135,000 Btu/gallon.
Aviation gasoline = 120,200 Btu/gallon.
Automotive gasoline = 125,000 Btu/gallon.
Diesel motor fuel = 138,700 Btu/gallon.
Compressed natural gas = 138,700 Btu/gallon.
Distillate fuel = 138,700 Btu/gallon.
Residual fuel = 149,700 Btu/gallon.
Natural gas = 1,031 Btu/ft3.
Electricity 1kWh = 3,412 Btu, negating electrical system losses. To include approximate electrical system losses, multiply this conversion factor by 3.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, tables 4-5 & 4-6. Available at http://www.bts.gov as of November 2013.

The predominance of the highway mode in transportation energy use is shown in greater detail in table 8-1. In 2011 highway vehicles used five times more energy than all other modes combined, accounting for 83.5 percent of the total. Air transport comes in a distant second with 6.7 percent of transport energy use, but this number excludes energy for international flights. Jet fuels supplied to international flights originating in the United States amounted to 939.6 trillion Btu in 2011 [USEPA 2013b]. Water transportation is third with 4.4 percent, but once again most of the energy used in international shipments is not included in this figure. An estimated 620.2 trillion Btu were supplied to international ships at U.S. ports in 2011 [USEPA 2013b]. Rail freight accounts for 2.0 percent of transportation energy use, although it carries roughly one-half of U.S. ton-miles. Transit operations are responsible for 0.6 percent of transportation energy use.

Greenhouse Gas Emissions

The transportation sector is the second largest producer of greenhouse gas (GHG) emissions, accounting for 27.3 percent of total U.S. emissions in 2011 [USEPA 2013b]. Carbon dioxide (CO_2) produced by the combustion of fossil fuels in internal combustion engines is the predominant GHG emitted by the transportation sector. In 2011 motor vehicles accounted for 95.9 percent of the 1,834 million metric tons of CO_2 equivalent emissions by the transportation sector. The four principle GHGs—methane (CH_4), CO_2, nitrous oxides (N_2O), and hydrofluorocarbons (HFC)—emitted by transportation have different global warming potentials. Figure 8-4 shows the common metric of equivalent grams of CO_2 for each emission.

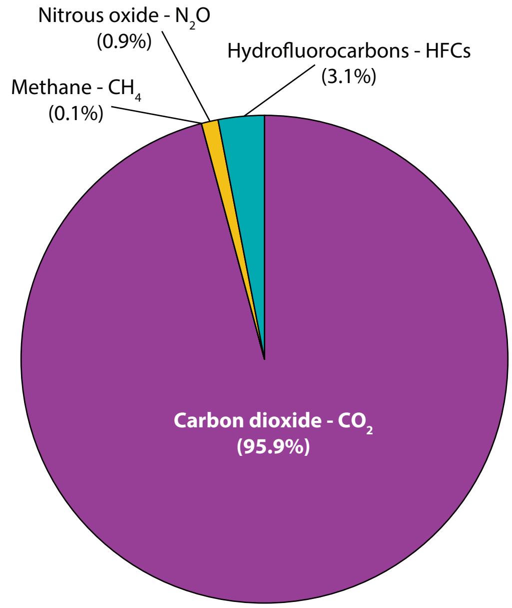
Hydrofluorocarbons and other replacements for ozone-destroying gases once used in automotive air conditioners are second in importance.[3] HFCs are the most potent GHGs known. GHG emission regulations for personal vehicles give manufacturers credits for reducing these emissions, and it is likely that HFC emissions will decrease in the future. Nitrous oxides are chiefly produced in the catalytic converters of motor vehicles, and a very small quantity of methane emissions is produced by incomplete combustion of fossil fuels or by leakage.

Because 95.9 percent of transportation GHG emissions are CO_2 produced by fossil fuel combustion and because petroleum comprises 92.7 percent of transportation energy use, modal GHG emissions closely track modal energy use. Transportation GHG emissions increased from 1990 to 2007, fell sharply with the economic recession in 2008, and remained at about 1,850 teragrams (million metric tons) through 2011 (figure 8-5). Evident in figure 8-5 are the results of the U.S. Environmental Protection Agency's (EPA's) decision to change the definitions of passenger cars and light trucks in 2007. Many vehicles formerly classified as light trucks, but designed predominantly for passenger transportation, were reclassified as passenger cars, causing an apparent jump in passenger car

[3] The original coolants were chlorofluorocarbons (CFCs), which when released into the atmosphere were found to create holes in the stratospheric ozone layer that helps to protect the Earth's surface from harmful radiation.

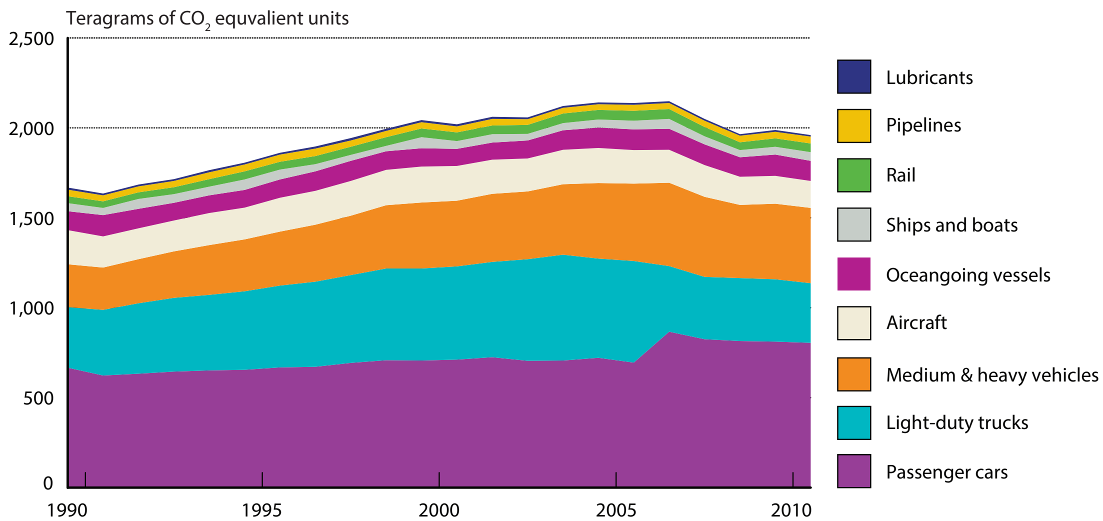
FIGURE 8-4 Transportation-Related Greenhouse Gas Emissions: 2011

Total = 1,834 teragrams of CO_2 equivalent units



SOURCE: U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (Washington, DC: Annual Issues), table 2-15. Available at http://epa.gov/climatechange/emissions/usinventoryreport.html as of November 2013.

FIGURE 8-5 Greenhouse Gas Emissions by Transportation Source: 1990–2011



KEY: Tg CO_2 Eq = teragrams of carbon dioxide equivalent.

NOTES: Totals may not sum due to independent rounding. Passenger cars and light-duty trucks include vehicles typically used for personal travel and less than 8,500 lbs; medium- and heavy-duty trucks include vehicles larger than 8,500 lbs.

SOURCE: U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (Washington, DC: Annual Issues), table 2-15. Available at http://epa.gov/climatechange/emissions/usinventoryreport.html as of November 2013.

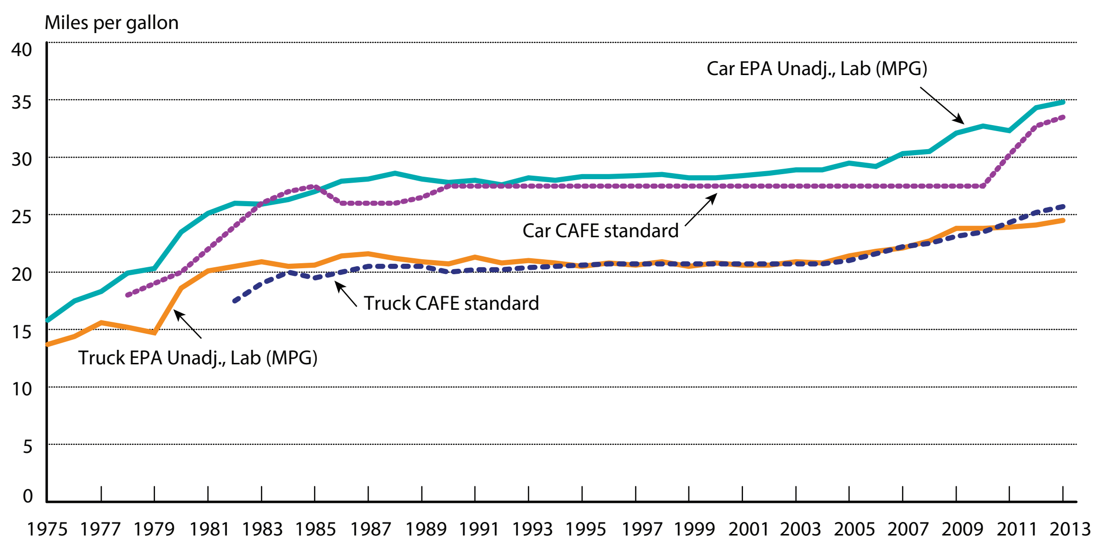
emissions that were offset by a compensating drop in light truck emissions.

Energy Efficiency

In the past, transportation reduced the growth of its energy use by improving the efficiency with which energy was used. The fuel economies of passenger cars and light trucks have closely tracked the Corporate Average Fuel Economy (CAFE) standards since they took effect in 1978 (figure 8-6). The miles per gallon (mpg) values shown in figure 8-6 are the unadjusted test values on which compliance with the standards is based. However, the actual mpg values seen on window stickers and in public advertising are adjusted downward to better represent the fuel economy drivers will likely experience on the road.

The estimated on-road fuel economy for all personal vehicles (passenger cars and light trucks) increased through 1987 but remained nearly constant through 2000. After 2000, fuel prices increased and CAFE standards were raised, first for light trucks and then for passenger cars. The apparent decrease in on-road fuel economy estimates after 2005 more likely reflects a change in the definitions of passenger cars and light trucks and the methods used to estimate their travel and fuel use than an actual decrease in miles per gallon.

FIGURE 8-6 Car and Truck Corporate Average Fuel Economy (CAFE) and Miles per Gallon (MPG): Model Years 1975–2013

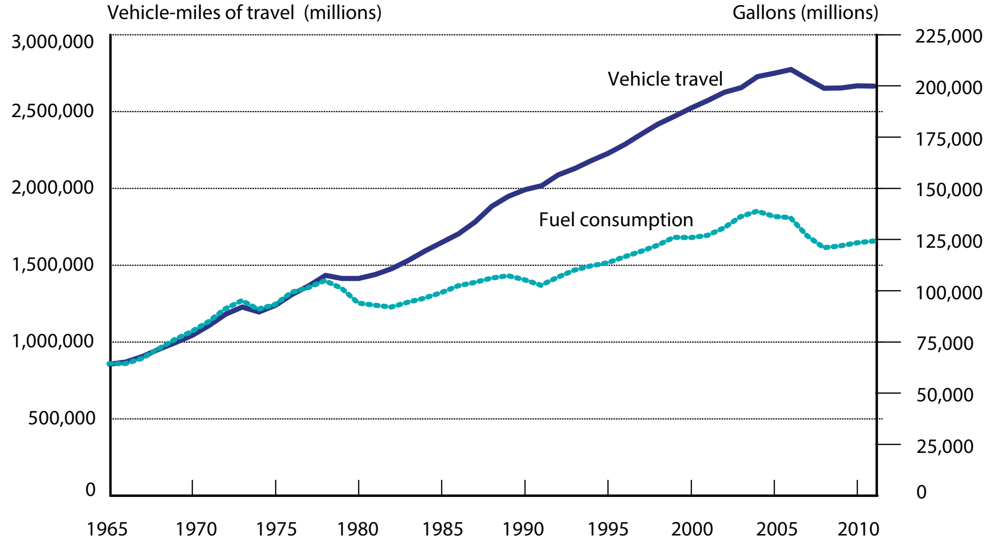


KEY: MPG = Miles per Gallon, CAFE = Corporate Average Fuel Economy, EPA = U.S. Environmental Protection Agency.

NOTES: Corporate Average Fuel Economy (CAFE) standards, which must be met at the manufacturer level were established by the *U.S. Energy Policy and Conservation Act of 1975* (PL94-163).

SOURCE: All Car and All Truck CAFE Stds: Davis, S.C., S.W. Diegel and R.G.Boundy. *Transportation Energy Data Book*, Edition 33 (July 2014), Oak Ridge National Laboratory, Oak Ridge, TN. Tables 4-21 and 4-22. Available at cta.ornl.gov/data as of October 2014. **Car and All Truck EPA MPG:** U.S. Environmental Protection Agency (EPA), *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 - 2013*. Table 9.1. Available at http://epa.gov/otaq/fetrends.htm as of October 2014.

FIGURE 8-7 Miles of Travel and Fuel Use by Personal Vehicle: 1965–2011



NOTES: Includes passenger cars, light trucks and motorcycles for years 1965. The definition of a light-duty vehicle was changed after 2006 resulting in about 5 percent higher fuel economy than previous years.

SOURCE: Vehicle-Miles of Travel: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics* (multiple years), Vehicle-miles of travel tables, available at http://www.fhwa.dot.gov/policyinformation/statistics.cfm as of November 2013. **Fuel Consumption**: U.S. Department of Transportation, Federal Highway Administration, Highway Statistics (multiple years); Motor-Fuel Use table, available at http://www.fhwa.dot.gov/policyinformation/statistics.cfm as of November 2013.

Starting in 2006, the U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA) began reporting vehicle travel and fuel consumption statistics for short- and long-wheelbase light-duty vehicles rather than for the previous categories of passenger cars and two-axle, four-tire trucks.[4] As a result, the post 2006 on-road fuel economy data are not consistent with the data from 2006 and earlier years.

[4] A vehicle's wheelbase is the distance from the center of its rear axle to the center of its front axle. "Short-wheelbase" light-duty vehicles include passenger cars, pick-up trucks, vans, minivans, and sport-utility vehicles with wheelbases less than or equal to 121 inches. The same types of vehicles with wheelbases longer than 121 inches are classified as "long-wheelbase" light-duty vehicles. Typically, light-duty vehicles have gross vehicles weights of less than 10,000 pounds.

Before 1975 personal vehicle travel and fuel use typically moved in parallel tracks (figure 8-7). Fuel economy improvements after 1975 broke the close connection as the amount of fuel used per vehicle mile of travel steadily decreased. The gap widened as newer, higher miles per gallon (mpg) vehicles came to dominate the on-road fleet, eventually raising average mpg from 13.3 in 1975 to 21.4 in 2012. However, drops in fuel use are tempered somewhat by increases in travel stimulated by improvements in fuel economy, a phenomenon known as the "rebound effect."[5] In 2012 light-

[5] There is a reasonable consensus in the economics literature that the rebound effect over this period of time induced a 1 percent to 2 percent increase in vehicle travel for each 10 percent increase in fuel economy (GREENE 2011).

duty vehicles used 76 billion fewer gallons of motor fuel than they would have assuming the same level of vehicle travel, but 1975 average on-road fuel economy. The average price of gasoline in the United States in 2012 was $3.70 per gallon, or $3.30 net of motor fuel taxes, implying a net savings due to fuel economy improvements of approximately $225 billion dollars in 2012 alone.

On August 28, 2012, the USDOT and the EPA set fuel economy and GHG emissions standards for passenger cars and light trucks through 2025. Nominally, the standards require a total fleet average of 54.5 mph (163 grams of CO_2 equivalent) for new personal vehicles by 2025 [USEPA 2012]. However, this is based on laboratory test cycles rather than real world driving and does not consider the many ways manufacturers can earn fuel economy credits. Credits may be earned for more efficient air conditioners that leak less HFC, which is a potent greenhouse gas; for solar panels on hybrids; engine shut off at idle; and other features that improve real world fuel economy, but are not reflected in the test cycle. Additional credits may be earned for production of plug-in electric vehicles, hydrogen fuel cell vehicles, and vehicles powered by compressed natural gas. Furthermore, the new standards vary with the size of the vehicles a manufacturer produces. If a manufacturer produces mostly large vehicles, then its actual fuel economy requirement will be lower than if it produces mostly small vehicles.[6] Taking all these factors into account, USDOT and EPA estimated that manufacturers would achieve fuel economy levels of 46.2 to 47.4 mpg on the laboratory test cycles [FEDERAL REGISTER 2012]. Fuel economies achieved in actual driving would likely be 15 to 20 percent lower.

Medium- and heavy-duty highway vehicles are the second largest energy users among modes, accounting for 21.9 percent of transportation energy use in 2012. In 2011 the USDOT and the USEPA announced the first fuel economy and emission standards for this vehicle class for model years 2014–2018 [USEPA 2011]. The standards apply to highway vehicles with gross vehicle weights above 8,500 pounds and set targets that vary depending on the type of vehicle and its functions. With the promulgation of these standards, nearly all highway vehicles became subject to fuel economy and CO_2 emissions rules. By 2018 the requirements for combination tractor trailers specify fuel economy improvements ranging from 9 to 23 percent, depending on the truck type. Goals for pickups and vans average 12 percent for gasoline engines and 17 percent for diesels. Similar improvements are required for the diverse class of vocational vehicles, such as dump trucks, cement mixers, and school buses. The EPA standards also require reductions in methane and nitrous oxides emissions and HFC leakage.

The energy intensities[7] of passenger modes have generally declined over time with five out of six passenger modes now averaging

[6] The size of a vehicle is defined as the rectangular "footprint" formed by its four tires. A vehicle's footprint is its track (width) multiplied by its wheelbase (length).

[7] Energy intensity is the amount of energy used to produce a given level of output or activity, e.g., energy use per passenger-mile of travel.

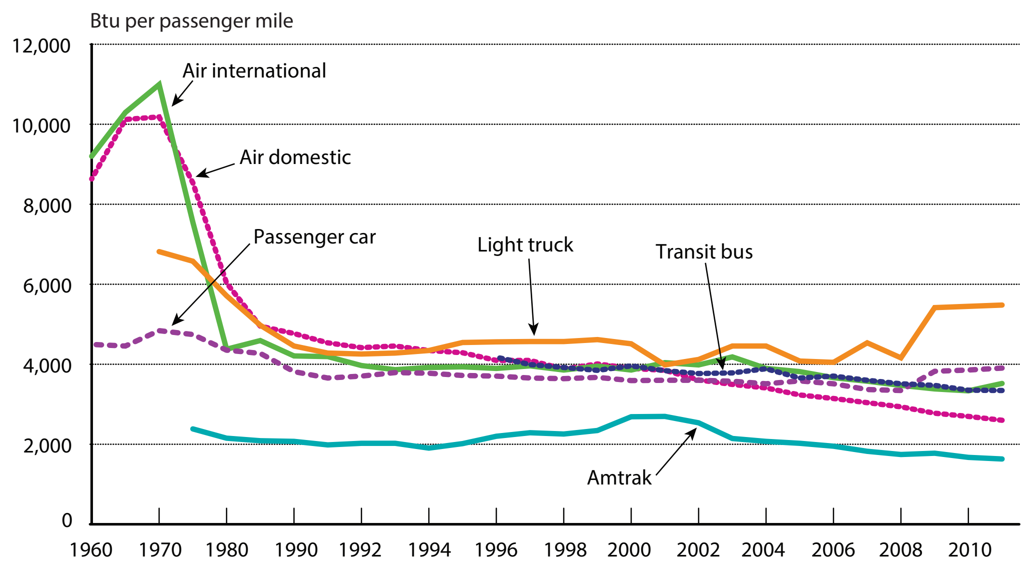
about 4,000 Btu per person-mile or about 30 person-miles per gallon of gasoline equivalent (figure 8-8). These declines are largely the result of more aerodynamic vehicles and efficient engines as well as improved operating efficiencies (e.g., higher air carrier load factors). In the decade from 2001 to 2011, the energy intensity of light trucks rose while that of passenger cars increased a smaller amount. The energy intensity of the other passenger modes—air, transit bus, and Amtrak —all declined.

The energy intensity of rail freight transport decreased at an average annual rate of 2.3 percent per year from 1960–1990 and 1.6 percent per year thereafter. In 2011 moving 1 ton of freight 1 mile required 35 percent as much energy as it did in 1960. This was accomplished by reducing energy use per freight car-mile by 18.2 percent while simultaneously increasing tons carried per car-mile by 132.2 percent [USDOT BTS NTS 2013].

Alternative Fuels and Vehicles

A large part of the growing use of biofuels in transportation, shown in figure 8-2, can be attributed to the requirements of the Federal Renewable Fuels Standard (RFS). Enacted as part of the *Energy Policy Act* of 2005 (Pub. L. 109-58) and extended by the *Energy Independence and Security Act* of 2007 (Pub. L. 110-140), the RFS requires the introduction of increasing amounts of renewable energy into gasoline and diesel fuels each year, ultimately reaching 36 billion gallons by 2022 [USLOC CRS 2013]. At least 16 billion gallons must be

FIGURE 8-8 Energy Intensity of Passenger Modes: 1960–2011



KEY: Btu = Britsh thermal unit.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 4-20, Available at http://www.bts.gov as of November 2013.

cellulosic ethanol,[8] and no more than 15 billion gallons can be ethanol produced from corn starch. In 2011 the United States produced and consumed 14 billion gallons of fuel ethanol and 878 million gallons of biodiesel [USDOE EIA 2013c]. In comparison, a total of 36 billion of gallons of diesel fuel were consumed by vehicles in 2012 [USDOE EIA 2013h].

The RFS is currently facing two important challenges: 1) there is still almost no capacity to produce cellulosic ethanol, which has led the EPA to reduce cellulosic ethanol requirements every year and, 2) the blending of ethanol with gasoline is very close to market saturation at the current 10 percent level. This means that additional ethanol production can only be absorbed by expanding the current distribution network of high ethanol blend fueling stations and increasing the numbers of vehicles capable of using these higher blends—up to and including E85 (85 percent ethanol, 15 percent gasoline). In 2013 the EPA decreased the requirement for cellulosic ethanol from 14 billion to 6 million gallons per year, less than one one-thousandth of the statutory amount, reflecting the absence of adequate production capacity for cellulosic ethanol. The EPA also has expanded the types of biofuels that can qualify under the RFS program to include such fuels as gasoline produced from biomass. At present, however, the capacity does not exist to produce these fuels in volumes that could make a meaningful contribution to achieving the RFS goals.

[8] Cellulosic ethanol is produced from non-food based feedstock, such as wood and crop residues (corn husks, cobs and stalks), and switch grass.

Nearly all U.S. gasoline now contains up to 10 percent ethanol. All automobile manufacturers' warranties allow 10 percent ethanol/90 percent gasoline blends (E10). In 2012 motor vehicles used 134 billion gallons of gasoline, including almost 13 billion gallons of ethanol [USDOE EIA 2013c]. Higher levels of ethanol of up to 15 percent (E15) may pose difficulties for motorcycles, older vehicles, and off-highway engines. The EPA has not approved nor tested E15 for proper engine performance and fuel economy in motorcycles [FRANK 2013]. Generally, manufacturers have been reluctant to extend their warrantees to include higher level blends. The 10-percent limit has been termed the "blend wall," in that it appears to constrain the amount of ethanol that can be safely mixed with gasoline as a strategy for meeting the RFS. In 2011, after extensive study, the EPA issued a rule permitting E15 use in model year 2001 and newer motor vehicles (the majority of personal vehicles on the road). However, manufacturers have challenged the ruling based on concerns about the potential for misfueling of older vehicles not capable of using E15 without risking mechanical problems. Concern about the potential risk of misfueling appears to be responsible for the very limited availability of E15. As of June 2013 there were only 24 refueling stations in the United States, out of a total of approximately 150,000, offering E15 [ODELL 2013].

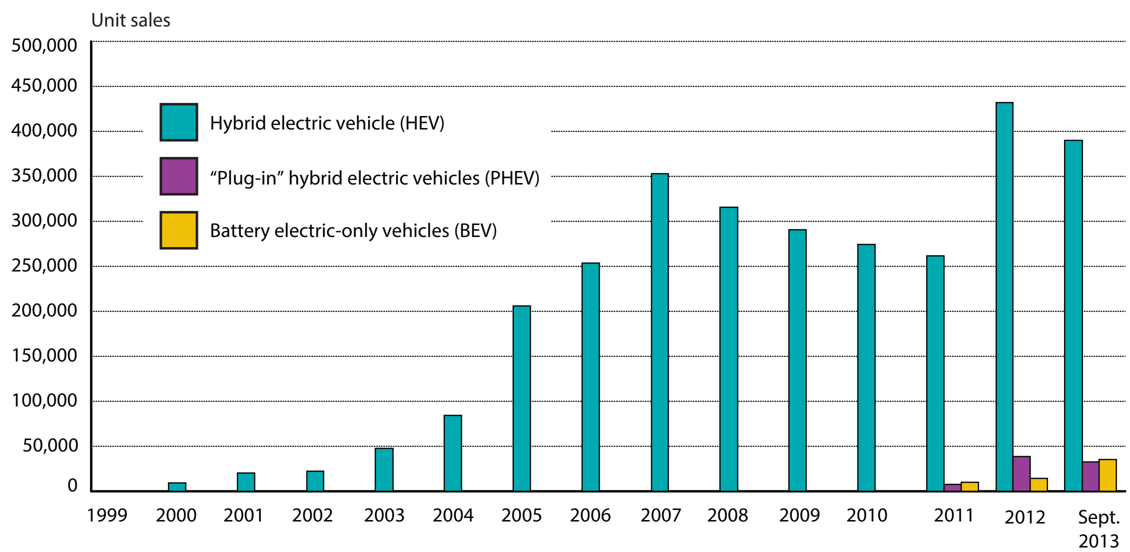
Flexible-fuel vehicles (FFVs) can safely use mixtures of up to 85 percent ethanol

(E85) with gasoline.[9] In 2011 there were approximately 10 million FFVs operating on U.S. roads, but only about 10 percent have used E85 [USDOE EIA 2013e]. Until 2016 automobile manufactures can earn extra credits toward meeting Corporate Average Fuel Economy (CAFE) standards by making and selling FFVs. Future FFV sales are uncertain because the credits will be largely phased out by 2016 unless actual use of E85 increases substantially.

Electrically driven motor vehicles may someday transform transportation energy use, but at present there is substantial uncertainty about their ability to compete with the internal combustion engine. Until recently, gasoline or diesel fuel alone powered nearly all motor vehicles. The first mass-produced hybrid electric vehicle (HEV), powered by an internal combustion engine and an electric motor, was introduced in 1999. The internal combustion engine still provides all the energy for a hybrid vehicle, but kinetic energy normally wasted during braking is instead used to generate electricity that is stored in an onboard battery for later use by the electric motor. Hybrid vehicle sales have grown from 17 vehicles sold in 1999 to 432,000 vehicles in 2012 (figure 8-9) [USDOT BTS NTS 2013]. In 2013, 39 makes and models of hybrid vehicles were offered for sale in the United States [USDOE

[9] E85 may contain anywhere from 51 percent ethanol to 85 percent ethanol. Because fuel ethanol is denatured with approximately 2 percent to 3 percent gasoline, E85 is typically no more than 83 percent ethanol.

FIGURE 8-9 Sales of Hybrid, Plug-in Hybrid, and Battery Electric Vehicles: 1999–2012, January 2013–September 2013

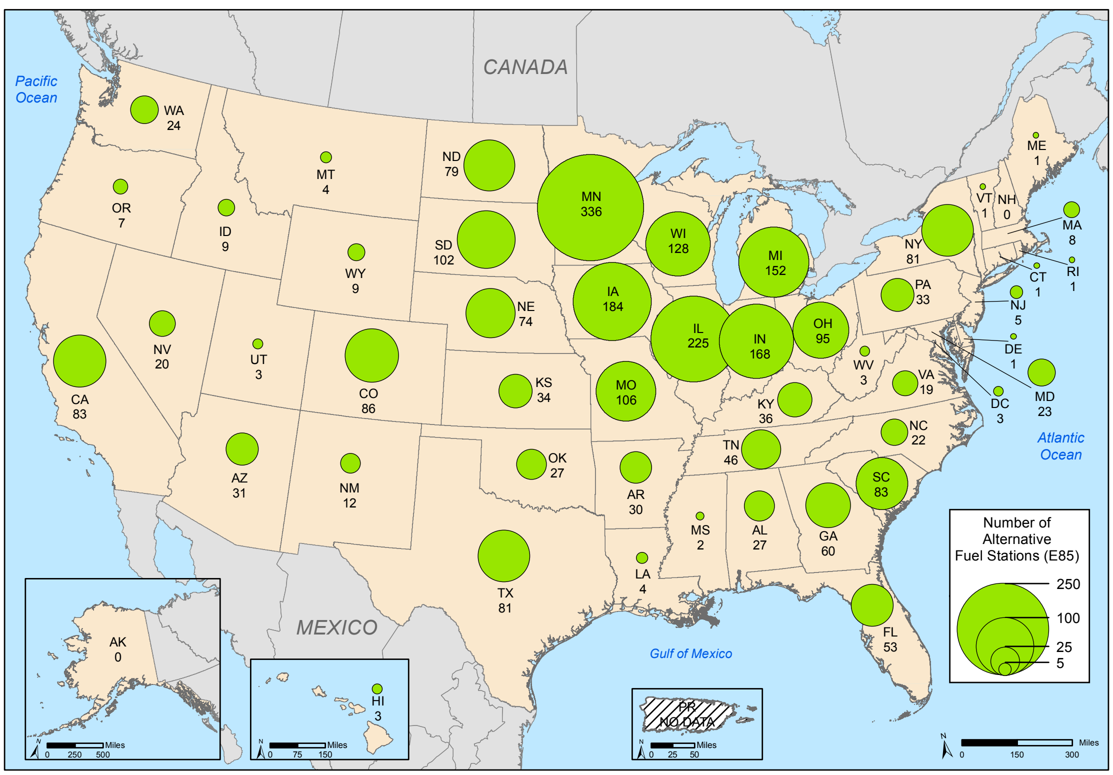


SOURCE: HEV 1999-2012: USDOT, BTS, National Transportation Statistics, Table 1-19. Available at http://www.rita.dot.gov/bts/ as of December 2013. **HEV 2013, PHEV and BEV 1999-Sept. 2013**: Electric Drive Transportation Association. *Electric Drive Vehicle Sales Figures (U.S. Market)-EV Sales*. Available at http://electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952 as of December 2013.

and USEPA 2013], and sales through the first three quarters of the year totaled 390,000 out of 11.6 million conventional vehicles [USDOC BEA 2013].

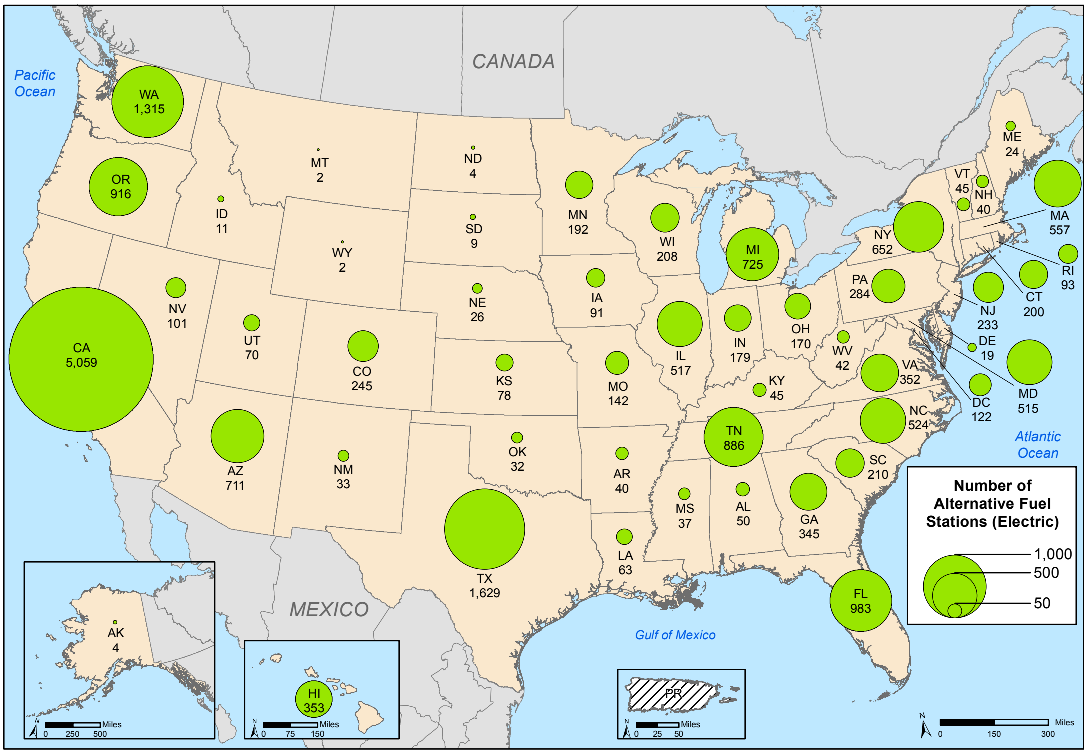
The first mass-produced "plug-in" hybrid electric vehicles (PHEV), able to draw electric power from the utility grid and store it on-board, were 2011 model year vehicles sold in 2010. In 2010 just 19 electric-only and 325 plug-in hybrid vehicles were sold. Through September 2013, combined sales of grid-connected vehicles exceeded 67,000 units. Over the same period the number of makes and models of battery electric-only vehicles increased from 3 to 10, while plug-in hybrid offerings increased from 1 to 4. Despite this growth, hybrid and grid-connected vehicles comprised just 3.6 percent of total 2012 light-duty vehicle sales of 13.3 million and a small percentage of vehicles on the road. Both types of vehicles face several challenges: reducing costs, overcoming the market's unfamiliarity with the new technology, decreasing the length of time required for recharging batteries, and developing a recharging infrastructure. Considerable progress has been made in creating a nationwide recharging infrastructure. By fall 2013, 6,686

FIGURE 8-10 E85-Ethanol Flex Fuel Refueling Stations by State: 2013



SOURCE: U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. 2013. *Ethanol Fueling Station Locations*. Available at http://www.afdc.energy.gov/fuels/ as of October 2013.

FIGURE 8-11 Electric Vehicle Recharging Stations by State: 2013



SOURCE: U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. 2013. *Electric Vehicle Charging Station Locations*. Available at http://www.afdc.energy.gov/fuels/ as of October 2013.

nonresidential recharging stations had been installed across the United States [USDOE EIA AFDC 2013].[10]

The geographical distribution of refueling stations for alternative fuels partly reflects the numbers of vehicles in each state but also reflects the interests of residents and public policies. E85 stations are disproportionately concentrated in states that grow corn and produce ethanol (figure 8-10). The distribution of electric vehicle recharging stations tends to favor states that have opted into California's Zero Emission Vehicles (ZEV) standards (figure 8-11).[11] Manufacturers selling electric vehicles in these states earn credits towards meeting the ZEV requirements. The distribution of compressed and liquefied natural gas refueling stations, on the other hand, more closely reflects

[10] A single electric vehicle recharging station may include multiple recharging outlets. Residential recharging locations are not included in the station count.

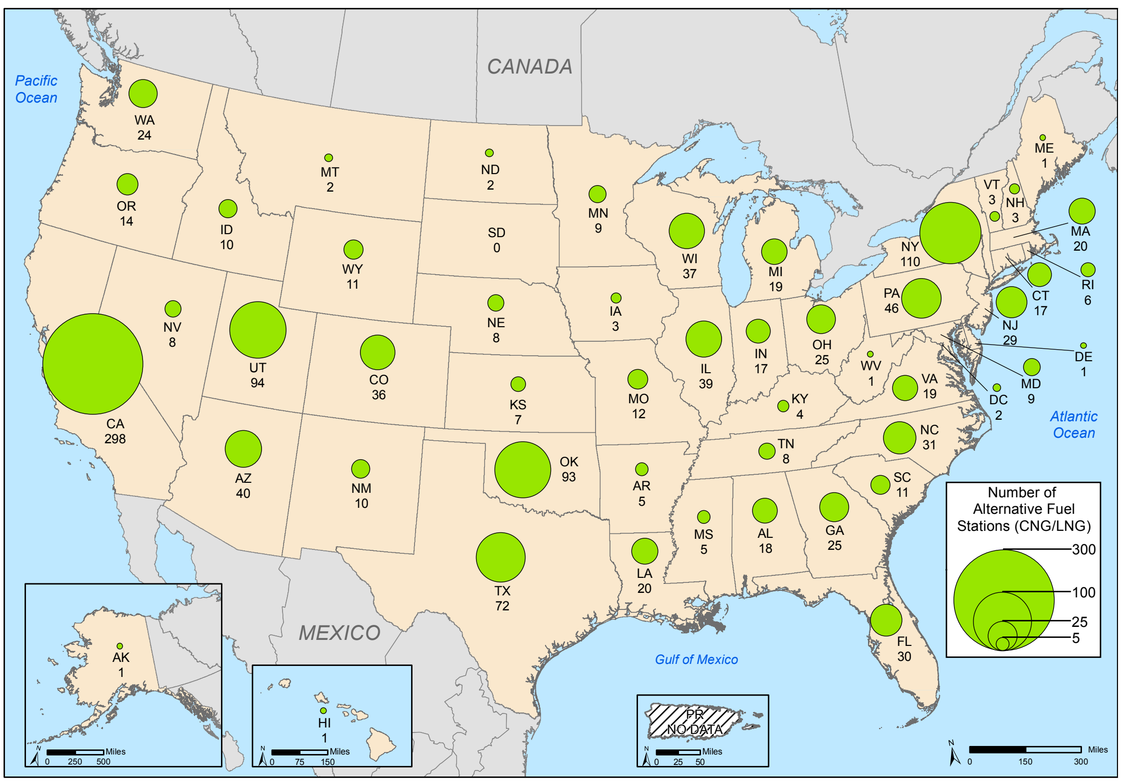
[11] Connecticut, Maine, Maryland, Massachusetts, New Jersey, New Mexico, New York, Oregon, Pennsylvania, Rhode Island, Vermont, Washington, Delaware, Georgia, and North Carolina have adopted the California Air Resources Board (CARB) regulations for a vehicle class or classes in accordance with the Section 177 of the *Clean Air Act*.

the number of CNG/LNG vehicles registered in the state (figure 8-12). Natural gas vehicles save their operators money on energy costs; help fleets meet national clean, alternative fuel vehicle requirements; and help reduce harmful emissions in urban areas.

Transportation's Energy Outlook

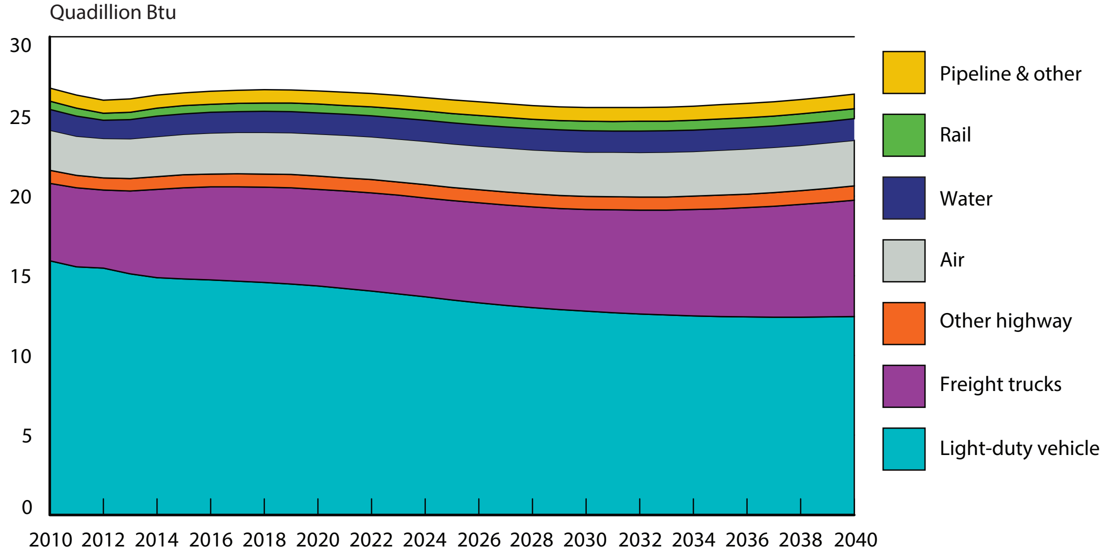
The U.S. Department of Energy (USDOE), Energy Information Administration (EIA) has projected the likely effects of current trends and existing policies on transportation's future energy use and GHG emissions. The 2013 projections anticipate transportation energy use remaining at or near the current level of 27 quadrillion Btu for the next three decades [USDOE EIA 2013d]. Existing fuel economy and GHG emissions standards are expected to decrease light-duty vehicle energy use by 20 percent by 2030 and 28 percent by 2040, resulting in a little more than 12 quadrillion Btu of energy use (figure 8-13). Most of this reduction is expected to be offset by growth in energy use by medium and heavy-duty trucks, although that could change if fuel economy and emissions standards for those vehicles are further tightened. For all other modes,

FIGURE 8-12 Compressed and Liquefied Natural Gas Refueling Stations by State: 2013



SOURCE: U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. 2013. *Compressed and Liquefied Natural Gas Station Locations*. Available at http://www.afdc.energy.gov/fuels/ as of October 2013.

FIGURE 8-13 Transportation Energy Use: Projected 2010 to 2040



SOURCE: U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2013*. Table 16. Available at http://www.eia.gov/forecasts/aeo/ as of November 2013.

activity growth is approximately balanced by improvements in energy efficiency. These projections are based on existing policies and increasing oil prices. Natural gas use by motor vehicles in compressed and liquefied form is projected to increase from just 0.04 quads in 2010 to 1.1 quads by 2040. EIA attributed all of the projected increase in natural gas use by motor vehicles to medium- and heavy-duty trucks and buses.

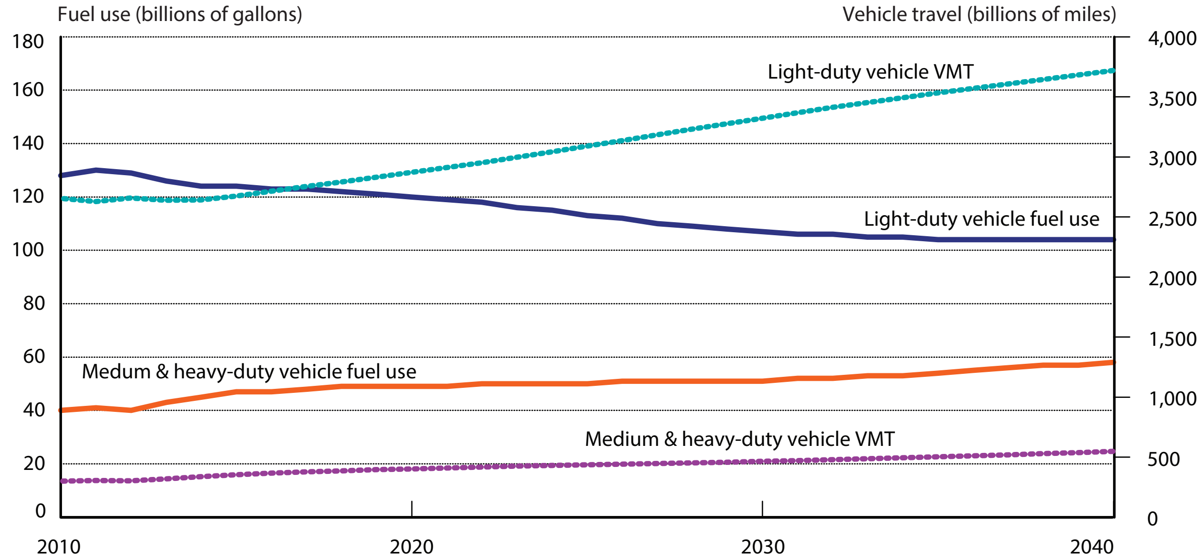
According to the EIA, the 2011-2025 fuel economy standards, together with the market's response to higher gasoline prices, are projected to save personal vehicle owners about 40 billion gallons of motor fuel in 2025 compared to what consumption would have been at the same level of vehicle travel without any increase in fuel economy (figure 8-14).

By fuel type, gasoline use declines from 16.8 quads in 2010 to 12.6 in 2040, in line with light-duty vehicle energy use. Diesel fuel use increases from 5.8 to 7.9 quads, which is consistent with the growth of truck freight energy use. E85 and electricity use increases but will still amount to only 0.17 quads and 0.07 quads of energy in 2040, respectively.

Air and Water Quality, Noise, and Habitat Impacts

Vehicle emissions controls and other policies have reduced all of transportation's air pollutant emissions in comparison to their 1990 levels, a trend that continues in the most recent years. From 2009 to 2013, emissions from every one of the air pollutants declined from year to year (figure 8-15). Motor vehicles

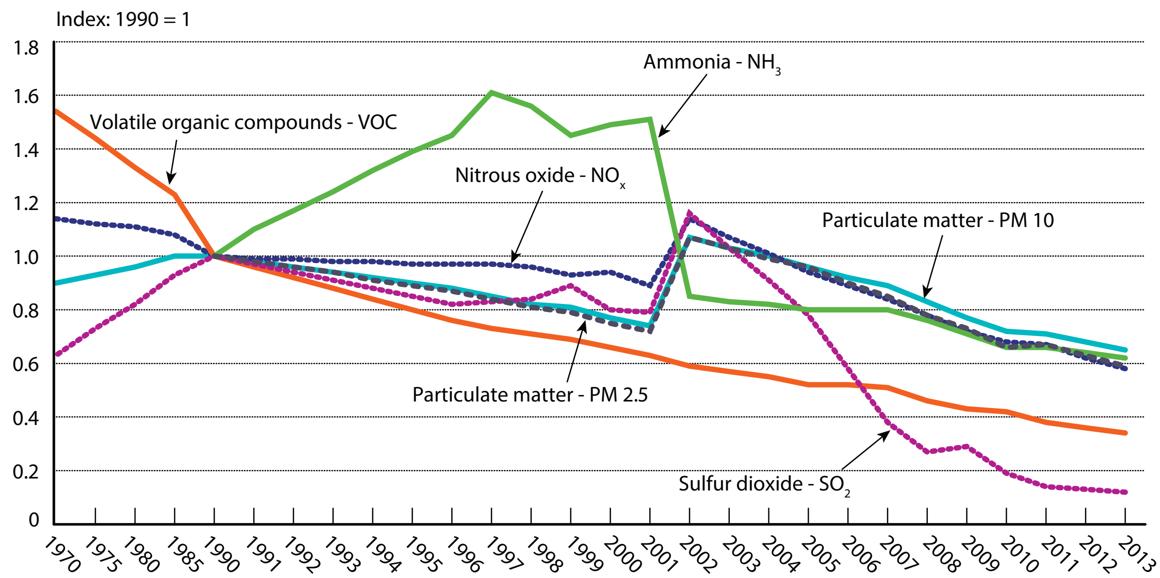
FIGURE 8-14 Highway Vehicle Fuel Use and Travel: Projected 2010 to 2040



KEY: VMT = Vehicle-miles Travelled

SOURCE: U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2013*. Reference Case table 7. Available at http://www.eia.gov/forecasts/aeo/ as of November 2013.

FIGURE 8-15 Indexes of Key Air Pollutant Emissions From U.S. Transportation: 1970–2013



SOURCE: U.S. Environmental Protection Agency, *National Emissions Inventory Air Pollutant Emissions Trends Data, 1970-2013*, Average Annual Emissions All Criteria Pollutants, Available at http://www.epa.gov/ttn/chief/trends/index.html as of October 2014.

are the primary source of GHG (as shown in figure 8-5) and their emissions have been linked to negative effects on our respiratory and cardiovascular health [CDC 2010]. Smog-forming emissions of volatile organic compounds (VOC) and nitrogen oxides (NO_x) were 65.6 to 42.2 percent lower, respectively, in 2013 than they were in 1990. In recent years, NO_x emissions have decreased more rapidly, partly due to more advanced diesel emission controls and the use of cleaner, ultra-low sulfur diesel fuel.

Transportation's share of total U.S. PM-2.5 emissions decreased from 8.2 percent in 1990 to 5.9 percent in 2013, while the share of PM-10 emissions decreased from 2.6 in 1990 to 2.2 percent of total emissions over the same period.

Emissions of ammonia (NH_3) increased between 1990 and 2001, and in 2013 were 38.1 percent of the 1990 level. Transportation comprised 2.4 percent of total U.S. emissions of ammonia in 2013.[12] Emissions of sulfur dioxide (SO_2) are 87.8 percent lower in 2013 than 1990, due in large part to reductions in the sulfur contents of gasoline and diesel fuel.

Reductions in transportation's pollutant emissions have contributed to improved air quality in the Nation's urban areas. In 87 continuously monitored urban areas, the number of days of nonattainment of at least one National Ambient Air Quality Standard decreased from 4,091 in 1990 to 1,012 in 2010 (figure 8-16). Although the total number of nonattainment days had been reduced by 75.3 percent, most cities still experienced at least one day in the year with poor air quality. Of the 87 cities continuously monitored, 83 had at least 1 nonattainment day in 1990 and 80 had at least 1 day in 2010.

Spills of crude oil and petroleum products from pipelines, ships, railroad cars, and tank trucks pollute surface waters and navigable waterways.[13] The annual volume spilled varies greatly from year to year and is strongly affected by infrequent, large events (figure 8-17). For example, Hurricane Katrina caused numerous spills into navigable waterways from a variety of sources in Louisiana and Mississippi in 2005 as the volume of petroleum spilled jumped from 1.4 million gallons in 2004 to 9.9 million in 2005.[14]

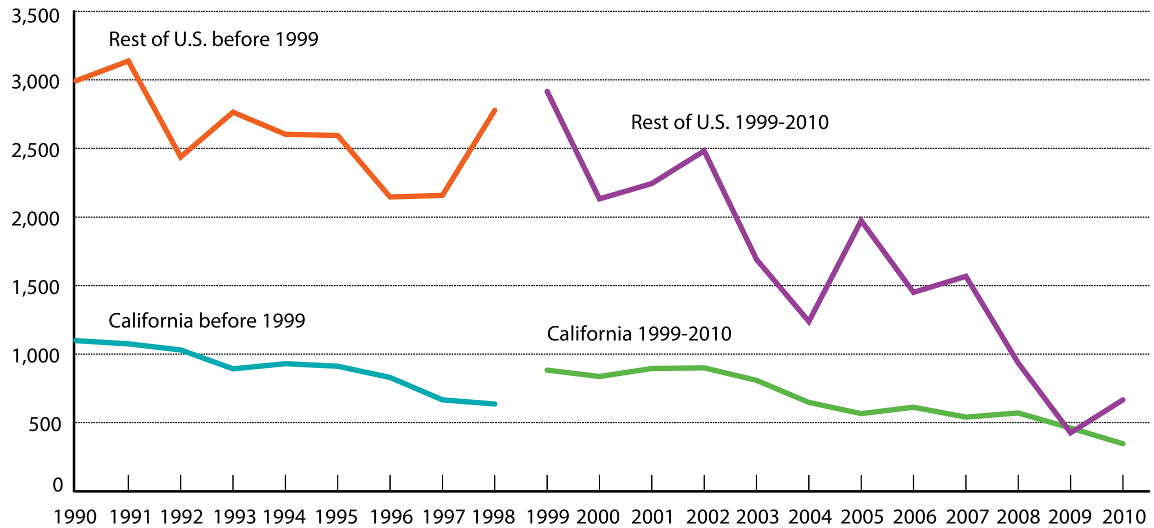
While the number fluctuates from year-to-year, the number of spills from vessels in 2011 was the lowest in more than two decades. The number of spills from pipelines in 2011 was also substantially below the annual average. In 1985, in response to a congressional requirement, the USEPA began an effort to regulate underground storage tanks that can

[12] Ammonia is not a by-product of fuel combustion but is formed in a vehicle's three-way catalytic emissions control systems. The introduction of 3-way catalytic converters initially caused increased NH_3 formation but this was later offset by improvements in newer emissions control systems and the aging and retirement of vehicles with the earliest 3-way catalytic systems.

[13] Spills of hazardous materials in general are covered in Chapter 7.

[14] The much larger Deepwater Horizon release of 206 million U.S. gallons is not included in the database of spills into navigable waterways of the United States and is not considered to be a spill from a transporting vessel (USLOC CRS 2013).

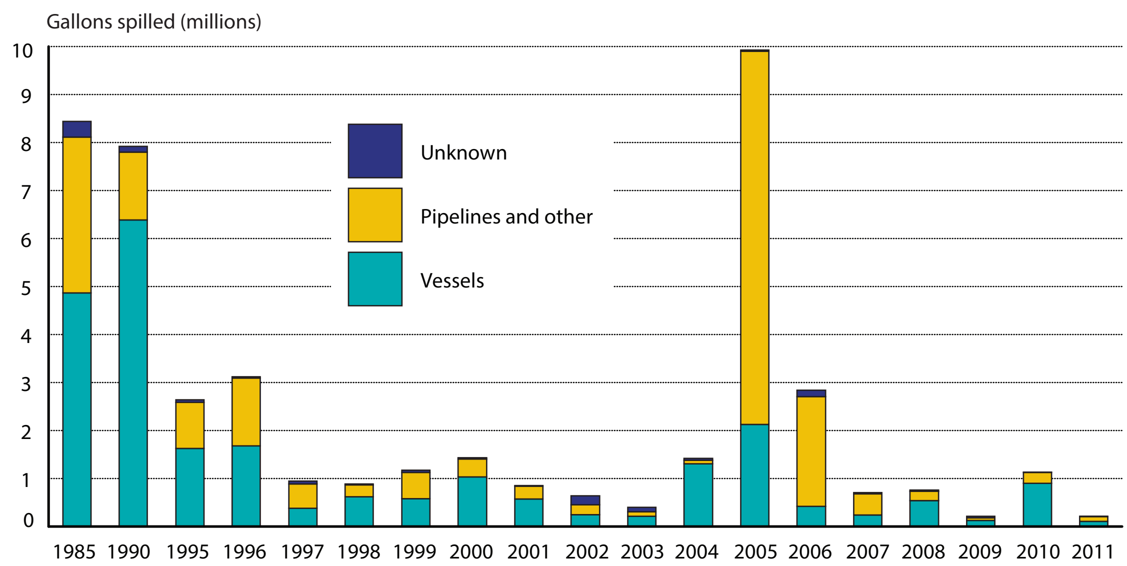
FIGURE 8-16 Number of Days With Air Quality Index > 100 at Monitoring Sites in U.S. Urban Areas: 1990–2010



NOTE: 1999 was the first year PM2.5 was included in the AQI.

SOURCE: U.S. Environmental Protection Agency, *Number of Days with Air Quality Index Values Greater than 100 at Trend Sites, 1990-2010*, and All Sites in 2010. Air Quality Index Information. Available at http://www.epa.gov/airtrends/aqi_info.html as of October 2013.

FIGURE 8-17 Petroleum Spills Impacting Navigable Waterways: 1985, 1990, and 1995–2011



NOTES: The spike in Gallons spilled for 2005 can be attributed to the passage of Hurricane Katrina in Louisiana and Mississippi on Aug. 29, 2005, which caused numerous spills approximating 8 million gallons of oil in U.S. waters. The largest spill in U. S. waters began on April 20, 2010 with an explosion and fire on the mobile offshore drilling unit (MODU) DEEPWATER HORIZON. Subsequently, the MODU sank, leaving an open exploratory well to discharge crude oil into the Gulf of Mexico for several weeks. The most commonly accepted spill amount from the well is approximately 206.6 million gallons, plus approximately 400,000 gallons of oil products from the MODU. The totals in this table may be different from those that appear in the source, due to rounding by the source.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 4-54, Available at http://www.bts.gov as of November 2013.

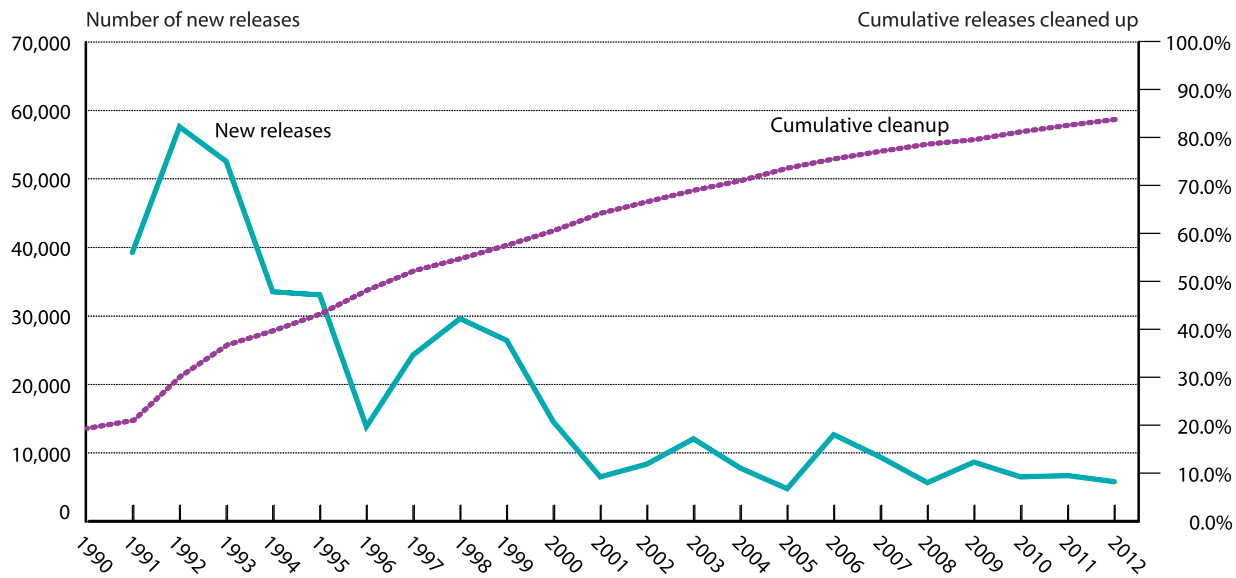
contaminate ground water, to clean up leaks, and prevent them in the future [USEPA 2013c]. Since then, the number of new leaks from storage tanks has been reduced by nearly an order of magnitude, and over 80 percent of all leaks have been cleaned up (figure 8-18).

As rainwater or snowmelt runs off transportation infrastructure, like roads, parking lots and bridges, it picks up de-icing salts, rubber and metal particles from tire wear, antifreeze and lubricants, and other wastes that may have been deposited on infrastructure surfaces. The runoff carries these contaminants into streams, lakes, estuaries, and oceans [USEPA 2010].

Highways and other transportation infrastructure also affect wildlife via road kills, habitat loss, and habitat fragmentation. Numerous projects have been undertaken across the United States to mitigate these impacts, from salamander and badger tunnels to mountain goat underpasses on highways to fish passages through culverts.[15] There are no systematic estimates of the numbers of wildlife killed by transportation vehicles in the United States. In certain circumstances, the population effects of road kill have been shown to be substantial, even threatening the survival of endangered species. In general, the number of bird kills greatly exceeds the number of mammals killed. Annual deer kills from road accidents alone have been estimated at between 720,000 and 1.5 million [FORMAN 2003].

[15] While there are no comprehensive statistics on mitigation efforts, numerous case studies of highways mitigation efforts can be found at http://www.fhwa.dot.gov/environment/wildlife_protection/index.cfm .

FIGURE 8-18 Leaking Underground Storage Tank Releases and Cleanup: 1990–2011



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 4-2, Available at http://www.bts.gov as of November 2013.

Transportation noise is pervasive and difficult to avoid in the United States [USDOT FHWA HEP 2013]. It is generated by engines, exhaust, drive trains, tires, and aerodynamic drag. At freeway speeds tire-pavement noise dominates for highway vehicles, while exhaust and aerodynamic noise dominate for aircraft. However, a national noise exposure inventory does not exist. The United Kingdom has developed a noise inventory for 23 large urban areas by estimating noise levels using computer models that are based on transportation activity data [UKDEFRA 2014]. Similar methods could be applied to collect and analyze noise issues in the United States.

Unwanted noise can have a variety of impacts including annoyance, sleep disruption, interference with communication, adverse impacts on health and academic performance, and consequent reductions in property values. There is almost no part of the United States in which transportation noise is not noticeable [WAITZ 2007]. When transportation noise levels are below 45 decibels (dB) the level of annoyance in the population is negligible, but when noise levels exceed 65 dB, impacts can be severe.[16] Although highways are the most widespread source of transportation noise, exposure to transportation noise is systematically measured only for aircraft. In 1970, 7 million people resided in high noise (> 65 dB) areas around U.S. airports. By 1990 that number had been reduced to 2.7 million through a combination of changes in engine and airframe design and operational strategies. In 2011 just over 300,000 individuals lived in areas with excessive aircraft noise [USDOT BTS NTS 2013]. Take-off and landing operations are the primary source of annoying aircraft noise, which per dB is generally more annoying to the public than highway or rail noise.

The extent and severity of highway noise can be only indirectly inferred from statistics on the construction of noise barriers, which can typically reduce noise exposure by 10 dB, or one half. Barriers, which typically cost $1–2 million per mile to construct, provide a partial measure of the economic impacts of highway noise.

Under certain circumstances, unwanted and unnecessary light is considered "light pollution" [MRSCW 2014]. Transportation vehicles and facilities can be sources of light pollution. While light pollution is a special concern for facilities like astronomical observatories, it is also known to adversely affect biodiversity in urban areas and to have harmful effects on human metabolism [COE 2010]. No systematic data on light pollution due to transportation in the United States exists.

In addition to the primary performance measures of how efficiently, reliably, and safely people and goods move on the system, transportation's energy usage and its environmental impacts are also important measures of how well the transportation system performs its societal function. In recognition of this, there have been efforts to mitigate

[16] Noise (sound) is measured in decibels (dB) on a logarithmic scale. Each increase of 10 dB represents a doubling of the noise level.

transportation's dependence on petroleum and environmental impacts. As detailed in this chapter, transportation has become more efficient over the past few decades in its use of energy and has reduced many of its environmental impacts even though activity levels have increased. It continues, however, to be the second leading emitter of greenhouse gases in the United States and has had other major impacts on the environment, such as oil pollution, habitat loss, and noise. Going forward, appropriate and accurate data will be needed to monitor progress and determine whether societal efforts to improve the system's performance are having the desired effect.

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CHAPTER 9

The State of Transportation Statistics

Congress underscored the importance of statistical information for transportation investment decisions, policy initiatives, and other public actions when it established the Bureau of Transportation Statistics (BTS) in 1992 and required BTS to assess the state of statistics in an annual report. More than two decades after the creation of BTS, the transportation community's emphasis on performance measurement—the process of collecting, analyzing, and reporting information on the performance of transportation systems—underscores the importance of data in decision making.

Progress made in compiling and distributing statistics on passenger travel, freight transportation, transportation's role in the economy, and the unintended consequences of transportation is briefly summarized below. Box 9-A illustrates major accomplishments during the past year. This chapter also highlights the major transportation data gaps and the challenges and opportunities facing future transportation statistics programs.

- Extensive data are available on local passenger travel, but limited data exists on long-distance travel; conversely, limited data exists on local freight movement, but extensive data exists on long-distance freight movement.
- Extensive data is available on the condition and performance of highways, bridges, airports, and waterway facilities, but little data exists on the condition of privately owned railroads and pipelines.
- Extensive data is available on accidents and air emissions, but limited data exists on noise and other forms of environmental and community disruptions caused by transportation.
- Information is available about transportation's share of gross domestic product, but there is little knowledge of the impact of transportation on the Nation's economy and the quality of life for its citizens.
- Alternatives to increasingly expansive surveys, such as the use of administrative records and technology-based monitoring, are needed to develop transportation statistics. The digital revolution presents opportunities and challenges for improving transportation statistics.

BOX 9-A Accomplishments in the Last Year

Since publication of the 2012 *Transportation Statistics Annual Report*, several major products and programs moved forward:

- Working with the U.S. Census Bureau, the Bureau of Transportation Statistics (BTS) released preliminary results from the 2012 Commodity Flow Survey of freight shipments and began work on final results, including a new public use microdata file. [1]
- To make statistics more accessible and understandable, BTS launched a Facts and Figures series with joint publication of *Freight Facts and Figures* with the Federal Highway Administration and release of the first edition of *Passenger Travel Facts and Figures*.
- Having demonstrated the value of the Confidential Close Calls Reporting System, BTS expanded the activity from a pilot to a permanent program supporting a major railroad, a transit system, and the offshore oil extraction industry.
- The National Transportation Library, a part of BTS, led development of a web portal to all of the department's publicly available data as part of the government-wide Open Data Initiative.
- The U.S. Department of Transportation continues to work with state departments of transportation and other stakeholders to implement the performance measurement requirements of MAP-21—*the Moving Ahead for Progress in the 21st Century Act* (P.L. 112-141).
- States are expanding locational information submitted to the FHWA to include all public roads for improved safety analysis and other purposes.
- BTS sponsored a Transportation Research Board task force on the Value of Transportation Infrastructure to develop improved statistics on the value of transportation to the economy and the quality of life.
- The Bureau of Economic Analysis significantly re-engineered the systems it uses to calculate the National Accounts, providing BTS with new data to update its *Transportation Satellite Account*. BTS also devised a new strategy for organizing and enhancing the mandated Intermodal Transportation Database.
- The Department of Transportation is working with the Department of Energy (DOE), Department of Agriculture (USDA), the Environmental Protection Agency (EPA), and other agencies to reinstate a modernized and updated Vehicle Inventory and Use Survey (VIUS). Last conducted in 2002, the VIUS is of critical importance to federal and local agencies and provides essential information for the analysis of safety and risks, fuel consumption, economic productivity, environmental impacts of transportation, highway usage and cost, and more.

[1] Microdata is detailed data on more than 4 million individual responses to survey questions.

Passenger Travel

Passenger travel data are collected by various government agencies, some periodically and others on a continual basis. The collection of these data can be categorized into two groups.

The first group collects overall system usage data without collecting data on individual travelers' characteristics. The data programs in this group include, but are not limited to, the following:

- the Highway Performance Monitoring System [USDOT FHWA HPMS 2010];
- the Federal Transit Administration's National Transit Database [USDOT FTA NTD 2012]; and
- the Bureau of Transportation Statistics' monthly passenger enplanement data [USDOT BTS 2012a],
- the National Census of Ferry Operators [USDOT BTS NFCO 2010], and
- the Intermodal Passenger Connectivity Database [USDOT BTS IPCD 2012b].

These data programs are crucial in the development of baseline information, the analysis of overall usage trends over time, and for understanding how changes in the economy influence the use of transportation systems.

The second group of passenger travel data programs collects data at the individual traveler's level (without identifying personal identifiable information) from which travel patterns and traveler characteristics for the population as a whole can be estimated. The most prominent program in this group is the National Household Travel Survey (NHTS), sponsored mainly by the Federal Highway Administration (FHWA) and with increased cosponsorship by states and metropolitan planning organizations [USDOE ORNL 2012].

The NHTS collects not only information on individual trips but also demographic, household vehicle ownership, and neighborhood characteristic data as well as other factors that influence a household member's decision on when, how, and how far to travel. Although the NHTS collects all personal travel taken by all modes of transportation, it mainly captures local travel. The high cost of conducting this type of nationwide survey has limited the frequency of this survey to once every 5 to 8 years. Despite these limitations, NHTS remains the only national source that provides the comprehensive data needed to understand travel decisions and predict travel demand.

The Census Bureau's American Community Survey (ACS) is another commonly used source of passenger travel information. The ACS collects commute-to-work data from an annual survey of the population. This survey provides small-area information every year, unlike the once-per-decade information formerly provided by the decennial census. The ACS also provides statistics for small units of geography averaged over several years, while the 374 metropolitan statistical areas, as defined by the Office of Management and Budget, are the lowest levels of geography covered by the NHTS [USDOC ACS 2011].

Freight Transportation

Due to the complexity of freight transportation, there is no single data source that provides a comprehensive picture of annual freight movement from origin to destination, by all modes of transportation, and by all commodity types. Among the various data sources, the Commodity Flow Survey (CFS), cosponsored by BTS and the Census Bureau, serves as the backbone for developing a comprehensive picture of U.S. freight flows. The CFS is the only source of national- and state-level data on domestic freight shipments by manufacturing, mining, wholesale, and selected retail industries. It also provides comprehensive data on domestic hazardous material shipments. The CFS is conducted every 5 years as part of the Economic Census.

To develop an integrated national picture of freight movement, FHWA's Freight Analysis Framework (FAF) relies on CFS data as its base and supplements that data with multiple, publicly available data sources, such as the data on freight flows across U.S. land borders and data on the international movement of air cargo collected by BTS [USDOT BTS 2012c]. The FAF also includes forecasts.

The performance of the Nation's freight transportation system is primarily measured by freight travel time, which includes, but is not limited to, the following:

- for each major railroad, the average train speed and average wait time for loaded train cars to proceed;
- vessel delay times for transiting through each lock on the inland waterway system;
- truck speed and reliability on major highways and at border crossings; and
- productivity measures for selected ports.

The major national data sources for freight movement and performance are described at USDOT's freight transportation website at freight.dot.gov.

Transportation's Role in the Economy

In 2012 transportation-related expenditures as part of final demand accounted for nearly 8.6 percent of U.S. gross domestic product (GDP) in chained 2009 dollars and enabled linkages among natural resources, manufacturers, distribution centers, and consumers [USDOT BTS NTS 2013].

Transportation's direct economic contribution is derived from statistics on the costs paid by households and businesses for transportation services, employment in transportation industries and occupations, and the value of transportation infrastructure and equipment. These statistics come from the Census Bureau, the Bureau of Economic Analysis (BEA), and the Bureau of Labor Statistics, each of which treats transportation as a significant sector of the economy.

For-hire transportation is one of the many sectors covered in the Economic Census, conducted every 5 years. This sector is also covered in the Census Bureau's Services Annual Survey, which collects operating revenue and other industry-specific data. These data are used by the BEA to estimate the flow of expenditures among sectors of the economy in order to understand how changes in the costs in a specific sector affect the rest of the economy. BTS expands on this accounting in its Transportation Satellite Account to include the sizable contribution to the economy made by in-house transportation services within nontransportation industries, such as truck fleets operated by large retail companies.

Transportation is not often highlighted in monthly national economic statistics. To provide a perspective on transportation's role in a dynamic economy, BTS developed the monthly Freight Transportation Services Index (TSI) [USDOT BTS TSI 2012d]. This index is based on activity in all modes of for-hire freight transportation services, and affords a better understanding of the relationship between transportation and the current and future course of the economy. The Freight TSI is being expanded to include in-house transportation to provide a complete picture.

Transportation and its Unintended Consequences

In addition to the intended economic activity that transportation creates, it has unintended impacts on safety, energy consumption, the environment, and communities. Of these, safety dominates the statistical activities of the USDOT. The National Highway Traffic Safety Administration (NHTSA) and the Federal Motor Carrier Safety Administration account for 40 percent of the expenditures on major statistical programs in the Department [USEOP OMB 2013b]. One major safety data effort is the modernization of NHTSA's National Automotive Sampling System (NASS) General Estimates System (GES) to ensure the reliability and timeliness of safety data collection and analysis. The Pipeline and Hazardous Materials Safety Administration and FHWA also have large-scale safety programs in place. Altogether, the Department's annual expenditures on safety data exceed $50 million.[1]

Recognizing that roadway safety improvement requires stronger partnerships and collective efforts across all modes of transportation and stakeholders, senior USDOT leadership initiated the development of the Roadway Safety Plan to bring an integrated focus to roadway safety issues [USDOT OST RSP 2012]. One of the priorities of this plan is to improve the systematic collection of safety data and analytical tools. These improvements are intended to facilitate the identification of high-risk road users and commercial vehicle operators, prioritize safety investment decisions, and evaluate the effectiveness of safety measures.

The relatively low fatality rates in nonhighway modes, such as commercial aviation, railroads, and transit, do not reduce the need for data to understand risks and maintain or improve the safety of these modes. The focus of data programs for nonhighway modes has shifted from determining causes of crashes to understanding circumstances surrounding

[1] Office of Management and Budget, *Statistical Programs of the United States Government*: *Fiscal Year 2013* (November 26, 2013), p. 88. Available at http://www.whitehouse.gov/ as of August 2014.

near misses or other mishaps that could have resulted in a serious incident. The National Aeronautics and Space Administration (NASA) provides a close calls reporting system for the Federal Aviation Administration that allows airline employees to make confidential reports that can be used to identify and mitigate safety problems. Nearly 5,000 reports are filed each month [NASA 2012]. NASA provides a similar reporting system for Amtrak. BTS has initiated the first urban close calls reporting system with a major transit system. The BTS program is also being expanded to a Class I railroad and off-shore oil extraction and connecting pipeline operations.

The transportation sector accounts for more than two-thirds of the petroleum consumed in the country and produces between one-quarter and one-third of all of the carbon dioxide (CO_2) emitted by the Nation's energy consumption. The U.S. Department of Energy has a major data program that tracks energy consumption by transportation sector [USDOE EIA 2012], and transportation's contributions to greenhouse gases and other emissions are tracked by the Environmental Protection Agency [USEPA OTAQ 2012]. While individual agencies compile information to meet specific needs, integrating these data and developing analytical techniques from many disciplines are the keys to effectively using these data sources to reduce transportation-related energy consumption and emissions. For example, the relationships between vehicle usage patterns and energy usage intensity are crucial to measuring and assessing the effectiveness of different energy and emission reduction opportunities and policies. Unfortunately, with the discontinuation of the Vehicle Inventory and Use Survey in 2002, much of the data necessary to help make these assessments are now more than 10 years out of date [USDOC CB VIUS 2002].

Data Gaps and Challenges

To understand transportation activity, its contributions to the economy, consequences for the environment, and the potential impacts of policies and investments, it is crucial to estimate the interactions among the following components:

- *sectors of the economy* that produce the demand for transportation and depend on transportation for productivity and health;
- the response of *businesses within supply chains* to regulations, private and public investment, and the impact those responses have on both the time and location of transportation activities;
- *household* mobility needs and expenditures that determine the time and location of transportation activity and how travelers respond to transportation investments and regulations;
- *infrastructure and assets* that are needed to serve the mobility requirements of households and businesses, to stimulate local economic growth, and to mitigate the adverse safety and environmental impacts of passenger and freight transportation; and
- *transportation investments* that improve transportation services and promote economic growth and global competitiveness; and

- transportation's role in *economic development.*

To better understand these interactions, BTS and its partners continue to collect data through traditional approaches (e.g., surveys), mine data sources not originally designed for statistical purposes (e.g., administrative records), explore information from mobile devices (e.g., Global Positioning System and radio-frequency identification), and improve modeling approaches to fill data gaps.

Tables 9-1 and 9-2 highlight the strengths and weaknesses of statistics compiled from these surveys, administrative records, monitoring technologies, and models. Major data gaps include the following:

- intercity passenger travel by surface modes of transportation and general aviation,
- transportation provided by social service agencies and nonprofit organizations,
- the domestic transportation of international trade,
- local freight movement,
- the condition and performance of freight railroads,
- the current condition of transit infrastructure,
- the cost of freight transportation,
- in-use fuel economy of motor vehicles,
- noise related to surface transportation facilities, and
- disruptions to natural and cultural environments.

In some cases a data gap affects multiple topics. For example, exposure to safety risks cannot be estimated without a complete picture of where and how people travel.

Of the major data gaps, intercity passenger travel is particularly significant. Long-distance travel by all modes and by demographic characteristics of the traveler has not been measured since 1995. Recent discussions about trends in passenger travel are limited to local travel. This limitation may result in misguided conclusions because long-distance travel involves different trip purposes and conditions than local travel, and one long-distance trip can generate as many miles of travel as dozens or even hundreds of local trips.

Challenges facing BTS and its partners are not limited to filling data gaps. The simple availability of data does not assure that effective statistics exist to help answer the questions of decision makers. Significant quality issues and the lack of methods for summarizing data into useful information can undermine the effectiveness of key data programs. All data sources have quality issues, but some questions about statistical quality have greater potential consequences for public perceptions and decision making.

Geospatial data provide another quality challenge. BTS compiles data from a variety of sources for its National Transportation Atlas Database and provides a web-based application to access and visualize the data. Errors and inconsistencies in the data are revealed when users zoom in on very small areas.

TABLE 9-1 Data on Transportation Use, Extent, Condition, and Performance

Topic	Coverage of Existing Data	Major Gaps in Existing Data
Intercity and international travel	Volumes and origin-destination patterns of commercial aviation passengers; Amtrak ridership; volumes of people and number of motor vehicles at border crossings	Origins, destinations, and volumes of travelers by personal vehicles, buses, and general aviation; amount of travel by demographic characteristics of travelers; travel by general aviation; domestic surface travel of international visitors
Local travel	National volumes and demographic patterns of travelers by type of place; transit ridership by property; detailed origin-destination patterns of journeys to work and demographic characteristics of commuters; geographic and demographic patterns of all resident travelers in metro areas that have conducted local surveys	Travel by non-motorized modes; local travel other than commuting in metro areas that have not conducted local surveys; ridership on transportation services provided by social service and non-profit organizations
International freight movement	Volumes and value of freight at international gateways; value of trade by country	Domestic transportation of international trade, including domestic leg of imports, exports, and transshipments through the United States
Intercity freight movement	Region-to-region flows by commodity and mode	Relationships between industry supply chains and region-to-region commodity flows
Local freight movement	Freight movement only in the rare cases where state and metro area surveys are conducted	County-to-county and intra-county flows of freight; through movement of freight
Vehicle movement	Number of vehicles on highway segments; number of aircraft by airport; number of car-loadings by rail segment; number of vessels by port and waterway	Inconsistent differentiation among types of highway vehicles (car, bus, truck); pipeline volumes by segment
Extent of and geographic access to the transportation system	Multiple versions of the highway and rail networks; detailed representation of the waterway network; intermodal passenger connectivity database	Piecemeal representation of intercity and transit bus service coverage; little data on social service and non-profit transportation coverage
Condition and performance	Condition and reliability of highways by segment, transit by property, and inland waterways by facility; reliability of commercial aviation by flight and airport	Condition and reliability of freight railroads; non-comparable throughput data among ports; condition of urban bus and rail transit maintenance facilities, and rail transit infrastructure

TABLE 9-2 Data on Transportation Economics, Safety, and Other Consequences

Topic	Existing Data	Major Gaps in Existing Data
Transportation expenditures	Total transportation expenditures by households, businesses, and government	Business investments and expenditures by mode of transportation
Transportation costs	Gasoline and diesel prices; costs of automobile ownership; air carrier costs for selected categories; carrier price indices; cost to maintain highway and waterway condition	Trucking costs by type of cost; rail costs based on actual operating expenses rather than regulatory formula; comprehensive costs for bus, general aviation, pipeline; cargo damage and loss
Transportation's contribution to the economy	Transportation as a share of Gross Domestic Product; transportation embedded in other industries (the Transportation Satellite Account); transportation employment	Transportation as a share of state and metropolitan domestic product; economic activity enabled by transportation; value of transportation infrastructure
Safety	Transportation fatalities and injuries by cause for all modes; safety incidents involving hazardous materials; precursor events (close calls) for aviation, selected railroads and transit, and off-shore oil extraction and transport	Exposure by type of safety risk; precursor events (close calls) for most surface transportation; disabilities and medical costs related to transportation injuries
Energy consumption, green house gasses, air quality	Air quality by type of pollutant and air shed, relationship of vehicle emissions to type of vehicle and vehicle speed	In-use fuel economy, amount of vehicle travel by type of vehicle and vehicle speed in each air shed
Noise, water quality, habitat dislocation	Noise footprints around airports, environmental disruptions related to individual transportation projects	National and regional inventories of noise exposure from all modes, natural habitat disruption
Community effects	Proximity of population to transportation facilities; community disruption for individual projects	Neighborhood access to transportation services; transportation barriers to employment for disadvantaged areas; national and regional inventories of human habitat disruption

The digital revolution presents the biggest opportunities and challenges for improving transportation statistics to support public decisions. Nearly all business transactions are now electronic, as are a growing share of personal transactions. The databases created by business transactions and credit card purchases, communications systems, traffic management systems, and onboard vehicle diagnostics can be mined to estimate passenger and freight movement, identify the costs to travelers and businesses of those movements, and even measure the emissions created by vehicles in motion or idling. The coverage of databases continues to expand and the tools for mining them, popularly known as Big Data, Data Analytics, and similar terms, have improved dramatically. Technology promises timelier, more accurate, and less expensive data, especially when compared to data provided by surveys.

Technology-based data typically provide narrower windows on the phenomena being measured than do surveys and place a premium on data integration and statistical representation. Technology also raises major privacy, confidentiality, and intellectual property issues. Beyond improved data collection and processing applications, technology shows promise in enhanced understanding of transportation activities and impacts. The processing power of personal computers creates opportunities for widespread use of new analytical and visualization techniques.

The Challenge of Performance Measurement

MAP-21, the *Moving Ahead for Progress in the 21st Century Act* of 2012 (Public Law 112-141) requires states and the USDOT to publish performance measures and progress toward performance targets for many aspects of surface transportation. These requirements reflect a growing emphasis on accountability and management for improved performance in all fields of public administration. Performance measurement involves many statistical challenges and opportunities in addition to institutional concerns for the transportation community.

MAP-21 and the *Government Performance and Results Act* (GPRA) (Public Law 103-62) ask whether government actions are making a difference. The answer requires statistics beyond basic indicators of a general condition, such as the number of fatalities, tied to a generally stated goal, such as improved safety. More detailed statistics and more complex analysis are typically needed to answer the questions identified in this law.

Performance measures are typically defined as output or outcome measures, though many performance measures are actually basic indicators that reflect goals or basic conditions. For example, the number of fatalities is a basic indicator. Fatalities by cause provide a more useful measure against which outputs and outcomes can be considered.

Outputs of government programs should be relatively easy to define, except that programs often involve a variety of specific actions that are difficult to characterize in simple measures. Furthermore, the output of one program may be the input of another. The major output of Federal agencies implementing MAP-21 is spending on safety and other aspects of surface transportation. The outputs of recipients of Federal funds may involve a wide variety of facilities and services purchased with those funds. Statistics on the facilities and services may be lacking for formula grant programs, leaving total expenditures as the only available measure of output.

While outputs should be relatively easy to define in most cases, outcomes are the most difficult to measure. Outcomes are not just changes in an actionable condition following an output. Simple correlation is not enough. To be an outcome, some evidence of causality is required from targeted monitoring, such as before and after studies.

Given resource limitations for expensive new data collection programs, managers of transportation statistics will be challenged to adapt existing data program and analytical techniques to serve performance measurement. For example, current transportation planning models and supporting data are designed to measure problems, such as congestion, and predict how proposed changes, such as increased capacity, will affect those problems. Research is underway to estimate basic indicators and actionable conditions with these models and use forecasting elements to set targets by which actual outcomes can be judged.

Performance measurement will ultimately require some new data collection. MAP-21, GPRA, and the *American Recovery and Reinvestment Act* of 2009 (Public Law 111-5) all encourage the development and publication of better output and outcome measures. Outcome data from before-and-after studies and other quasi-experimental designs that measure program effectiveness can both serve performance measurement and become a new source of data for planning models.

Priority Areas Requiring Focused Attention by BTS

MAP-21 and its successor legislation establish priorities for transportation statistics in the years ahead. MAP-21 reaffirms the mandate for BTS and adds the establishment of a safety data program on behalf of the Secretary. MAP-21 requires performance measurement for most surface transportation programs, such as safety improvement and infrastructure preservation. MAP-21 also adds new provisions for freight transportation that require data, including designation of freight corridors, development of investment analysis tools, and creation of a national freight strategic plan and state freight plans. MAP-21 also encourages states to maintain a base map of all public roads on which fatal and serious injury accidents can be located and analyzed.

To support decision making throughout the transportation community, BTS continues to seek better ways to develop and report statistics on the extent, use, condition, performance, and consequences of the transportation system. Major initiatives include the following:

- Improve the usefulness of existing statistics, including an expanded *Facts and Figures* series of reports to visualize key statistics on current topics and a new National Transportation Atlas application to explore geographic data on the web.
- Based on the Freight Analysis Framework, establish a National Commodity Origin-Destination Account. It will integrate with the Commodity Flow Survey, the Transborder Freight Data Program, and other public data to form a complete and timely picture of freight movement throughout the Nation as well as serve as a model framework for creating the National Travel Origin-Destination Accounts for a similar picture of passenger travel.

- Develop improved economic statistics, especially related to the value of transportation infrastructure.
- Fully implement the Open Data Policy under Office of Management and Budget memorandum M-13-13 of May 9, 2013 to make transportation data and research findings transparent and accessible to the public, inspiring actions to improve the quality of underlying data and encouraging the creative use of that data [OMB 2013a].
- Explore administrative records and advanced data mining analytics (e.g., Big Data) to measure phenomena like passenger travel for which traditional surveys are decreasingly effective.
- Continue to work with other agencies to enhance the quality and integrity of transportation statistics, acting as the champion for better transportation statistics among other Federal agencies

Some of these BTS initiatives will address several of the gaps and challenges discussed above, and some will explore identified opportunities. Through these and other efforts, BTS will continue to strive toward achieving the vision of Abraham Lincoln who said, in reference to proposed Federal investments in transportation facilities, "Statistics will save us from doing what we do, in wrong places [Lincoln, A; 1848, pp. 709-711]."

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APPENDIX A Legislative Responsibilities, including Cross Reference

BTS compiles these and other statistics under Section 52011: *Moving Ahead for Progress in the 21st Century Act* (Public Law No. 112-141), which requires information on:

i. transportation safety across all modes and intermodally;

ii. the state of good repair of United States transportation infrastructure;

iii. the extent, connectivity, and condition of the transportation system, building on the national transportation atlas database developed;

iv. economic efficiency across the entire transportation sector;

v. the effects of the transportation system on global and domestic economic competitiveness;

vi. demographic, economic, and other variables influencing travel behavior, including choice of transportation mode and goods movement;

vii. transportation-related variables that influence the domestic economy and global competitiveness;

viii. economic costs and impacts for passenger travel and freight movement;

ix. intermodal and multimodal passenger movement;

x. intermodal and multimodal freight movement; and

xi. consequences of transportation for the human and natural environment

Appendix A: Legislative Responsibilities, Including Cross Reference

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APPENDIX B Glossary

Air carrier: Certificated provider of scheduled and nonscheduled services.

Alternative fuel (vehicle): Nonconventional or advanced fuels or any materials or substances, such as biodiesel, electric charging, ethanol, natural gas, and hydrogen, that can be used in place of conventional fuels, such as gasoline and diesel.

Arterial: A class of roads serving major traffic movements (high-speed, high volume) for travel between major points.

Block hours: The time elapsed from the moment an aircraft pushes back from the departure gate until the moment of engine shutoff at the arrival gate following its landing.

Bus: Large motor vehicle used to carry more than 10 passengers, including school buses, intercity buses, and transit buses.

Capital stock (transportation): Includes structures owned by either the public or private sectors, such as bridges, stations, highways, streets, and ports; and equipment, such as automobiles, aircraft, and ships.

Chained dollars: A method of inflation adjustment that allows for comparing in dollar values changes between years.

Class I railroad: Railroads earning adjusted annual operating revenues for three consecutive years of $250,000,000 or more, based on 1991 dollars with an adjustment factor applied to subsequent years.

Commercial air carrier: An air carrier certificated in accordance with Federal Aviation Regulations Part 121 or Part 127 to conduct scheduled services on specified routes.

Commuter rail: Urban/suburban passenger train service for short-distance travel between a central city and adjacent suburbs run on tracks of a traditional railroad system. Does not include heavy or light rail transit service.

Consumer Price Index (CPI): Measures changes in the prices paid by urban consumers for a representative basket of goods and services.

Current dollars: Represents the dollar value of a good or service in terms of prices current at the time the good or service is sold.

Deadweight tons: The number of tons of 2,240 pounds that a vessel can transport of cargo, stores, and bunker fuel. It is the difference between the number of tons of water a vessel displaces "light" and the number of tons it displaces when submerged to the "load line."

Demand-response: A transit mode comprised of passenger cars, vans, or small buses operating in response to calls from passengers or their agents to the transit operator, who then dispatches a vehicle to pick up the passengers and transport them to their destinations.

Directional route-miles: The sum of the mileage in each direction over which transit vehicles travel while in revenue service.

Directly operated service: Transportation service provided directly by a transit agency, using their employees to supply the necessary labor to operate the revenue vehicles.

Distribution pipeline: Delivers natural gas to individual homes and businesses.

E85: A gasoline-ethanol mixture that may contain anywhere from 51 to 85 percent ethanol. Because fuel ethanol is denatured with approximately 2 to 3 percent gasoline, E85 is typically no more than 83 percent ethanol.

Energy intensity: The amount of energy used to produce a given level of output or activity, e.g., energy use per passenger-mile of travel. A decline in energy intensity indicates an improvement in energy efficiency, while an increase in energy intensity indicates a drop in energy efficiency.

Enplanements: Total number of revenue passengers boarding aircraft.

Expressway: A controlled access, divided arterial highway for through traffic, the intersections of which are usually separated from other roadways by differing grades.

Ferry boat: A vessel that provides fixed-route service across a body of water and is primarily engaged in transporting passengers or vehicles.

Flex fuel vehicle: A type of alternative fuel vehicle that can use conventional gasoline or gasoline-ethanol mixtures of up to 85 percent ethanol (E85).

Footprint (vehicle): The size of a vehicle defined as the rectangular "footprint" formed by its four tires. A vehicle's footprint is its track (width) multiplied by its wheelbase (length).

For-hire (transportation): Refers to a vehicle operated on behalf of or by a company that provides services to external customers for a fee. It is distinguished from private transportation services in which a firm transports its own freight and does not offer its transportation services to other shippers.

Freeway: All urban principal arterial roads with limited control of access not on the interstate system.

Functionally obsolete bridge: does not meet current design standards (for criteria such as lane width), either because the volume of traffic carried by the bridge exceeds the level anticipated when the bridge was constructed and/or the relevant design standards have been revised.

GDP (gross domestic product): The total value of goods and services produced by labor and property located in the United States. As long as the labor and property are located in the United States, the suppliers may be either U.S. residents or residents of foreign countries.

General aviation: Civil aviation operations other than those air carriers holding a Certificate of Public Convenience and Necessity. Types of aircraft used in general aviation range from corporate, multiengine jets piloted by a professional crew to amateur-built, single-engine, piston-driven, acrobatic planes.

Heavy rail: High-speed transit rail operated on rights-of-way that exclude all other vehicles and pedestrians.

Hybrid vehicle: Hybrid electric vehicles combine features of internal combustion engines and electric motors. Unlike 100% electric vehicles, hybrid vehicles do not need to be plugged into an external source of electricity to be recharged. Most hybrid vehicles operate on gasoline.

In-house (transportation): Includes transportation services provided within a firm whose main business is not transportation, such as grocery stores that use their own truck fleets to move goods from warehouses to retail outlets.

Interstate: Limited access divided facility of at least four lanes designated by the Federal Highway Administration as part of the Interstate System.

International Roughness Index (IRI): A scale for roughness based on the simulated response of a generic motor vehicle to the roughness in a single wheel path of the road surface.

Lane-mile: Equals one mile of one-lane road, thus three miles of a three-lane road would equal nine lane-miles.

Large certificated air carrier: Carriers operating aircraft with a maximum passenger capacity of more than 60 seats or a maximum payload of more than 18,000 pounds. These carriers are also grouped by annual operating revenues: majors—more than $1 billion; nationals—between $100 million and $1 billion; large regionals—between $20 million and $99,999,999; and medium regionals—less than $20 million.

Light-duty vehicle: Passenger cars, light trucks, vans, pickup trucks, and sport/utility vehicles regardless of wheelbase.

Light-duty vehicle, long wheelbase: Passenger cars, light trucks, vans, pickup trucks, and sport/utility vehicles with wheelbases longer than 121 inches.

Light-duty vehicle, short wheelbase: Passenger cars, light trucks, vans, pickup trucks, and sport/utility vehicles with wheelbases equal to or less than 121 inches and typically with a gross weight of less than 10,000 lb.

Light rail: Urban transit rail operated on a reserved right-of-way that may be crossed by roads used by motor vehicles and pedestrians.

Linked trip: A trip from the origin to the destination on the transit system. Even if a passenger must make several transfers during a journey, the trip is counted as one linked trip on the system.

Load factor: Revenue passenger-miles as a percent of available seat-miles in revenue passenger services. The term is used to represent the proportion of aircraft seating capacity that is actually sold and utilized.

Local road: All roads not defined as arterials or collectors; primarily provides access to land with little or no through movement.

Long-distance travel: As used in this report, trips of more than 50 miles. Such trips are primarily served by air carriers and privately owned vehicles.

Major collector: Collector roads that tend to serve higher traffic volumes than other collector roads. Major collector roads typically link arterials. Traffic volumes and speeds are typically lower than those of arterials.

Minor arterial: Roads linking cities and larger towns in rural areas. In urban areas, they are roads that link, but do not enter neighborhoods within a community.

Minor collector: Collector roads that tend to serve lower traffic volumes than other collector roads. Traffic volumes and speeds are typically lower than those of major collector roads.

Motorcoach: A vehicle designed for long-distance transportation of passengers, characterized by integral construction with an elevated passenger deck located over a baggage compartment. It is at least 35 feet in length with a capacity of more than 30 passengers.

Motorcycle: A two- or three-wheeled vehicle designed to transport one or two people, including motorscooters, minibikes, and mopeds.

National Highway System (NHS): This system of highways designated and approved in accordance with the provisions of 23 United States Code 103b *Federal-aid systems*.

Nominal dollars: A market value that does not take inflation into account and reflects prices and quantities that were current at the time the measure was taken.

Nonself-propelled vessels: Includes dry cargo, tank barges, and railroad car floats that operate in U.S. ports and waterways.

Oceangoing vessels: Includes U.S. flag, privately owned merchant fleet of oceangoing, self-propelled, cargo-carrying vessels of 1,000 gross tons or greater.

Offshore gathering line: A pipeline that collects oil and natural gas from an offshore source, such as the Gulf of Mexico. Natural gas is collected by gathering lines that convey the resource to transmission lines, which in turn carry it to treatment plants that remove impurities from the gas. On the petroleum side, gathering pipelines collect crude oil from onshore and offshore wells. The oil is transported from the gathering lines to a trunk-line system that connects with processing facilities in regional markets.

Offshore transmission line (gas): A pipeline other than a gathering line that is located offshore for the purpose of transporting gas from a gathering line or storage facility to a distribution center, storage facility, or large volume customer that is not downstream from a distribution center.

Onshore gathering line: A pipeline that collects oil and natural gas from an onshore source, such as an oil field. Natural gas is collected by gathering lines that convey the resource to transmission lines, which in turn carry it to treatment plants that remove impurities from the gas. On the petroleum side, gathering pipelines collect crude oil from onshore and offshore wells. The oil is transported from the gathering lines to a trunk-line system that connects with processing facilities in regional markets.

Onshore transmission line (gas): A pipeline other than a gathering line that is located onshore for the purpose of transporting gas from a gathering line or storage facility to a distribution center, storage facility, or large volume customer that is not downstream from a distribution center.

Particulates: Carbon particles formed by partial oxidation and reduction of hydrocarbon fuel. Also included are trace quantities of metal oxides and nitrides originating from engine wear, component degradation, and inorganic fuel additives.

Passenger-mile: One passenger transported one mile. For example, one vehicle traveling 3 miles carrying 5 passengers generates 15 passenger-miles.

Person-miles: An estimate of the aggregate distances traveled by all persons on a given trip based on the estimated transportation-network-miles traveled on that trip. For instance, four persons traveling 25 miles would accumulate 100 person-miles. They include the driver and passenger in personal vehicles, but do not include the operator or crew for air, rail, and transit modes.

Person trip: A trip taken by an individual. For example, if three persons from the same household travel together, the trip is counted as one household trip and three person trips.

Personal vehicle: A motorized vehicle that is privately owned, leased, rented or company-owned and available to be used regularly by a household, which may include vehicles used solely for business purposes or business-owned vehicles, so long as they are driven home and can be used for the home to work trip (e.g., taxicabs, police cars, etc.).

Planning Time Index (PTI): The ratio of travel time on the worst day of the month compared to the time required to make the same trip at free-flow speeds.

Post Panamax vessel: Vessels exceeding the length or width of the lock chambers in the Panama Canal. The Panama Canal expansion project, slated for completion in 2015, is intended to double the canal's capacity by creating a new lane of traffic for more and larger ships.

Real dollars: Value adjusted for changes in prices over time due to inflation.

Self-propelled vessels: Includes dry cargo vessels, tankers, and offshore supply vessels, tugboats, pushboats, and passenger vessels, such as excursion/sightseeing boats, combination passenger and dry cargo vessels, and ferries.

Short ton: A unit of weight equal to 2,000 pounds.

Structurally deficient (bridge): Characterized by deteriorated conditions of significant bridge elements and potentially reduced load-carrying capacity. A "structurally deficient" designation does not imply that a bridge is unsafe, but such bridges typically require significant maintenance and repair to remain in service, and would eventually require major rehabilitation or replacement to address the underlying deficiency.

TEU (twenty-foot equivalent unit): A TEU is a nominal unit of measure equivalent to a 20' x 8' x 8' shipping container. For example, a 50 ft. container equals 2.5 TEU.

Tg CO_2 Eq.: Teragrams of carbon dioxide equivalent, a metric measure used to compare the emissions from various greenhouse gases based on their global warming potential.

Ton-mile: A unit of measure equal to movement of 1 ton over 1 mile.

Trainset: One or more powered cars mated with a number of passenger or freight cars that operate as one entity.

Transit bus: A bus designed for frequent stop service with front and center doors, normally with a rear-mounted diesel engine, low-back seating, and without luggage storage compartments or rest room facilities. Includes motor and trolley bus.

Transmission line: A pipeline used to transport natural gas from a gathering, processing, or storage facility to a processing or storage facility, large volume customer, or distribution system.

Transportation Services Index (TSI): A monthly measure indicating the relative change in the volume of services over time performed by the for-hire transportation sector. Change is shown relative to a base year, which is given a value of 100. The TSI covers the activities of for-hire freight carriers, for-hire passenger carriers, and a combination of the two. See www.bts.gov for a detailed explanation.

Travel Time Index (TTI): The ratio of the travel time during the peak traffic period to the time required to make the same trip at free-flow speeds.

Trip-chaining: The practice of adding daily errands and other activities, such as shopping or going to a fitness center, to commutes to and from work.

Trolley bus: See transit bus.

Unlinked trips: The number of passengers who board public transportation vehicles. Passengers are counted each time they board vehicles no matter how many vehicles they use to travel from their origin to their destination.

Vehicle-mile: Measures the distance traveled by a private vehicle, such as an automobile, van, pickup truck, or motorcycle. Each mile traveled is counted as one vehicle-mile regardless of number of passengers.

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