U.S. Department of Transportation
Office of the Secretary of Transportation
Bureau of Transportation Statistics

2020

Transportation Statistics Annual Report

U.S. Department of Transportation
Office of the Secretary of Transportation
Bureau of Transportation Statistics

Transportation Statistics Annual Report 2020

Free Copy
Not Meant for Sale

To obtain free copies of the *Transportation Statistics Annual Report 2020* and other BTS publications, please use the following:

Mail U.S. Department of Transportation
Bureau of Transportation Statistics
Attn: Product Orders
1200 New Jersey Avenue
Washington, DC 20590

Internet https://www.bts.gov/tsar

BTS Information Service

Ask-A-Librarian http://transportation.libanswers.com/

Phone 202-366-DATA (3282)

Recommended citation

U.S. Department of Transportation, Bureau of Transportation Statistics, *Transportation Statistics Annual Report 2020* (Washington, DC: 2020).

https://doi.org/10.21949/1520449

Acknowledgements

U.S. Department
of Transportation

Bureau of Transportation Statistics

Patricia Hu

Director

Rolf Schmitt

Deputy Director

Produced under the direction of:

Long Nguyen

Acting Director, Office of Transportation Analysis

Project Managers

Matthew Chambers

Sonya Smith-Pickel

Editor

William H. Moore

Visual Information Specialist

Alpha Wingfield

Major Contributors

Michael Bronzini

Wendell Fletcher

Theresa Firestine

David Greene

Michael Myers

Alan Pisarski

Joanne Sedor

Contributors

Steve Beningo

Justyna Goworowska

Mindy Liu

Janine McFadden

Dominic Menegus

Robert Nazareth

Steve Polzin

Clara Reschovsky

Chris Rick

Jordan Riddle

Demi Riley

Kyle Titlow

Special thanks to all our colleagues throughout the U.S. Department of Transportation who provided data used in this report and critical review of the narrative.

Quality Assurance Statement

The Bureau of Transportation Statistics (BTS) provides high quality information to serve government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. BTS reviews quality issues on a regular basis and adjusts its programs and processes to ensure continuous quality improvement.

Notice

Introduction

Transportation is fundamental to individuals, businesses, the economy, the environment, and the Nation. To assure that statistics provide effective support for transportation decision making, Congress requires the Bureau of Transportation Statistics (BTS), in the U.S. Department of Transportation, to publish and deliver the *Transportation Statistics Annual Report* (TSAR) each year to Congress and the President. BTS published the first TSAR in 1994.

This 26th edition of the report is based on information collected or compiled by BTS—a principle Federal statistical agency. This TSAR describes the Nation's transportation system, the system's performance, its contributions to the economy, and its effects on people and the environment—examining national trends for all modes of transportation.

This BTS report of the BTS Director to Congress and the President summarizes the Bureau's findings on the following topics as required by law,[1] using the latest transportation statistics available:

- the extent, connectivity, and condition of the transportation system, building on the BTS National Transportation Atlas Database—Chapters 1, 2, 3, and 4;
- intermodal and multimodal passenger movement—Chapters 1 and 3;
- intermodal and multimodal freight movement—Chapters 1 and 4;
- transportation safety across all modes and intermodally—Chapter 6;
- the state of good repair of United States transportation infrastructure—Chapters 1 and 2;
- economic efficiency across the entire transportation sector—Chapters 2, 4, and 5;
- the effects of the transportation system on global and domestic economic competitiveness—Chapters 3, 4, and 5;
- demographic, economic, and other variables influencing travel behavior, including choice of transportation mode and goods movement—Chapters 1, 3, and 4;
- transportation-related variables that influence the domestic economy and global competitiveness—Chapters 3, 4, and 5;
- economic costs and impacts for passenger travel and freight movement—Chapters 3, 4, and 5;
- consequences of transportation for the human and natural environment—Chapter 7.

[1] 49 U.S. Code § 6302

A notable addition to this report is coverage of the effects that the Coronavirus (COVID-19) pandemic has had on all modes of transportation—effects that BTS closely monitors. BTS provides a wide range of transportation statistics online, showing the pandemic's effects on passenger travel and freight shipments. These measures are available at https://www.bts.gov/covid-19.

BTS welcomes comment on the *Transportation Statistics Annual Report* and the Bureau's other products. Comments, questions, and requests for printed copies should be sent to bts@dot.gov or to the Bureau of Transportation Statistics, U.S. Department of Transportation, 1200 New Jersey Avenue SE, Washington DC, 20590.

Table of Contents

Chapter 5—Transportation Economics

Chapter 6—Transportation Safety

CHAPTER 1

Extent and Use

Introduction

In the decade since the recession of 2008, and leading up to the onset of the Coronavirus Disease 2019 (COVID-19) pandemic, use of the American transportation system has grown significantly, while the infrastructure that supports that use remained largely built out and stagnant.

Although the current pandemic has suppressed use of the transportation system, it has not stopped the development of new and innovative technologies and services to meet evolving demands, extending the capacity and flexibility of the transportation system. Innovative forms of transportation continue to develop and grow, ranging from autonomous vehicles, connected transportation systems, drones, and Positive Train Control to forms of micromobility, such as bikeshare and e-scooter systems.

This chapter includes the latest transportation data available from 2017, 2018, and 2019. Annual statistics that reveal changes in the transportation system brought on by the COVID-19 pandemic will be available in future editions of this report.

Highlights

- The COVID-19 pandemic has dramatically changed the availability and use of the transportation system. Although its effects on the U.S. transportation system were not fully felt until March 2020, this report must make note of these events. Schedules and ridership for commercial airlines, Amtrak, transit systems, ocean vessel services, and other forms of transportation dropped to record lows beginning in March 2020 as passenger volumes and freight movement declined. The full consequences this has for year-end totals and longer-term changes will be revealed in the months and years ahead.
- Transportation activity is often highly concentrated on portions of the network. For example, the more than 48,000-mile Interstate Highway System in 2018 comprised 1.2 percent of total highway miles available but carried 25.6 percent of total highway vehicle-miles of travel.
- Automated vehicle development is advancing across all transportation modes, with 38 jurisdictions permitting testing of driverless highway vehicles in 2018, more widespread autonomous port systems and ships, and the use of Positive Train Control systems.

The U.S. Transportation System

In 2018 the U.S. transportation system served 327 million U.S. residents, including those who may not own a vehicle or rarely travel, and 80 million foreign visitors. Transportation is used to commute to work, obtain goods and services, visit with family and friends, and travel for leisure and work. It also drives the economy, connecting 7.9 million business establishments with customers, suppliers, and workers [USDOC CENSUS 2019].

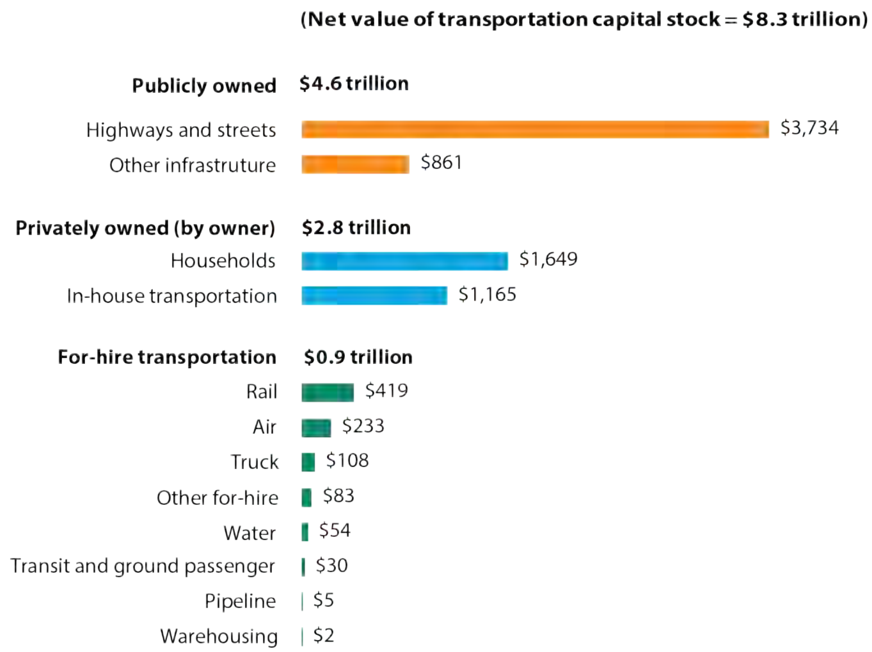
Capital Stock and Investments

Value of Transportation Infrastructure Exceeds $8 Trillion

Transportation capital stock is the total value of transportation infrastructure and equipment in existence on a specific date. The net value of U.S. transportation capital stock was estimated at $8.3 trillion in 2018 (figure 1-1), up 4.4 percent from 2017.[1]

[1] For capital stock values in 2016 see TSAR 2018, figure 1-1.

FIGURE 1-1 Estimated Value of Transportation Capital Stock: 2018 ($billions)



NOTES: Data include only privately owned capital stock except for those otherwise noted. Capital stock data are reported after deducting depreciation. Other publicly owned transportation includes publicly owned airway, waterway, and transit structures but does not include associated equipment. Locks and dams may be included under other publicly owned transportation. Household includes personal vehicles, which are considered consumer durable goods. In-house transportation is capital stock owned by non-transportation companies. For example, grocery companies often use their own truck fleets to move goods from their warehouses to their retail outlets. In-house transportation and for-hire transportation figures cover the current cost net capital stock for fixed assets (transportation-related equipment including light trucks; other trucks, buses, and truck trailers; autos; aircraft; ships and boats; and railroad equipment as well as transportation-related structures including air, rail, transit, and other transportation structures and track replacement) owned by a firm. 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. Data may differ from those published in the 2018 TSAR due to revisions in the source data. Please see cited source for additional information.

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, Fixed Asset Tables, 7.1, 8.1, and Current-Cost Net Capital Stock of Private Nonresidential Fixed Assets table, available at https://apps.bea.gov/iTable/index_FA.cfm as of August 2019.

Transportation capital stock is owned by both the public and private sectors. Freight railroad facilities and equipment are almost entirely owned by the private sector, while highways, bridges, seaports, and transit structures are generally owned by state and local governments. Airport capital stock has mixed ownership because about three-quarters of airports are privately owned. In 2018 the public sector owned $4.6 trillion (55.1 percent of transportation capital stock), while the private sector owned $3.7 trillion (44.9 percent) (figure 1-1). Public highways and streets accounted for the largest share of publicly owned transportation capital stock ($3.7 of $4.6 trillion), while other publicly owned transportation, such as airports, seaports, and transit structures, accounted for the remaining share ($861 billion).

In 2018 personal motor vehicles owned by households, some of which are used for business purposes, accounted for the largest amount of privately owned transportation capital stock ($1.6 of $3.7 trillion) (figure 1-1). In-house transportation accounted for the second largest amount ($1.2 trillion) of private transportation capital stock, most of which was highway related, such as truck fleets owned by grocery chains. For-hire rail owned the next largest amount, accounting for $419 billion, followed by for-hire air at $233 billion. The distribution of transportation capital stock ownership in 2018 is essentially the same as it was in 2017.[2]

Roads, Bridges, Vehicles, and Parking

Expansive Infrastructure Required to Meet Demand

Roads

Since 2010 physical growth of the U.S. highway system infrastructure has slowed. Highway mileage, lane-miles, and the number of bridges have grown by less than one-half percent per year, plateauing at about 4.2 million center-line miles,[3] 8.8 million lane-miles in 2018,[4] and more than 617 thousand bridges in 2019. The exception is non-interstate expressway mileage, which almost increased by one-fourth over the 8-year period. Otherwise, today's road building consists primarily of widening projects that increase lane-miles, new or upgraded state highways and local streets to serve new commercial and residential developments, and rehabilitation and maintenance projects to maintain existing highways.

Local roads are by far the most extensive, amounting to 2.9 million miles (around 69 percent of total centerline-miles) in 2018 (table 1-1). However, interstate highways, which accounted for about 48,000 miles (just over 1 percent of total system-miles), handled the highest volumes of traffic as measured by vehicle-miles traveled (VMT)— just under 26 percent in 2018 [USDOT FHWA 2019a].

Figure 1-2 shows the National Highway System (NHS) and other principal arterials and intermodal connectors, comprising an extensive system of highways supporting densely populated urban centers in the northeast and parts of the Midwest, South, and West. The NHS includes interstate highways as well as other roads important to the Nation's economy, defense, and mobility. Since initial development of the interstate highway system in the 1950s, the growth of the interstates has followed U.S. population growth in the metropolitan areas in the south and along the Pacific coast [USDOT FHWA 2017].

[2] Additional information on transportation investments can be found in chapter 5.

[3] A centerline-mile has a total length of 1 mile as measured along the highway centerline.

[4] Lane-miles are the product of the centerline length (in miles) multiplied by the number of lanes. For example, the one-mile centerline length of a two-lane road equals two lane-miles.

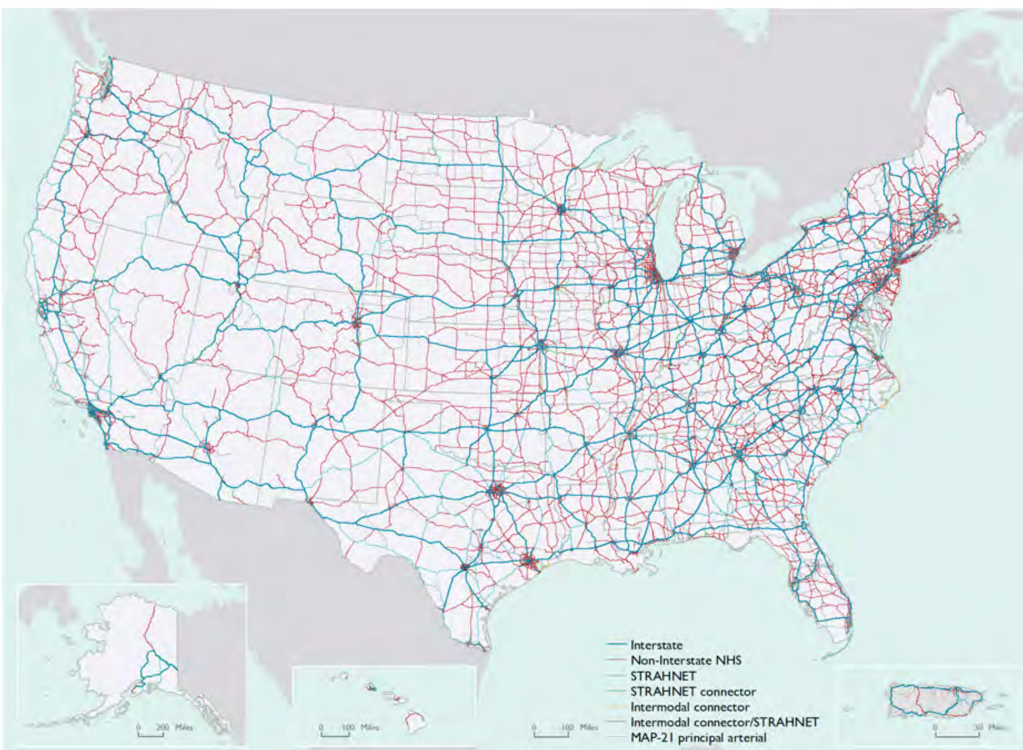
TABLE 1-1 Public Roads, Streets, and Bridges: 2010, 2017, and 2018

	2010	2017	2018	Percent change since 2010
Public Road and Street Mileage by Functional Type (centerline-miles)	4,067,076	4,165,349	4,176,915	2.7
Interstate	46,900	48,254	48,440	3.3
Other freeways and expressways	14,619	18,741	18,603	27.3
Other principal arterial	157,194	156,081	156,614	-0.4
Minor arterial	242,815	246,644	246,214	1.4
Collectors	799,226	815,892	814,585	1.9
Local	2,806,322	2,879,736	2,892,459	3.1
Total lane-miles	8,581,158	8,765,578	8,794,569	2.5
Total bridges	604,460	615,002	616,096	1.9
Total registered vehicles	250,070,048	272,480,899	273,602,100	9.4
Vehicle-miles of travel (millions)	2,967,266	3,212,347	3,240,327	9.2

NOTE: Lane-miles are the centerline length in miles multiplied by the number of lanes.

SOURCE: 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, 1-6, 1-11, 1-28, and 1-35, available at http://www.bts.gov/ as of March 2020.

FIGURE 1-2 National Highway System, Intermodal Connectors, and Principal Arterials: 2018



KEY: NHS = National Highway System or the interstate highway system; STRAHNET = Strategic Highway Network or a network of highways that are important to the U.S. strategic defense policy. MAP-21 principal arterials = those rural and urban roads serving major population centers not already categorized above.

SOURCE: U.S. Department of Transportation (USDOT), Federal Highway Administration, Highway Performance Monitoring System, as cited in USDOT, Bureau of Transportation Statistics, National Transportation Atlas Database, available at www.bts.gov as of September 2018.

Bridges

A total of 617,084 highway bridges were in use in 2019, ranging in size from rural one-lane bridges crossing creeks to urban multilane and multilevel interstate bridges and major river crossings. Rural bridges, including those on rural interstate highways, accounted for just under three-quarters of the total bridge network [USDOT FHWA 2019a]. While rural and urban interstate bridges accounted for over 9.4 percent of all bridges, they carried 45.5 percent of motor vehicle traffic. Texas had the most bridges, accounting for about 8.8 percent of the entire U.S. bridge inventory, followed by Ohio (about 4.4 percent) and Illinois (about 4.3 percent) [USDOT FHWA 2019a].

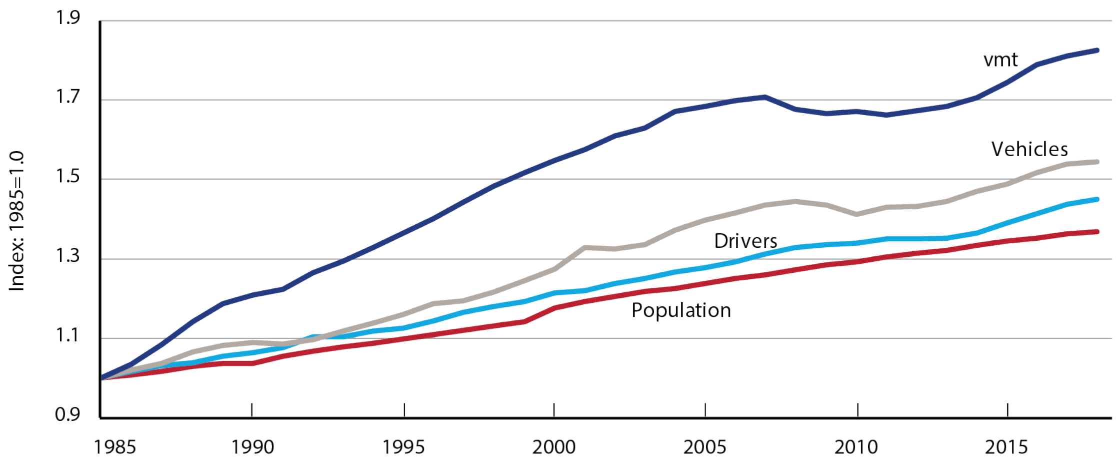
According to the Federal Highway Administration, the road system in rural America is well developed. Most rural areas have a well-established network of interstate highways; arterials; and state, county, and local roads. The more than 6.0 million rural lane-miles accounted for about 69 percent of the total lane-miles in 2018 (8.8 million) and about 30 percent of the 3.3 trillion vehicle-miles of travel (VMT) in 2019 [USDOT FHWA 2019a and USDOT FHWA 2019b]. About 46 percent of combination and single-unit truck VMT occurred in rural areas in 2018 [USDOT FHWA 2019b].

Rural roads are more likely to be narrower and have fewer lanes than urban roads. In 2013 about 86 percent of the Nation's rural non-freeway arterial roads had two lanes, compared to 56 percent for comparable urban routes [TRIP 2019]. City and county governments fund and maintain almost all rural unpaved roads and more than half of rural paved roads [USDOT FHWA and FTA 2019].

Vehicles

Government, businesses, private individuals, and nongovernmental organizations owned and operated about 273.6 million motor vehicles in 2018 and drove a total of more than 3.2 trillion miles [USDOT FHWA 2019a]. Although commercial vehicles (trucks and buses) comprised about 5 percent of registered vehicles, their use accounted for about 10 percent of VMT [USDOT FHWA 2019]. Many new vehicles offer advanced technologies, such as forward collision warning, automatic emergency braking, lane departure warning, lane keeping assist, blind spot monitoring, rear cross-traffic alert, and adaptive cruise control,

FIGURE 1-3 Licensed Drivers, Vehicle Registrations, Vehicle-Miles Traveled, and Population: 1985–2018



KEY: VMT = vehicle-miles traveled.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2018*. Tables DL-1C and VM-1, available at http://www.fhwa.dot.gov/policyinformation/statistics/2018 as of March 2020.

which assist drivers and help improve highway safety. Over 194 makes and models offered these technologies[5] as standard or optional features for model years 2016 and 2017 [AAA 2018].

While highway system growth may be relatively stagnant, quite the opposite is true for the number of highway vehicles and the miles they are driven, both of which have grown at a faster rate than licensed drivers and the population since 1985 (figure 1-3). This growth produced a slight increase in the average number of motor vehicles owned by households, rising from an average of 1.86 vehicles per household in 2009 to 1.88 vehicles per household in 2017 as discussed further in chapter 3 [USDOT FHWA NHTS 2019c]. Increasing traffic on a relatively fixed stock of highways also leads to increases in traffic congestion, traffic delays, and the degradation of system performance and the environment, as discussed further in chapter 2.

Most daily personal travel, particularly work commutes, is in privately owned vehicles. According to the National Household Travel Survey, the average vehicle was driven slightly more than 10,000 miles a year in 2017, which is about the same as in 2009. However, the average miles per vehicle are down from their peak in the 1990s [USDOT FHWA NHTS 2019c]. Comparable public data for commercial trucks are not available. The Vehicle Inventory and Use Survey (VIUS), formerly conducted every 5 years by the Census Bureau (the last survey was in 2002), provided further data on the physical and operational characteristics of the Nation's commercial truck population. An updated VIUS will be conducted in 2022 [USDOT BTS 2020a].[6]

Parking

The parking infrastructure in the United States is both vast and largely unmeasured at the national level.[7] However, some national or state transportation issues require data on parking supply. For example, while parking spaces for commercial trucks are a small portion of the total parking supply, adequate truck parking along major freight corridors to help commercial vehicle operators obtain adequate rest while adhering to Federal hours of service regulations is a major highway safety concern.[8]

Public Transit

A New Marketplace for Shared Mobility, Bikeshare, and E-Scooter

About 950 urban transit agencies and more than 1,400 rural and tribal government transit agencies offer a range of travel options, including commuter rail, subway, and light-rail; transit and trolley bus; demand response services; and ferryboat. In 2018 these transit agencies operated over 5,140 stations.[9] There were 13,109 fixed rail transit track-miles and 4,864 fully controlled or limited access bus lane-miles in 2018 [USDOT FTA 2018]. Figure 1-4 shows the nationwide extent of public transit services.

Transit agencies vary widely in size, ranging from social service agencies operating a single vehicle to the 13,000 vehicles[10] operated by the New York City Metropolitan Transportation Authority. Nationwide, buses accounted for nearly half (about 47 percent) of the 135,000 transit vehicles in 2018 (table 1-2).

[5] Vehicle automation is discussed further later in this chapter.

[6] For further information on the VIUS, please see Chapter 8 State of Transportation Statistics.

[7] One reason that national estimates are lacking is that parking is inherently a local, mostly private-sector enterprise that is within the purview of land developers, businesses, and individual drivers.

[8] For additional information on truck parking, please see: https://ops.fhwa.dot.gov/freight/infrastructure/truck_parking/.

[9] With about 80 percent compliant with the *Americans with Disabilities Act* (Pub. L. 101-336).

[10] Includes commuter bus, demand response, heavy rail, bus, and bus rapid transit.

FIGURE 1-4 Top 50 Transit Stations by Total Ridership: 2019

SOURCE: U.S. Department of Transportation, Federal Transit Administration, National Transit Database, available at www.fta.dot.gov as of May 2020.

TABLE 1-2 Transit Vehicles and Ridership: 2010, 2017, and 2018

	2010	2017	2018
TOTAL, transit vehicles	134,815	135,805	135,426
TOTAL, rail transit vehicles	20,374	20,391	20,515
Heavy rail cars	11,510	10,705	10,763
Commuter rail cars and locomotives	6,768	7,129	7,023
Light rail cars	2,096	2,557	2,729
TOTAL, non-rail transit vehicles	114,441	115,414	114,911
Motor bus	63,108	64,298	63,855
Demand response	32,696	33,012	33,253
Ferry boat	134	147	171
Other	18,503	17,957	17,632
Rail transit stations	3,124	3,399	3,448
Person-miles (millions)	52,627	54,826	53,830
Unlinked passenger trips (billions)	10.04	10.13	9.93
Rail transit	4.51	4.91	4.81
Non-rail transit	5.53	5.22	5.12

NOTES: **Motor bus** includes bus, commuter bus, bus rapid transit, and trolley bus. **Light rail** includes light rail, streetcar rail, and hybrid rail. **Demand response** includes demand response and demand response taxi. **Other** includes Alaska railroad, automated guideway transit, cable car, inclined plane, monorail, publico, and vanpool. **Unlinked passenger trips** is 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. **Rail transit stations** is the sum of Alaska Railroad, commuter rail, heavy rail, and light rail.

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). Tables 1-11, available at http://www.bts.gov/ as of January 2020. **Person-miles traveled**—USDOT/FTA/NTD as cited in USDOT/BTS/NTS. Table 1-40, available at http://www.bts.gov/ as of January 2020. **Transit Stations**—USDOT/FTA/NTD as cited in USDOT/BTS/NTS. Table 1-7, available at http://www.bts.gov/ as of March 2020. **Unlinked passenger trips**—USDOT/FTA/NTD, available at https://www.transit.dot.gov/ntd/ntd-data as of June 2020.

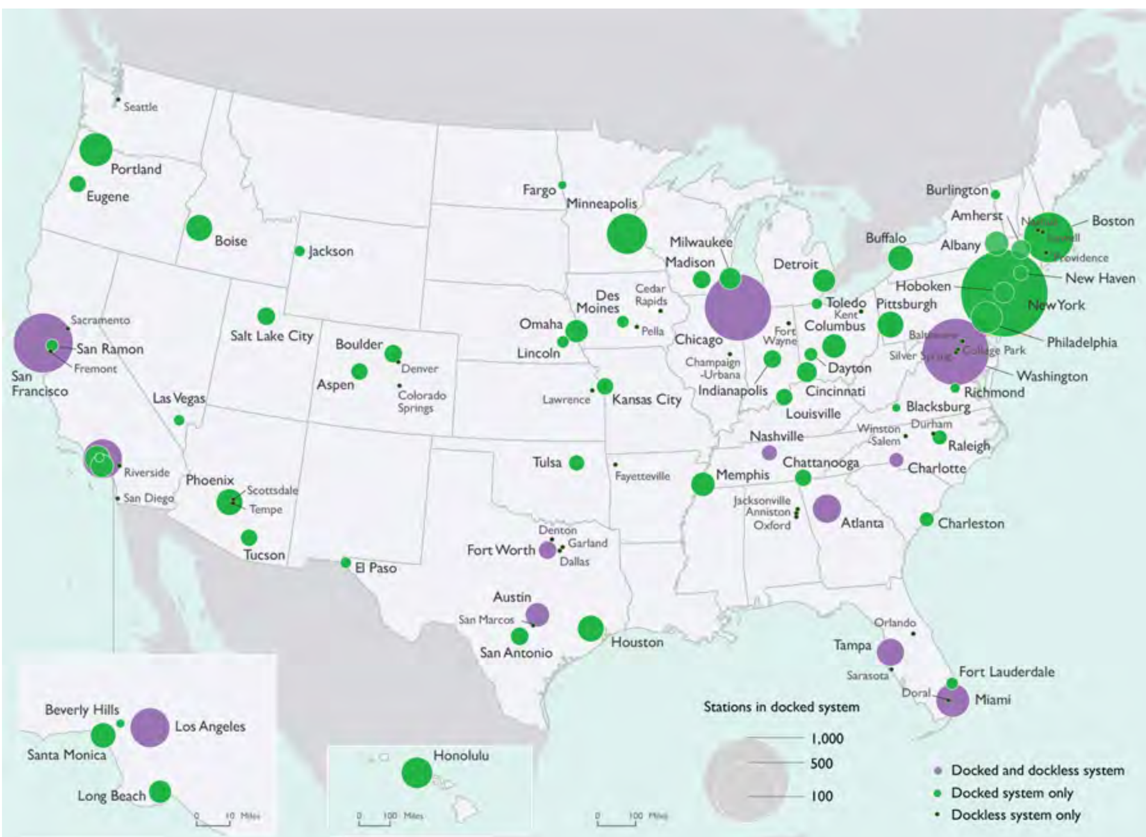
Transit ridership surpassed 9 billion beginning in 2007, reaching a high of 9.9 billion in 2014 [USDOT BTS 2019d]. Ridership declined in subsequent years, even before the COVID-19 pandemic, falling to 9.1 billion in 2018—a decline of about 355 million, and 3.8 percent below the 2010 level shown in table 1-2. Rail transit (heavy, commuter, and light rail) comprised approximately 15 percent of the transit vehicles but 46 percent of transit trips and 60 percent of person-miles traveled (PMT). Buses recorded the highest share of transit trips at 53 percent but only 31 percent of PMT. This can be attributed to the fact that bus passengers generally take shorter trips. Conversely, due to longer trips, rail carries three-fifths of all transit PMT. Demand-response or paratransit systems, which are largely social service agency trip providers in areas without fixed services or timetables, operated around 25 percent of transit vehicles in 2018. Demand-response and paratransit systems sometimes operate in rural areas and tend to service those with a disability or those who do not own a car.

Two new, rapidly growing travel services that affect both driving and transit usage in urban areas are ride-hailing and vehicle-sharing. These on-demand services have created new business models, including transportation network companies (TNCs), mobility on demand (MOD), and mobility-as-a-service (MaaS) that rely on a digital platform that integrates various forms of transport services into a single on-demand service. Usage of these new travel options is discussed further in chapter 3. Figure 1-5 shows the extent of two types of vehicle sharing in the United States—bikeshare and e-scooter (see box 1-A).

A ride-hailing service uses an online platform to connect riders to drivers, typically using an application (app) on a mobile phone through which the rider may both arrange for a ride and make payment. The largest ride-hailing companies currently providing service in the United States are Uber and Lyft, most of whose drivers use their personal vehicles. Data on most aspects of ride-hailing are unavailable,[11] due primarily to its novelty, rapid growth, and lack of required reporting by the companies and drivers (other than their private Federal income tax returns).

[11] Effective March 2020, BTS is working to produce data products that provide insights on nationwide activity and trends related to taxi and limousine services that include ride-hailing services (also known as Transportation Network Companies).

FIGURE 1-5 U.S. Cities with Bikeshare Service: 2020



SOURCES: **Docked bikeshare systems**—U.S. Department of Transportation, Bureau of Transportation Statistics, Intermodal Passenger Connectivity Database, available at https://data-usdot.opendata.arcgis.com/datasets/bikeshare as of November 2019. **Dockless bikeshare and e-scooter systems**—U.S. Department of Transportation, Bureau of Transportation Statistics, available at https://data-usdot.opendata.arcgis.com/datasets/bikeshare-scooter-systems as of November 2019.

Box 1-A Bikeshare and E-Scooters in the United States

Micromobility refers to modes of transportation that comprise light, low-occupancy vehicles—such as e-scooters, electric skateboards, shared bicycles, and electric pedal assisted bicycles (e-bikes). These systems have recently emerged as a solution for potential transit riders who do not live near a transit stop or are going to a location that is far enough from transit that walking is not a viable option to complete the trip.

As shown in figure 1-5, bikeshare and e-scooter systems are available in urban areas throughout the United States, ranging from large metro areas (e.g., Washington, DC) to small cities (e.g., Aspen, CO). From 2015 through July 2019, there were 85 new docked bikeshare systems launched across the United States. These and existing systems added a net of 3,279 new docking stations, bringing the total number of docking stations to 6,872. A total of 111 bikeshare systems operators serve over 200 cities. On average, systems have 63 docking stations operating, with the largest system (Citi Bike in New York City) operating over 800 stations, while 27 systems have 10 or fewer stations. Nationwide, 71 percent of all bikeshare docking stations are within one block of another public passenger transportation mode, and an additional 13 percent are within two blocks [USDOT BTS 2019a].

Docked vehicle share systems feature fixed locations where vehicles are picked up and returned. In dockless operation systems, vehicles may be picked up and dropped off virtually anywhere within the service area. Dockless bikeshare systems and e-scooters first appeared in the United States in 2017. As of July 2019, there were 69 dockless bikeshare systems and 192 e-scooter systems (not counting systems limited to college or employer campuses). Many systems serve the same city. These dockless bikeshare systems served 58 cities and e-scooters 110 cities. Dockless operation has made this travel option more accessible and increased mobility while raising safety concerns (particularly for scooters), prompting 26 states and many cities to pass legislation regulating bikeshare and e-scooter operations.

On shared bikes and scooters across the United States, 84 million trips were taken in 2018, more than double the 35 million trips taken in 2017 and up from 320,000 as recently as 2010 [NACTO 2019].

Aviation

Air Travel Reached New Highs in 2019 Prior to Pandemic

The main elements of aviation system infrastructure include airport runways and terminals, aircraft, and air traffic control systems. In 2019 the United States had about 19,600 airports (table 1-3), ranging from rural grass landing strips to large paved multiple-runway airports. About a quarter of the airports are public-use facilities, which include large commercial airports and general aviation airports that serve a wide range of users. The remaining three-quarters are private airports, which tend to be relatively small.

The number of U.S. airports with nonstop international service decreased from 207 in 2010 to 202 in 2018 to 192 in 2019, offering less commercial air service locations throughout the country to the world. While just under 100 airports lost international service (e.g., Huntsville

TABLE 1-3 U.S. Air Transportation System: 2000, 2010, 2017, 2018, and 2019

	2000	2010	2017	2018	2019
TOTAL, U.S. airports	19,281	19,802	19,655	19,627	19,636
Public use	5,317	5,175	5,104	5,099	5,080
Private use	13,964	14,353	14,263	14,528	14,556
Military	U	274	288	305	308
TOTAL, aircraft	225,359	230,555	218,953	219,224	219,963
General aviation aircraft	217,533	223,370	211,757	211,749	212,335
Commercial aircraft	7,826	7,185	7,196	7,475	7,628
Pilots	532,517	508,469	460,185	465,513	466,900
TOTAL, load factor	72.94	81.79	82.32	82.87	83.69
Domestic flights	71.14	82.07	84.42	84.33	84.94
International flights	75.02	81.48	80.51	81.59	82.58
TOTAL, passenger enplanements (thousands)	741,106	791,813	968,482	1,016,828	1,055,477
Enplanements on domestic flights	611,250	644,389	754,381	791,018	824,635
Enplanements on international flights of U.S. carriers	59,019	76,936	97,755	100,900	104,277
Enplanements on international flights of foreign carriers	70,837	70,488	116,346	124,910	126,565
TOTAL, revenue passenger-miles, U.S. carriers (millions)	708,903	809,068	969,904	1,016,996	1,060,860
Domestic, revenue passenger-miles (RPM) (millions)	515,598	564,695	693,818	730,426	762,890
International on U.S. carriers,revenue passenger-miles (RPM) (millions)	193,305	244,373	276,086	286,570	297,970
TOTAL, revenue ton-miles on U.S. carriers (millions)	101,703	117,422	138,095	145,569	149,559
Domestic, revenue ton-miles (RTM) (millions)	66,542	69,010	84,522	89,011	92,722
International on U.S. carriers, revenue ton-miles (RTM) (millions)	35,161	48,412	53,573	56,558	56,837

NOTES: General aviation includes air taxis. Pilots exludes student pilots. Major U.S. carriers have annual operating revenue exceeding $1 billion. National carriers have annual operating revenues between $100 million and $1 billion. These carrier categories differ from the more commonly used business model categories. Total includes both scheduled and non-scheduled passenger enplanements. Revenue passenger-miles (RPM) are calculated by multiplying the number of revenue passengers by the distance traveled. Revenue ton-miles (RTM) is 1 ton of revenue traffic transported 1 mile. RTM includes passenger, freight, express, and mail ton-miles using 5,280 feet to calculate mileage distance. Passengers and their baggage are estimated at 200 pounds. Load factor is a measure of the use of aircraft capacity that compares the system use, measured in RPMs as a proportion of system capacity, measured by available seat miles.

SOURCES: Airports—U.S. Department of Transportation (USDOT). Federal Aviation Administration (FAA), special tabulation, May 2020 as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, table 1-3. General aviation aircraft and Pilots—USDOT/FAA. FAA Aerospace Forecast, Fiscal Years (multiple issues), available at www.faa.gov as of March 2020. Passenger enplanements—USDOT, BTS, OAI, T-100 Market data, available at http://www.transtats.bts.gov/ as of March 2020. Load Factor—USDOT, BTS, OAI, T-100 Segment data, available at http://www.transtats.bts.gov/ as of July 2020. RPM and RTM—USDOT, BTS, OAI, T1: U.S. Air Carrier Traffic And Capacity Summary by Service Class, available at http://www.transtats.bts.gov/ as of July 2020.

International Airport), about 250 airports gained international service in that time span, such as Jackson–Medgar Wiley Evers International Airport and Brown Field Municipal Airport. The number of air passengers traveling between the United States and foreign points reached a new high in February 2020, just before restrictions on international travel due to the COVID-19 pandemic were implemented [USDOT BTS 2020b].

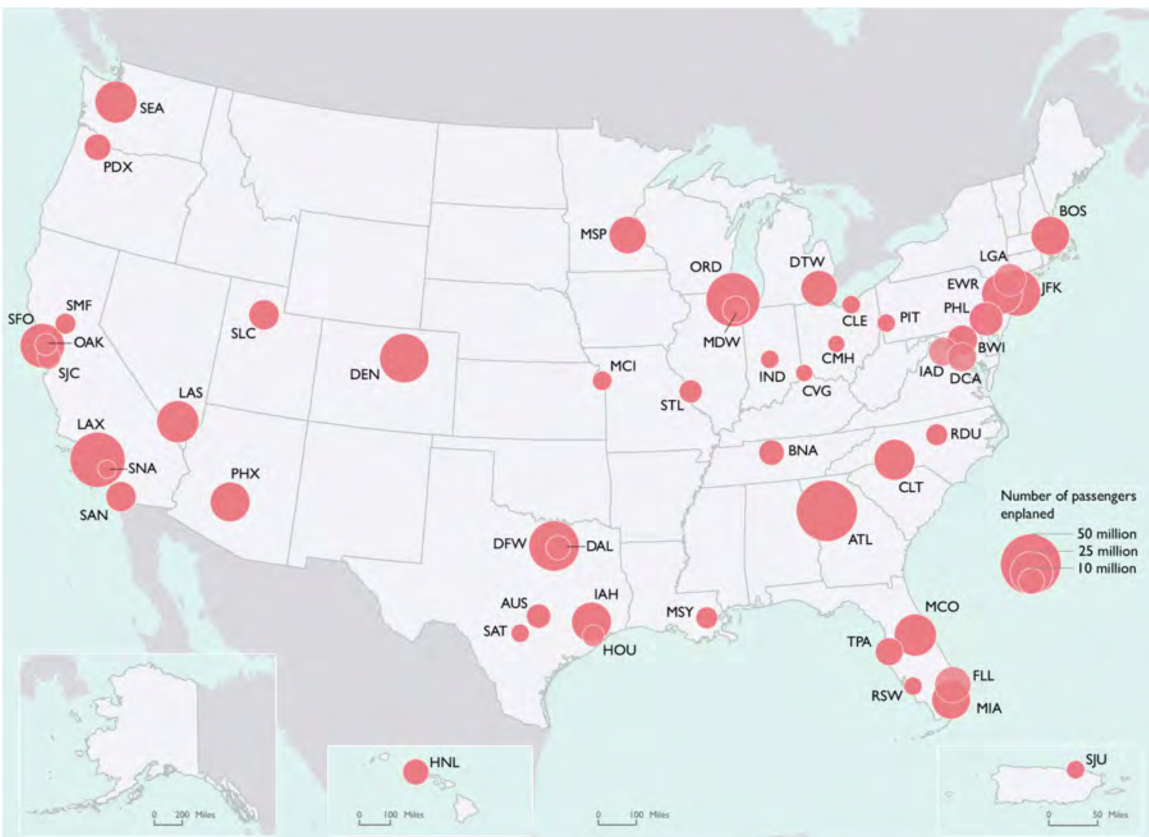
Figure 1-6 shows the airports with the most passenger enplanements, including Hartsfield-Jackson Atlanta International (53.5 million), Los Angeles International (42.9 million), and Chicago O'Hare (40.9 million). The top 50 airports accounted for about 85 percent[12] (about 786 million) of the U.S. airport passenger enplanements in 2019.

U.S. airports handled about 10.2 million[13] commercial airline flights in 2019. Total commercial flights on U.S. carriers have varied

[12] In 2018 this was changed to more accurately report the number of enplaned passengers in the United States and may not be compatible to those in previous editions of this report. The number of enplaned passengers is now dynamically filtered using the latest top airports and calculated using an internal database.

[13] Previous editions of this report have reported total commercial fights for major U.S. airports only, rather than for all U.S. airports.

FIGURE 1-6 Enplanements at the Top 50 U.S. Airports: 2019



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Office of Airline Information, available at www.bts.gov as of November 2019.

between 9.5 and 10.0 million since 2010 but remain below the pre-Great Recession (December 2007 to June 2009) levels, which exceeded 10.5 million [USDOT BTS 2019e]. At least some of this reduction is due to the trend for airlines to use larger aircraft and reduce the number of flights.

Airline deregulation, which began in 1978, has revealed two somewhat contradictory trends. Through a steady wave of acquisitions, mergers, and shutdowns, the industry has seen considerable consolidation. On the other hand, a group of new low-cost carriers have entered the market. The net result is that the number of scheduled passenger airlines designated as "major" decreased from 17 in 2000 to 13 in early 2020.[14] Five of the major airlines currently market themselves as low-cost carriers (Alaska, Frontier, JetBlue, SkyWest, and Spirit).

[14] A "major" airline is defined as an airline that has at least $1 billion in annual revenue. The major airlines in 2020 are Alaska, Allegiant, American, Delta, Envoy, Frontier, Hawaiian, JetBlue, Republic, SkyWest, Southwest, Spirit, and United.

Freight Railroads

New Efficiencies Help Railroads Carry More Cargo in Fewer Cars

The United States had 136,851 railroad route-miles in 2017, including 93,058 miles owned and operated by the seven Class I railroads [AAR 2019a].[15] About 600 local and regional railroads operated the remaining 43,793 miles. In 2018 Class I railroads provided freight transportation using 26,086 locomotives and 1.73 million railcars (table 1-4). Average freight car capacity was about 103 tons in 2010 and reached 105 tons in 2018 due to construction of larger cars, particularly new hopper and tank cars.

[15] According to the Association of American Railroads, Class I railroads had a minimum operating revenue of $489.94 million in 2018 (the latest year for which data are available). It includes BNSF Railway, CSX Transportation, Grand Trunk Corp. (Canadian National operations in the United States), Kansas City Southern, Norfolk Southern, Soo Line (Canadian Pacific operations in the United States), and Union Pacific.

TABLE 1-4 Rail Transportation System: FY 2010, 2017, and 2018

	2010	2017	2018
Equipment and mileage operated by Class I railroads			
Locomotives	23,893	26,547	26,086
Freight cars[a]	397,730	306,268	293,742
Average freight car capacity (tons)	103.1	104.8	105.1
System mileage	95,700	93,150	92,837
Ton-miles (trillions)	1.69	1.67	1.73
Capital expenditures, $billions			
Roadway and structures	$7.86	$9.56	$9.33
Equipment	$1.91	$3.40	$3.08
Total	$9.77	$12.96	$12.41

[a]Includes totals for Canada and Mexico.

NOTE: Fiscal year ending in September.

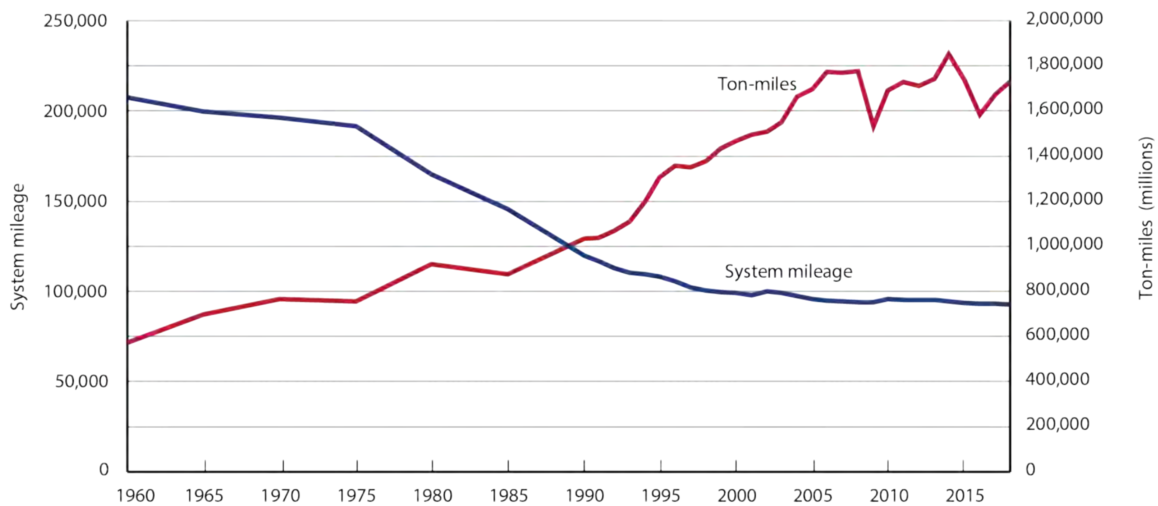
SOURCES: **Class I railroads-locomotives, freight cars, and system mileage**—Association of American Railroads, Railroad Facts (annual issues) as cited in USDOT/BTS/NTS. Tables 1-1 and 1-11, available at http://www.bts.gov/ as of November 2019. **Capital expenditures**—Association of American Railroads, Railroad Facts (annual issues), as of November 2019.

Rural areas accounted for 75.7 percent, or 109,371 miles out of a total of nearly 140,000 miles of railroad track in the United States in 2018 [BTS 2019g]. The United States has 77,895 rural public highway-rail crossings, which translate to roughly 61 percent of total public road-rail crossings (128,588). Rural roadway railroad crossings occur an average of every 1.4 track-miles, which is more frequent than that of urban roadway rail crossings, which occur an average of every 1.7 track-miles. Grade crossing related safety issues are discussed in chapter 6.

Over the past 50 years, Class I railroads and connecting facilities have developed increasingly efficient ways to carry and transfer cargo (e.g., larger cars as noted above, double-stack container railcars, and on-dock rail), allowing more cargo to be carried with fewer railcars. Figure 1-7 shows that the system mileage of Class I railroads in 2018 was less than 45 percent of the mileage in 1960. However, freight rail ton-miles tripled to 1.7 trillion during the same period (despite a decline during the Great Recession). The railroads, which are private companies, invested $12.4 billion in 2018 to improve their facilities (table 1-4), which is comparable to the average investment over the past 8 years [AAR 2019a].

One current technology initiative to improve safety across the rail industry is implementation of Positive Train Control systems (box 1-B).

FIGURE 1-7 Class I Railroad System Mileage and Ton-Miles of Freight: 1960–2018



NOTE: Data includes every 5 years until 1970. Data are yearly thereafter.

SOURCE: Association of American Railroads, Railroad Facts, Statistical Highlights (Washington, DC; annual issues), available at https://www.aar.org/ as of November 2019.

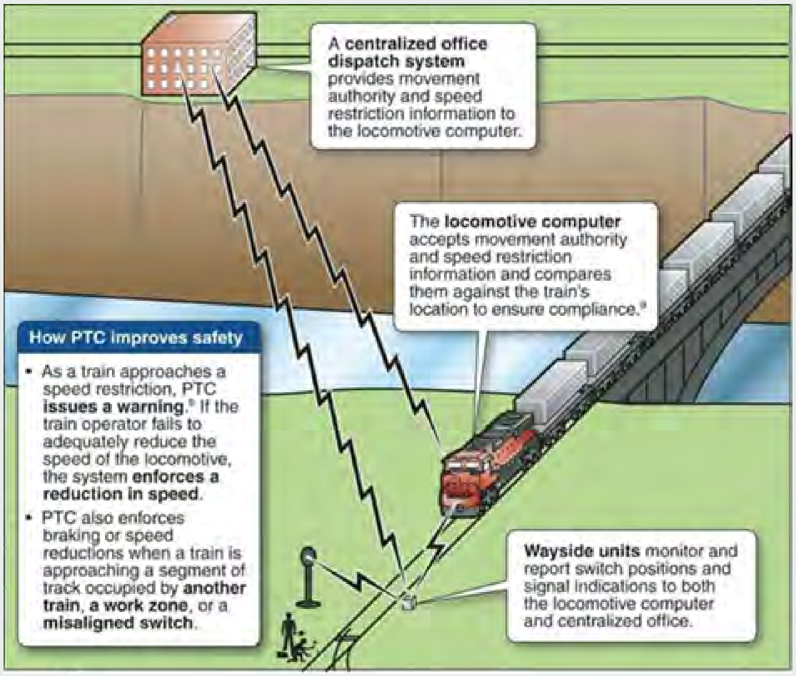
Box 1-B Positive Train Control

Following several high-profile train incidents, Congress passed the Rail Safety Improvement Act of 2008 [RSIA08; P.L. 110-432], which mandated Positive Train Control (PTC) on many passenger and freight railroads. PTC is a set of technologies designed to automatically stop or reduce the speed of a train under certain circumstances. PTC systems use communication-based and processor-based train control technology to reliably and functionally prevent train-to-train collisions, over speed derailments, incursions into established work zone limits, and movements of trains through switches in the wrong position [CRS 2018; USDOT FRA 2018]. The basic idea of how these systems work is illustrated in figure 1-8 below [USGAO 2013].

Each Class I railroad and each entity providing regularly scheduled intercity or commuter rail passenger transportation must implement a Federal Railroad Association certified PTC system on its main line if it meets the following criteria: transports 5 million or more gross tons of annual traffic and poison- or toxic-by-inhalation hazardous materials on its main line over which intercity or commuter rail passenger transportation is regularly provided [USDOT FRA 2018]. PTC is a building block for achieving higher levels of automation for the railroad industry.

As of July 1, 2019, the Nation's largest freight railroads are operating PTC across the clear majority—91 percent—of the required Class I PTC route miles nationwide [AAR 2019b]. On the Class I railroads, PTC system hardware has been installed, radio spectrum acquired, employees trained, and testing initiated. Through 2018 the railroads have spent over $10 billion developing, installing, and testing PTC [AAR 2019b]. Demonstrating interoperability between host and tenant railroads is a key remaining step.

FIGURE 1-8 Positive Train Control System Illustration



SOURCE: Government Accounting Office (GAO)

Passenger Rail

Amtrak Transports Passengers Across the United States, with the Highest Ridership in the Northeast Corridor

The National Railroad Passenger Corp. (Amtrak) is the primary operator of intercity passenger rail service in the United States. Amtrak operated 21,407 route-miles in 2018 and more than 500 stations that served 46 states and Washington, DC (table 1-5). On an average day, Amtrak operates more than 300 trains, using a fleet of approximately 1,400 passenger cars and over 400 locomotives. During fiscal year (FY) 2019, Amtrak riders took 31.8 million trips. When compared with U.S. airlines prior to the COVID-19 pandemic, Amtrak ranked 8th in passengers carried (behind Southwest Airlines, Delta Air Lines, American Airlines, United Airlines, JetBlue Airways, SkyWest Airlines, and Alaska Airlines) [USDOT BTS 2019e]. Amtrak carried more than three times as many riders between Washington, DC, and New York City as flew on all the commercial airlines combined [AMTRAK 2019].

Figure 1-9 depicts where people ride Amtrak in the United States. The heaviest ridership is in the Northeast Corridor between Boston and Washington, DC Ridership is also high around Chicago as well as at several locations in California and the Pacific Northwest. In FY 2019 the busiest Amtrak Station was Penn Station in New York City (16.2 million passengers) followed by Union Station in Washington, DC (5.2 million passengers) and Philadelphia 30th Street Station (4.5 million passengers) [AMTRAK 2018].

Amtrak owns a small fraction of its route-miles in the Northeast Corridor plus three other shorter segments in the following corridors: New Haven, CT—Springfield, MA; Harrisburg, PA—Philadelphia, PA; and Porter, IN—Kalamazoo, MI [AMTRAK 2019]. Nearly all passenger train services outside the Northeast Corridor are provided over tracks owned by and shared with the Class I freight railroads. Thus, the condition of the tracks used for Amtrak service is largely dependent on the maintenance activities of freight railroads.

Ports and Waterways

About 8,200 water transportation facilities exist in the United States. Dams and navigation locks are two of the principal infrastructure features of the U.S. inland waterway transportation system,[16] with nearly two-thirds of locks situated along this system. They enable shallow draft operations on many major rivers.[17]

[16] Mississippi, Ohio, Upper Atchafalaya, Ouachita, Illinois, Black Warrior, Tombigbee, and Alabama-Coosa River Basins.

[17] The principal exceptions are the Lower Mississippi River and the Missouri River, which are free flowing but still require some type of hydrologic structures (e.g., large rock, concrete groins, and revetments) to manage the flow of the river and preserve navigation.

TABLE 1-5 Passenger Rail Transportation System: 2010, 2017, 2018, and 2019

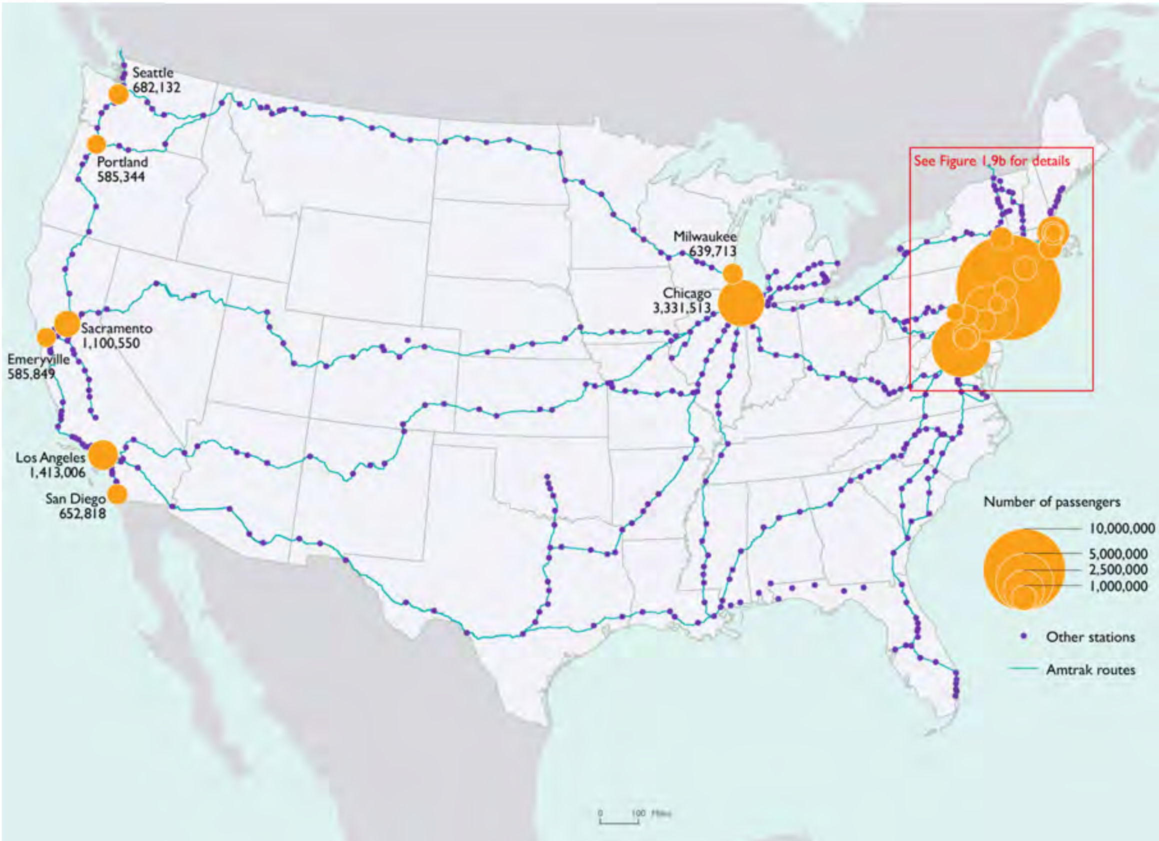
	2010	2017	2018	2019
Equipment and mileage operated by Amtrak				
Locomotives	282	419	431	NA
Passenger cars	1,274	1,405	1,403	NA
System mileage	21,178	21,407	21,407	NA
Stations	512	527	526	526
Passengers (millions)	29.1	32.0	31.8	32.6
Passenger-miles traveled (millions)	6,420	6,563	6,361	6,420

KEY: NA = not available.

NOTE: Fiscal year ending in September.

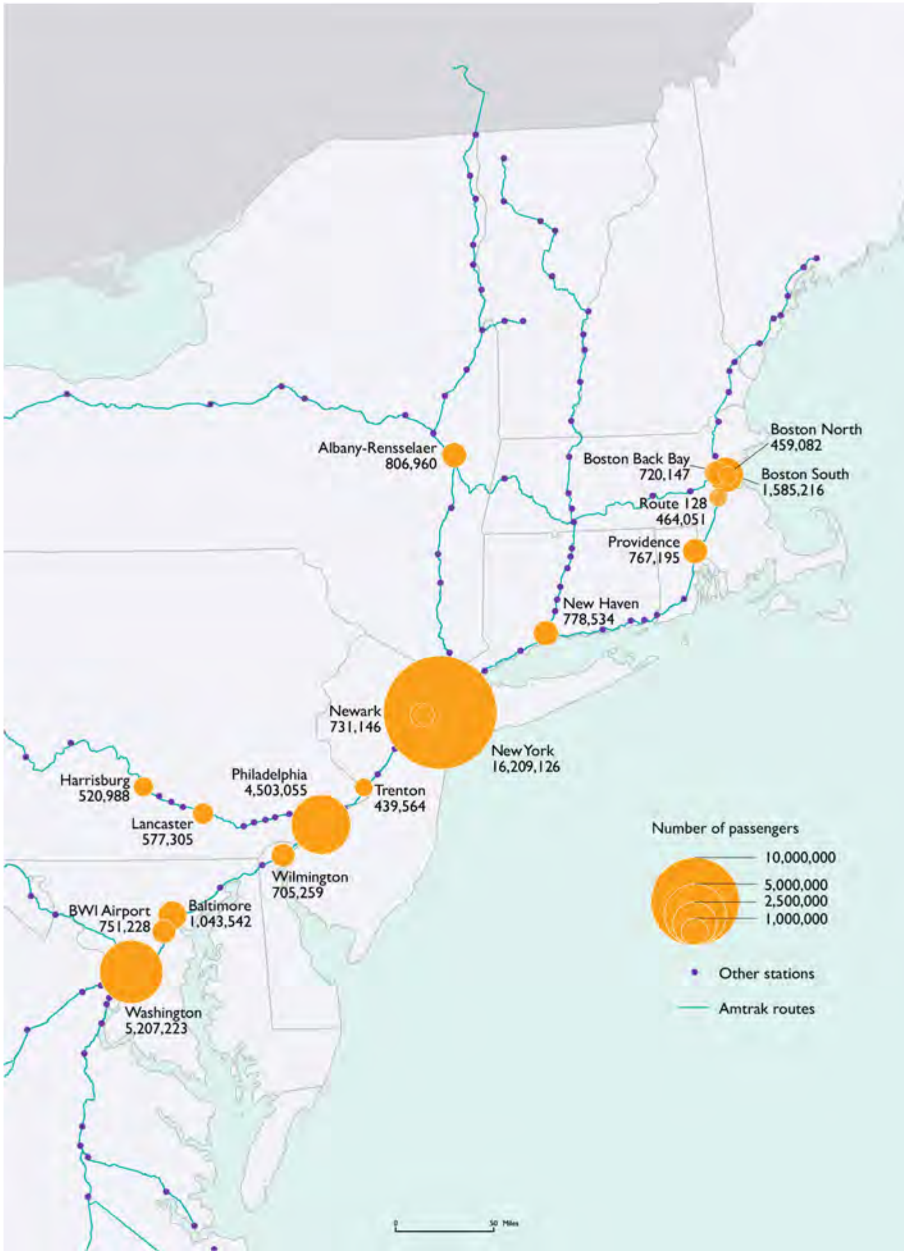
SOURCE: Association of American Railroads, Railroad Facts (annual issues) as cited in U.S. Department of Transportation. Bureau of Transportation Statistics. National Transportation Statistics. Tables 1-1,1-7, 1-11, 1-40, available at http://www.bts.gov/ as of November 2019.

FIGURE 1-9a Top 25 Busiest Amtrak Stations: 2019



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, based on the National Rail Passenger Corp. (Amtrak) State Fact Sheets, available at www.amtrak.com as of May 2020.

FIGURE 1-9b Amtrak Stations Along the Northeast Corridor: 2019



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, based on the National Rail Passenger Corp. (Amtrak) State Fact Sheets, available at www.amtrak.com as of May 2020.

TABLE 1-6 Water Transportation System: 2010, 2017, and 2018

	2010	2017	2018
Infrastructure			
Waterway facilities (including cargo handling docks)	8,060	8,239	8,238
Ports (handling over 250,000 tons)	178	186	181
Miles of navigable waterways	25,000	25,000	25,000
Lock chambers	239	239	239
Lock sites	193	193	193
U.S. flag vessels			
TOTAL, commercial vessels	39,883	42,152	42,138
Barge/non-self-propelled vessels	30,265	32,808	32,828
Self-propelled vessels	9,618	9,344	9,310
Recreational boats, millions	12.4	12.0	11.9
TOTAL, vessel calls	59,000	U	U
TOTAL, waterborne commerce (million tons)	2,334	2,387	2,438
Domestic	894	873	849
Foreign	1,441	1,514	1,589

KEY: U = unavailable.

NOTES: Vessel calls includes only oceangoing self-propelled, cargo-carrying vessels of 1,000 GT and above. Total, Commerical Vessels includes unclassified vessels. Ports includes coastal, Great Lakes, and inland ports, including those on the inland rivers and waterways primarily serving barges. For reporting purposes, the U.S. Army Corps of Engineers tabulates traffic at the docks within the boundary of the port and uses 250,000 short tons as the reporting threshold.

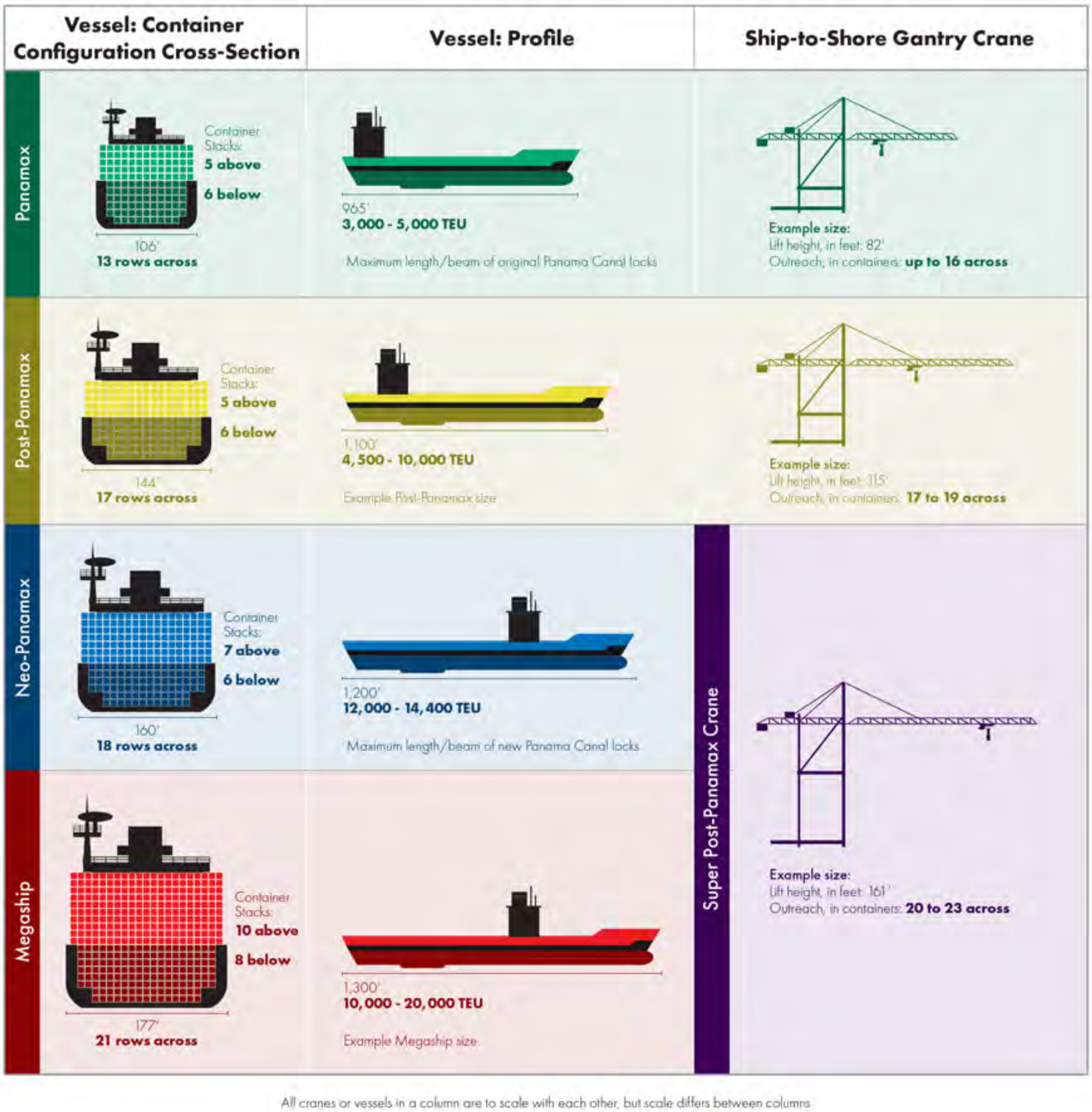
SOURCES: Fleet—U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, Navigation Data Center, Waterborne Transportation Lines of the United States (Annual issues), available at http://www.navigationdatacenter.us/ as of August 2018. Recreational boats—U.S. Department of Homeland Security, U.S. Coast Guard, Recreational Boating Statistics as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, Table 1-11, available at http://www.bts.gov/ as of December 2019. Waterways locks, facilities, and vessels—U.S. Army Corps of Engineers, Institute for Water Resources, available at https://www.iwr.usace.army.mil/ as of August 2018. The U.S. waterway system—Transportation Facts and Information (Annual issues), as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, tables 1-1 and 1-11, available at http://www.bts.gov/ as of December 2019. Vessel calls—U.S. Department of Transportation, Maritime Administration, Vessel Calls in U.S. Ports, Selected Terminals and Lightering Areas, available at https://www.marad.dot.gov/resources/data-statistics/ as of October 2018. Waterborne commerce—U.S. Army Corps of Engineers, Waterborne Commerce Cargo Data, available at https://www.iwr.usace.army.mil/ as of Febuary 2020, as cited in U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, tables 1-56.

U.S. coastal ports are dealing with the increasing size of the container vessels calling due to their greater economies of scale and the elimination of physical constraints (e.g., the new Panama Canal locks). The average size of containerships calling at the ports of Long Beach, Los Angeles, and New York and New Jersey has grown from 6,468, 6,433, and 5,280 twenty-foot equivalent units (TEU)[18] in 2015 to 7,238, 7,359, and 6,523 TEUs, respectively, in 2018. Fewer, but larger container vessels are calling at U.S. ports, placing greater demand on port infrastructure [USDOT MARAD 2019].

Many of the coastal seaports are served by large megaships as well as smaller Neo-Panamax (also known as New Panamax) ships—sized for the expanded Panama Canal locks that opened in 2016. Serving these large vessels efficiently calls for the port to have the requisite complement of large container cranes (figure 1-10). The capacity and throughput of coastal and inland ports are described in chapter 4 and the BTS annual reports to Congress [USDOT BTS 2020c].

[18] An inexact measure of cargo capacity with 1 TEU equal to a container 20 ft. long by 8 ft. tall by 8.5 ft. wide.

FIGURE 1-10 Vessel Size and Corresponding Port Infrastructure

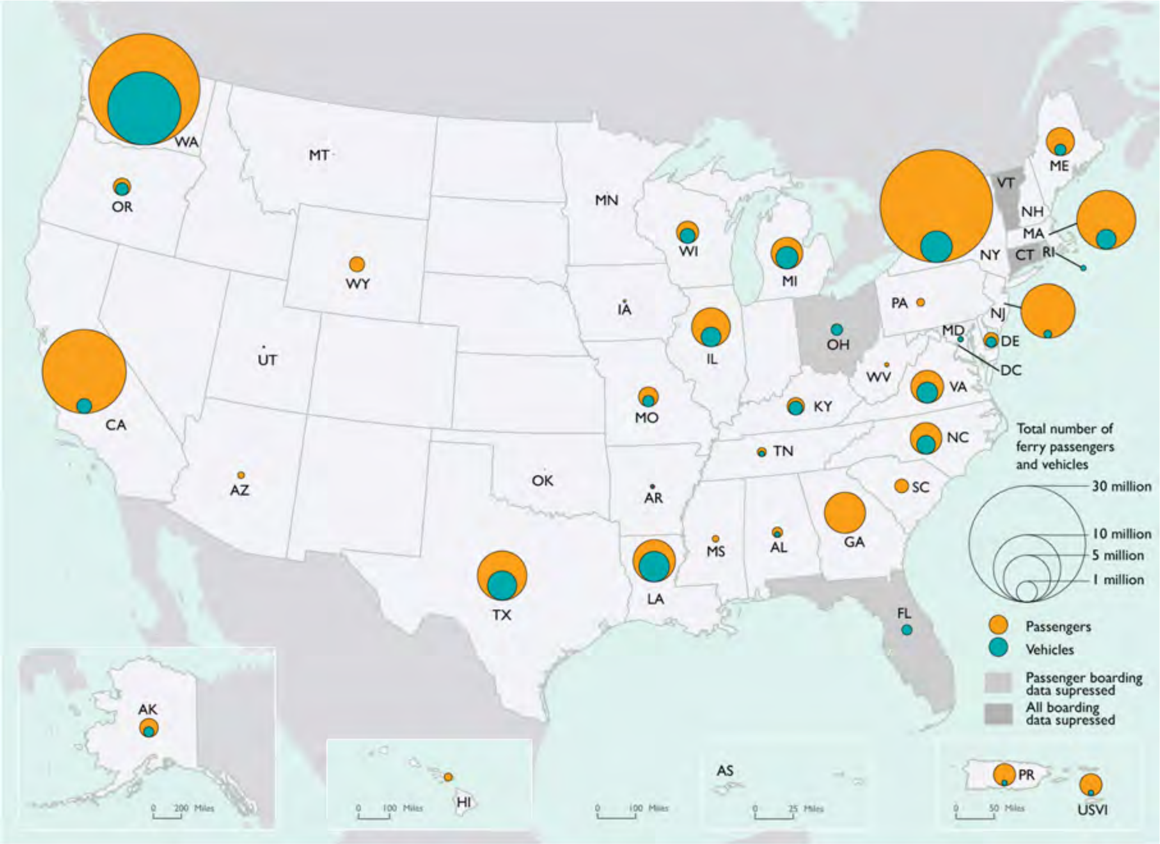


SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *Port Performance Freight Statistics Program: Annual Report to Congress 2018*, available at www.bts.gov as of January 2020.

Based on those ferry operations that responded to the 2018 National Census of Ferry Operators (NCFO), a reported total of 126.2 million passengers and 27.0 million vehicles were transported by ferry in 2017. Figure 1-11 shows that New York and Washington, the top two states for total passenger boardings, together reported transporting a combined total of 55.8 million passengers (28.3 and 27.5 million passengers, respectively). Ferry operators in Washington state alone transported about 43 percent of all reported vehicles by ferry (11.5 million vehicles) in 2017.

The highest number of reported ferry routes, otherwise known as route segments, were concentrated in the northeast, the west coast, and in Alaska. The top five states with the largest number of reported terminals operated half of the total reported route segments. Those top five states are: New York (14 percent of segments), Alaska (12 percent of segments), California (11 percent of segments), Washington (9.0 percent of segments), and Michigan (6 percent of segments) [USDOT BTS NCFO 2018].

FIGURE 1-11 Ferry Passenger and Vehicle Boardings: 2017



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Census of Ferry Operators, available at www.bts.gov as of October 2019.

Pipelines

Natural Gas Pipelines Connect 62 Million Households and 5 Million Commercial and Industrial Users

The U.S. natural gas terminal and pipeline system extends across the lower 48 states, with higher concentrations in Louisiana, Oklahoma, Texas, and the Appalachia region (figure 1-12). In 2018 natural gas was transported via about 320,000 miles of gathering[19] and transmission[20] pipelines and over 1.3 million miles of distribution lines[21] [USDOT BTS NTS 2019d]. These pipelines connect to 62 million households and 5 million commercial and industrial users [AGA 2018].

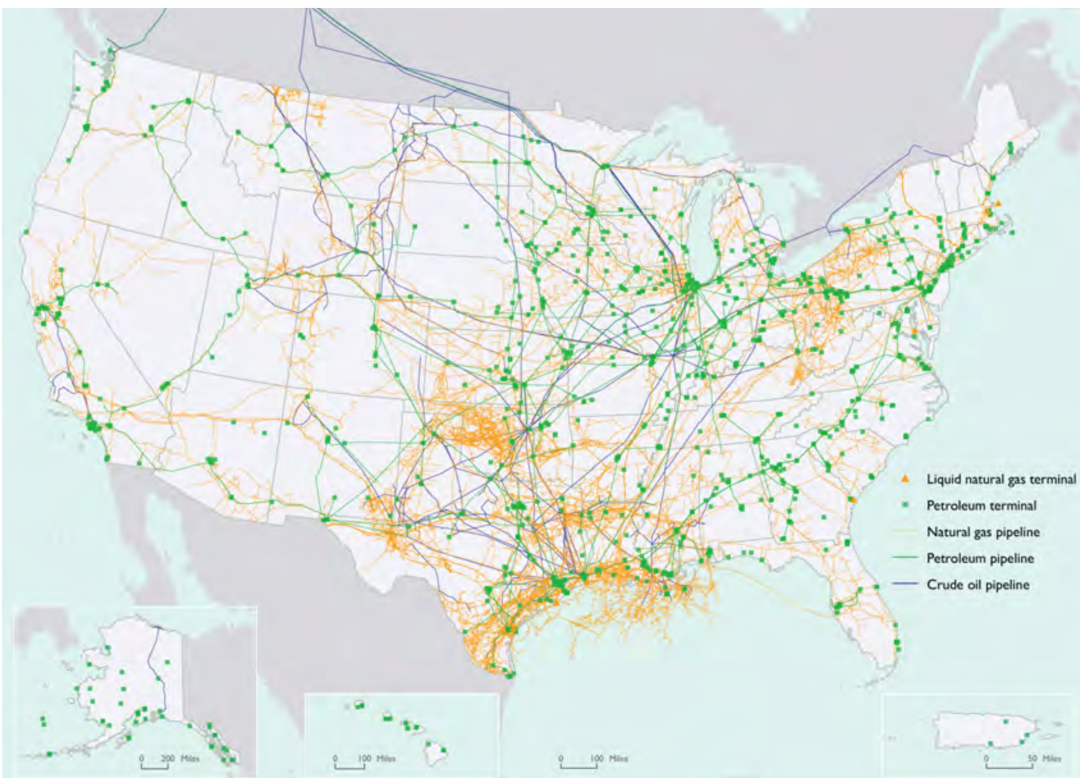
Petroleum terminals and crude oil and petroleum pipelines form a system that transports crude and refined petroleum to markets across the country (figure 1-12). The Trans-Alaska Pipeline System is a major instate crude-oil pipeline that extends from Prudhoe Bay to Valdez. There were almost 219,000 miles of crude/refined oil and hazardous liquid pipelines in 2018, up 20 percent since 2010 due almost entirely to construction of new crude

[19] Gathering pipelines are used to transport crude oil or natural gas from the production site (wellhead) to a central collection point.

[20] Transmission pipelines are used to transport crude oil and natural gas from their respective gathering systems to refining, processing, or storage facilities.

[21] A distribution line is a line used to supply natural gas to the consumer.

FIGURE 1-12 U.S. Petroleum and Natural Gas Pipelines: 2019



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, based on the U.S. Department of Energy, Energy Information Administration, U.S. Energy Mapping System, available at www.bts.gov as of November 2019.

petroleum pipelines.[22] This system carried 3.4 billion barrels across the United States in 2018, an increase of 50 percent over 2010 [USDOT BTS NTS 2019d].

U.S. natural gas production reached 30.6 trillion cubic feet in 2018. Pipelines deliver about 35 percent of natural gas production to power plants to produce electricity, 28 percent to the industrial sector, 12 percent to the commercial sector, and 17 percent to homes for heating and cooking [USDOE EIA 2019a].

In 2018 U.S. consumption accounted for 92 percent of the natural gas produced domestically. An export market is developing for liquefied natural gas (LNG) that is exported via LNG marine terminals [USDOE EIA 2018]. The export market accounted for the remaining 8 percent.

[22] For example, the Keystone pipeline from Alberta, Canada to Illinois (1,800 miles) and the Dakota Access pipeline from North Dakota to Illinois (1,172 miles) [USDOE EIA 2019b].

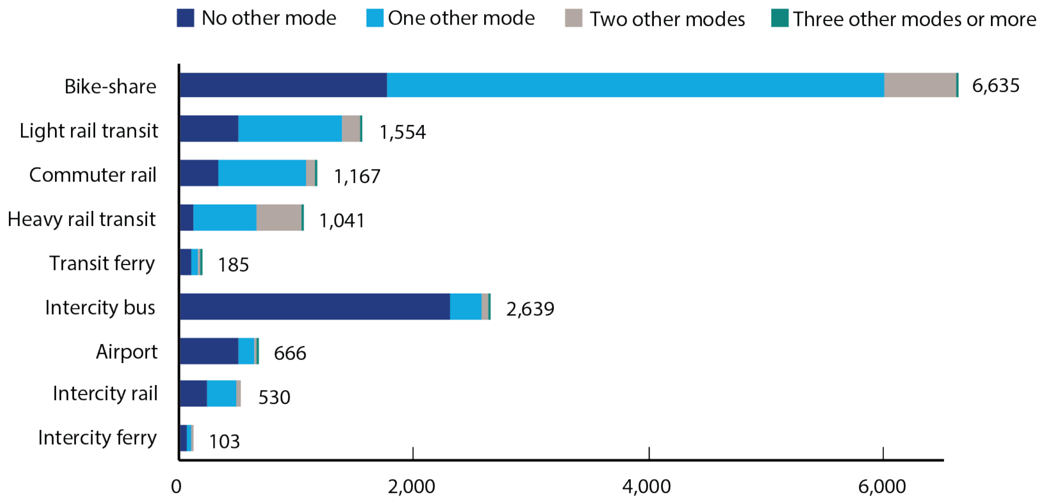
Intermodal Facilities

Of the approximately 14,700 intercity and transit rail, air, intercity bus, ferry, and bikeshare stations in the United States in 2019, about 58 percent offer travelers the ability to connect to other public passenger transportation modes [USDOT BTS 2019b]. Of this 58 percent, 49 percent connect to one other mode, 9 percent connect to two other modes, and 0.2 percent connect to three or more other modes (e.g., bus, air, rail, ferry, or bikeshare).

The Bureau of Transportation Statistics' Intermodal Passenger Connectivity Database (IPCD) includes the location of the terminal as well as the availability of intercity rail, commuter rail, heavy rail transit, light rail transit, scheduled intercity bus, intercity ferries, and transit or local ferries.

After bikeshare, as of 2019 the transit modes with the highest percent of intermodal connections were heavy rail transit (approximately 87 percent of 1,041 facilities), commuter rail (70 percent of 1,167 facilities), and light rail transit (68 percent of 1,554 facilities) (figure 1-13). Of the intercity

FIGURE 1-13 Intermodal Passenger Facilities by Mode: 2019



NOTES: Intercity bus connection includes intercity, code share, and supplemental bus service. Transit rail connection includes light rail, heavy rail, and commuter rail. Ferries includes both transit ferry and intercity ferry.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Intermodal Passenger Connectivity Database, available at www.bts.gov as of November 2019.

modes,[23] intercity rail terminals had the highest level of connectivity (approximately 55 percent of the 106 facilities) to other modes, followed by intercity bus stops (13 percent of the 2,639 stops), and airports (24 percent of the 666 airports).

Automated and Connected Transportation Systems

Research and testing to develop automated and connected transportation systems are proceeding at a fast pace. Automated systems improve many functions presently performed by human operators, taking advantage of sensors and computers to avoid collisions and improve traffic flow and aid the long-term goal of increasing safety.

The Society of Automotive Engineers classifies an automated vehicle's complexity using six levels of automation that range from zero to full automation (figure 1-14). While specific to highway vehicles, similar concepts apply to other travel modes.

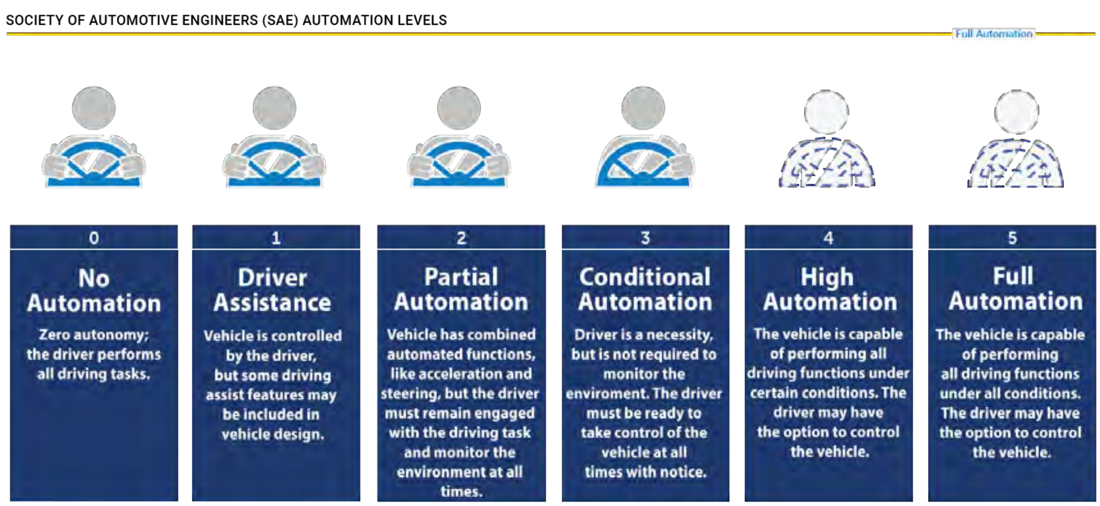
[23] These include intercity rail, bus, and ferries.

There currently is no timeline in the United States for requiring some level of automation, but these technologies are rapidly being adopted.

Automated vehicles (AVs), also known as self-driving, driverless, or robotic vehicles, are those in which varying levels of vehicle control are automated (AV levels 1–5). Level 0 means the vehicle has no automation; thus, the driver is performing all functions. As noted earlier in this chapter, most new vehicles in the United States have some level 1 (and even level 2) features as standard or optional equipment. At AV level 5, the highest level of automation, hands-off driving of the AV on all types of roads in a full range of traffic and weather conditions would be possible.

California is host to the most autonomous vehicle test sites and is the only state known to collect data on the test programs. The California Department of Motor Vehicles requires test operators to report annually on the numbers of vehicles, miles driven, and autonomous system disengagements—the moment the system hands back control to a safety

FIGURE 1-14 Levels of Automation



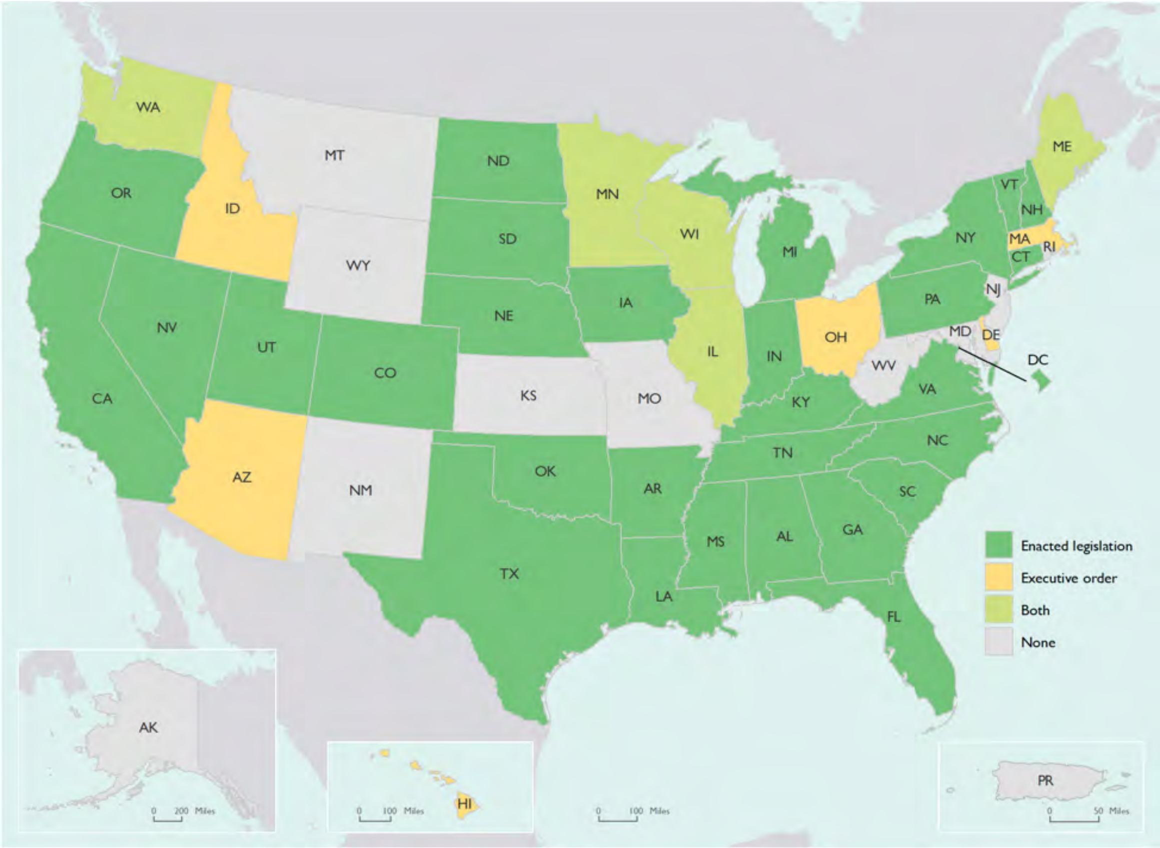
SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, Automated Vehicles for Safety, available at https://www.nhtsa.gov as of August 2018.

driver[24] or when the safety driver intervenes. Analysis of the Disengagement Report for 2018 shows that the 28 companies doing autonomous vehicle testing in California operated 467 vehicles for a total of 2,036,296 miles in autonomous mode and encountered 143,720 disengagements, resulting in a mean distance of about 14 miles between disengagements [LAST 2019].

[24] Safety driver sits behind the wheel of an AV during testing and is ready to take over manual control in case of an exception to normal operation or when an emergency arises.

As automated vehicle on-road testing in traffic mixed with non-equipped vehicles has become more widespread, many states have considered enacting regulations to address the potential effects of these vehicles on their roads. As of 2019 the District of Columbia and 29 states have enacted autonomous vehicle legislation, the governors of 7 states have issued executive orders, and 5 states have done both, for a total of 42 jurisdictions that have acted (figure 1-15). The 42 in 2019 is up from 38 state-level governments that had acted by 2018 and 27 by 2017.

FIGURE 1-15 Automated Vehicle Legislation by State: 2019



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, based upon the National Conference of State Legislators, Autonomous Vehicle Legislative Database, available at http://www.ncsl.org/ as of August 2020.

Automation Beyond Highways

Autonomous vehicle development is not limited to highways. The Federal Transit Administration (FTA) has a Transit Automation Research Program [USDOT FTA 2019a]; the maritime industry is investigating port automation and autonomous vessels; and railroads are building on long-standing experience with Automatic Train Control (ATC) to implement Positive Train Control (PTC) systems [USDOT FRA 2018]. Pipeline operators are also building on long-standing experience with instrumented capsules (sometimes called smart pigs) and supervisory control and data acquisition (SCADA) systems to develop new technologies to detect leaks and inspect land repair lines [USDOT PHMSA 2019].

Perhaps the quickest advance in adoption of automated transportation systems has been the increasing use of unmanned aircraft systems, or drones. A few decades ago, drones were confined to science fiction and other future fantasies. Today drones are rapidly becoming a part of our everyday lives. They are quickly increasing in numbers and complexity. The way we use drones ranges from recreation to commercial and military applications.

The FAA requires drone operators to register their aircraft and, in some cases, obtain a remote pilot certification. In 2019 there were 1.6 million total drones, and FAA forecasts the total small UAS[25] fleet to be 2.3 million by 2024. Currently, over 171,000 remote pilots have been certified. While three quarters of the registered drones are for recreational use, the remaining 440 thousand are dispatched for commercial tasks. Other typical applications are for agriculture, forestry, mining, construction, and land management [USDOT FAA 2019c].

Data Gaps

Needs for the Future

The principal data gaps related to system extent and usage are:

- Deployment of traffic control devices and systems and connected vehicle infrastructure at a national level.
- Data on use and users of ride-hailing and vehicle sharing systems.
- Connected and autonomous vehicle data at the national level.
- Usage of intermodal facilities.
- Parking capacity.
- Dedicated infrastructure for bicycles and other forms of active transportation.

The announced revival of the Vehicle Inventory and Use Survey (VIUS) will provide much needed data on the physical and operational characteristics of the Nation's commercial truck population, which has been a longstanding data gap.

[25] Unmanned Aircraft System (UAS) refers to an unmanned aircraft and its associated communications and control systems that are required for operation in the national airspace system. A small UAS is one that weighs less than 55 pounds.

References

American Gas Association (AGA). 2018. *Annual End Users*. Available at https://www.aga.org/ as of November 2019.

American Automobile Association (AAA). 2018. AAA Foundation for Traffic Safety. *Vehicle Owners Experiences with and Reactions to Advanced Driver Assistance Systems*. Available at https://aaafoundation.org/ as of November 2019.

Association of American Railroads (AAR):
—2019a. *Railroad Facts* (Annual issues). Available at https://www.aar.org/ as of November 2019.

—2019b. Freight Railroads & Positive Train Control. Available at https://www.aar.org/campaigns/ptc/ as of February 2020.

Congressional Research Service (CRS). 2018. *Positive Train Control (PTC): Overview and Policy Issues, R42637*, Washington, DC. Available at https://crsreports.congress.gov/ as of November 2019.

The Last Driver License Holder (LAST). 2019. UPDATE: Disengagement Reports 2018 – Final Results. Available at https://thelastdriverlicenseholder.com/ as of November 2019.

National Association of City Transportation Officials (NACTO). 2019. *Shared Micro mobility in the U.S.; 2018*. Available at https://nacto.org/ as of November 2019.

National Railroad Passenger Corporation (AMTRAK). 2019. *Amtrak FY 2018 Company Profile*. Available at https://www.amtrak.com/ as of November 2019.

National Transportation Research Nonprofit (TRIP). 2019. Rural Connections: Challenges and Opportunities in America's Heartland. May 22. Available as of October 2019.

U.S. Department of Commerce (USDOC). Census Bureau (CENSUS). 2019. *Quick Facts* (QF). Available at http://www.census.gov/ as of November 2019.

U.S. Department of Energy (USDOE). Energy Information Administration (EIA):

—2019a. *Natural Gas Summary* (July). Available at https://www.eia.gov/ as of November 2019.

—2019b. *Crude Oil and Petroleum Products Movements by Pipeline*. Available at http://www.eia.gov/ as of November 2019.

—2018. *Today in Energy*. U.S. Liquefied Natural Gas Export Capacity to More than Double by the End of 2019. December. Available at https://www.eia.gov/ as of November 2019.

U.S. Department of Transportation (USDOT). Bureau of Transportation Statistics (BTS):

—2020a. Vehicle Inventory and Use Survey (VIUS). Available at https://www.bts.gov/vius as of February 2020.

—2020b. *February 2020 U.S. Airline Traffic Data*. Available at https://www.bts.gov/ as of January 2020.

—2020c. *Port Performance Freight Statistics in 2018: Annual Report to Congress 2019*. Available at https://rosap.ntl.bts.gov/view/dot/43525 as of January 2020.

—2019a. *Bikeshare and E-Scooters in the U.S.* Available at https://data.transportation.gov/ as of November 2019.

—2019b *Intermodal Passenger Connectivity Database* (IPCD). Available at https://data-usdot.opendata.arcgis.com/ as of November 2019.

—2019c. National Transportation Atlas Database (NTAD). Available at https://www.bts.gov/geospatial/ as of November 2019.

—2019d. National Transportation Statistics (NTS). Available at https://www.bts.gov/ as of November 2019.

—2019e. Office of Airline Information (OAI). *Airlines and Airports*. Available at https://www.bts.gov/topics/airlines-and-airports-0 as of November 2019.

—2019g. *The Rural Roadway Challenge (ROUTES)*. Special tabulation. October 2019.

—2018. *Transportation Economic Trends 2018*. Available at https://www.bts.gov/ as of November 2019

—2018. *National Census of Ferry Operators* (NCFO). Available at http://www.bts.gov/ as of August 2018.

U.S. Department of Transportation (USDOT). Federal Aviation Administration (FAA):

—2020. Coronavirus (COVID-19) Information from the FAA, https://www.faa.gov/coronavirus/ as of May 2020.

—2019a. Air Traffic, https://www.faa.gov/air_traffic/ as of November 2019.

—2019b. Airport Improvement Program. https://www.faa.gov/airports/aip/ as of November 2019.

—2019c. Unmanned Aircraft Systems (UAS). *UAS by the Numbers*. Available at https://www.faa.gov/uas/resources/by_the_numbers/ as of June 2020.

U.S. Department of Transportation (USDOT). Federal Highway Administration (FHWA):

—2019a. Office of Highway Policy Information (OHPI). *Highway Statistics 2018*. Available at http://www.fhwa.dot.gov/ as of February 2020.

—2019b. Office of Highway Policy Information (OHPI). *Traffic Volume Trends 2019*. Available at https://www.fhwa.dot.gov/ as of January 2020.

—2019c. *National Household Travel Survey* (NHTS). Available at https://www.fhwa.dot.gov/ as of November 2019.

—2017. *Eisenhower Interstate Highway System-Interstate Density Map; The Changing Face of America*. Available at https://www.fhwa.dot.gov/ as of November 2019.

U.S. Department of Transportation (USDOT). Federal Highway Administration (FHWA) and Federal Transit Administration (FTA). *Planning for Transport in Rural Areas*. Available at www.fhwa.dot.gov as of October 2019.

U.S. Department of Transportation (USDOT). Federal Railroad Administration (FRA). 2018. Positive Train Control. Available at https://railroads.dot.gov/ as of February 2020.

U.S. Department of Transportation (USDOT). Federal Transit Administration (FTA):

—2018. *National Transit Database: 2017 Data Tables*. Available at https://www.transit.dot.gov/ntd as of November 2019.

—2019a. Transit Automation Research. Available at https://www.transit.dot.gov/ as of November 2018.

—2019b. Mobility on Demand (MOD) Sandbox Program. Available at https://www.transit.dot.gov/ as of November 2019.

—2019c. *Transit Bus Automation Market Assessment*, FTA Report No. 0144. Available at https://www.transit.dot.gov/ as of November 2019.

U.S. Department of Transportation (USDOT). Maritime Administration (MARAD). 2019. *Capacities of Containerships Calling on U.S. Ports, 2015-2018*. Special Tabulation.

U.S. Department of Transportation (USDOT). Office of the Secretary of Transportation (OST).

—2020. *Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0*, available at https://www.transportation.gov/av/4 as of February 2020.

U.S. Department of Transportation (USDOT). Pipeline and Hazardous Materials Safety Administration (PHMSA). 2019. Technology Research and Development: Success Stories. Available at https://www.phmsa.dot.gov/ as of February 2020.

U.S. Government Accountability Office (USGAO). 2013. *Positive Train Control: Additional Authorities Could Benefit Implementation, GAO-13-720*. Washington, DC. Available at https://www.gao.gov/ as of November 2019.

CHAPTER 2

Condition and Performance

Introduction

The transportation system must be resilient to withstand typical disruptions, such as extreme weather delays at the Nation's ports and airports, as well as new disruptions, such as cybersecurity threats. Condition of the system is affected by wear from use and damage from age and environmental forces. Performance is affected by the physical and operational capacity of infrastructure and services to handle demand, extreme weather, or human-caused disruptions.

New, innovative technologies and data sources help monitor transportation asset conditions and measure performance. Robots perform inspections of roads, bridges, railroad tracks, and pipelines to determine asset conditions. Live data feeds using sensors and crowdsourced information measure the latest statistics on highway congestion, dwell times of ships in ports, and airline on-time performance that facilitate informed operational decisions. Such transportation innovations contribute to improved performance.

The COVID-19 pandemic underscores how an unexpected anomaly can result in uncharted consequences for transportation. The congested "rush hour" in major cities largely disappeared as stay-at-home policies were implemented to counter the pandemic. As traffic volumes decreased, there were fewer delays and less congestion on many highways, and average speeds increased. Formerly congested airports sat largely empty as travelers stayed home, resulting in a drop in scheduled airline service. The full effects on annual measures and long-term trends remain to be seen and will be revealed by future statistics.

Highlights

Roads and Bridges:

- Between 2011 and 2018, the percentage of rural road mileage rated as rough remained relatively stable. Nearly 80 percent of rural interstates have a good ride quality compared to about two-thirds of urban interstates. This is generally attributed to more activity and wear on urban interstates than on rural interstates.
- Urban roads have a larger share of VMT on roads with poor pavement condition.
- Between 2010 and 2019, the number of the Nation's bridges in poor condition declined by 13,142, from about 10 to about 8 percent of all bridges.

continued on next page

Highlights (*continued*)

Aviation:

- In 2019 almost 80 million passengers on average flew every month, up 31 percent from 61 million in 2010.
- From 2010 to 2019, the percent of all flights arriving late by 2 hours or more rose from 1.6 to 2.6 percent.

Disruptions to the Transportation System:

- In 2019 disruptions exceeding $1 billion in total costs included 3 floods, 8 severe storms, 2 tropical cyclones, and 1 wildfire. For example, Hurricane Dorian closed 15 ports from Puerto Rico to Virginia and caused 4,150 flight cancellations.
- Midwest flooding closed 12 locks on the upper Mississippi River and inundated miles of highways and railroads.

Congestion Conditions in Most U.S. Cities:

- From 2017 to 2018, 8 (15 percent) of the metropolitan statistical areas (MSAs) reported improvement and 20 (38 percent) reported deterioration.

Roads, Highways, Bridges, and Vehicles

Condition of Roads and Highways

The Federal Highway Administration (FHWA) reports national statistics on pavement conditions using International Roughness Index (IRI) measurements, which measure the smoothness of pavement for three major categories:

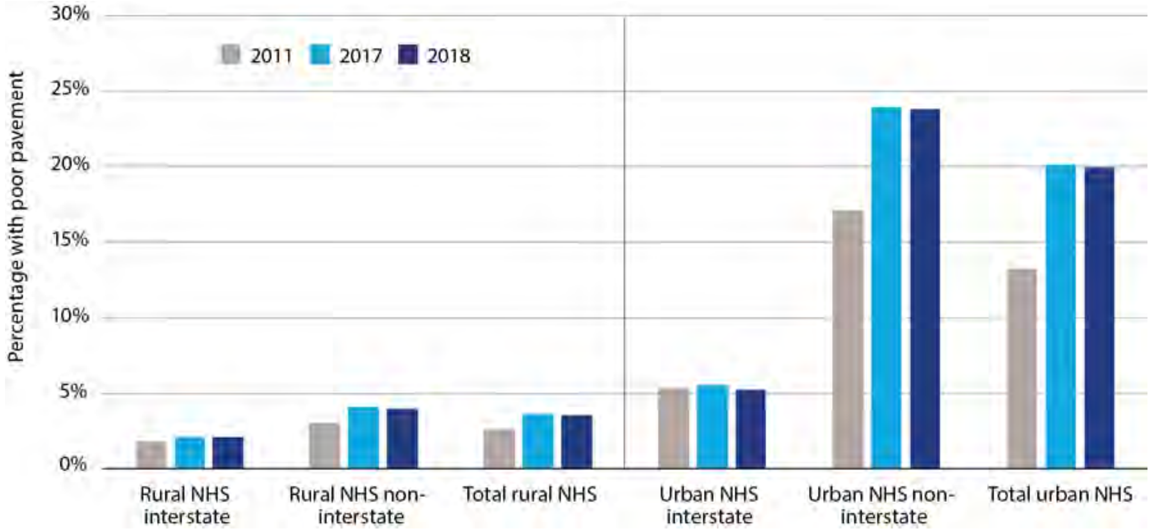
1. road-miles on the National Highway System (NHS), a network of strategic highways and roads in the United States that includes the interstate highway system;
2. road-miles by functional classification, such as interstates, other freeway and expressways, other principal arterials, and minor arterials; and
3. national system performance measures of daily vehicle-miles traveled (VMT) by NHS road pavement condition.

The percent of pavement in poor condition on the rural NHS has remained relatively stable (under 4.0 percent) since 2011,[1] with rural NHS interstate highways having the best pavement condition of all NHS roads (figure 2-1). The percentage of urban NHS interstate highways with poor pavement improved slightly from 5.4 percent in 2011 to 5.3 percent in 2018. From 2011 to 2018, the portion of the NHS with the poorest pavement has consistently been the urban non-interstate portion of the system, with a percentage 5 to 10 times greater than other portions of the NHS.

Looking at the pavement condition for all high function roads, including non-NHS federal and state roads that have high traffic volumes and densities, yields a broader and slightly different view of overall road condition than just examining the NHS (figure 2-2). The mileage of rural higher function roads with poor pavement conditions increased between 2011, 2017, and 2018. The percent of poor pavement miles in 2011 for rural interstates and other freeways/principal arterials was about 5, increasing to about 6 percent in 2018. The mileage of urban higher function roads

[1] No data were reported for 2010 due to a change in the data model, so data reported for 2011 were used in this section.

FIGURE 2-1 Percent Miles of the NHS System with Poor Pavement: 2011, 2017, and 2018

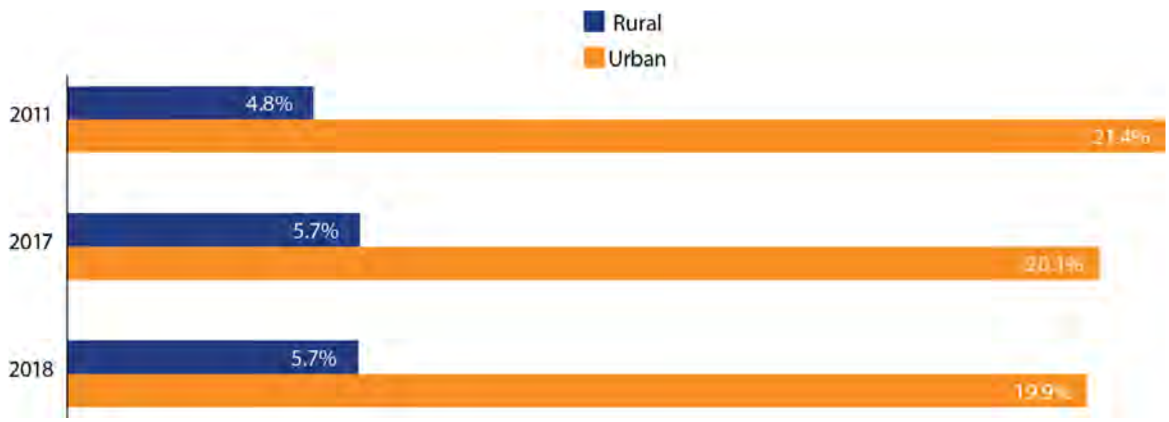


KEY: IRI = International Roughness Index; NHS = National Highway System.

NOTES: In the above figure, the total rural and urban NHS categories are a summary of the statistics of both the NHS interstate highways and non-interstate highways in each category, including Puerto Rico. No data were reported for 2010 due to a change in the data model, so data reported for 2011 were used. Poor condition is defined as any pavement with an IRI value greater than 170 inches/mile.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics*, table HM-47, available at http://www.fhwa.dot.gov/policyinformation/statistics.cfm as of February 2020.

FIGURE 2-2 Rural vs. Urban High-Function Roads with Poor Pavement Condition: 2011, 2017, and 2018

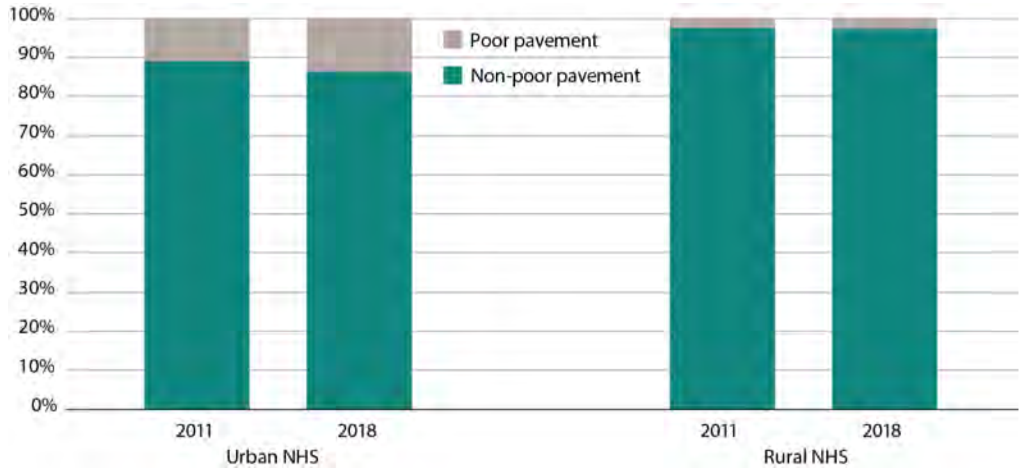


NOTES: In the above figure, the higher functionally classified roads in the urban category include interstates, other freeways and expressways, and other principal arterials for the entire road network. For the rural classified roads, the functional classification includes interstates and other principal arterials, including those for Puerto Rico. No data were reported for 2010 due to a change in the data model, so the data reported for 2011 were used for this period. Poor condition is defined as any pavement with an IRI value greater than 170 inches/mile.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics*, table HM-64, available at http://www.fhwa.dot.gov/policyinformation/statistics.cfm as of January 2020.

FIGURE 2-3 Daily Vehicle-Miles Traveled on NHS Roads with Poor Pavement Condition, Urban vs. Rural: 2018

Daily VMT = 4.8 billion



KEY: NHS = national highway system; VMT = vehicle-miles traveled.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *National Highway System Length – 2018, Daily Travel by Measured Pavement Roughness – Urban and Rural*, table HM-47A, available at https://www.fhwa.dot.gov/policyinformation/statistics/2018/hm47a.cfm as of January 2020.

with poor pavement conditions improved for all roadway classes, decreasing from about 21 percent in 2011 to about 20 percent in 2018.

Daily VMT was approximately 4.8 billion, of which 10.6 percent was over roads with pavement in poor condition (figure 2-3). Poor pavement conditions can lead from bumpy rides, vehicle wear, and flat tires to traffic congestion and crashes. Urban roads have a larger share of VMT on roads with poor pavement. The percentage of daily VMT on rural NHS roads with poor pavement increased from about 2 percent in 2011 to about 3 percent in 2018; for urban NHS travel on poor pavement, the percentage increased from about 11 to about 14 percent over the same period [USDOT FHWA 2019e].

The pavement condition across all road types (interstate, arterial, and collector roads) in rural areas tends to be better than in urban areas. Nearly 80 percent of rural interstates have a good ride quality compared to about two-thirds of urban interstates. This is generally attributed to more activity and wear on urban interstates than rural interstates. Between 2011 and 2018, the percentage of rural road mileage rated as rough by the Federal Highway Administration remained relatively stable for all but minor arterials [USDOT FHWA 2019c].

Condition of Bridges

The number of the Nation's bridges in poor condition[2] declined by 13,142 between 2010 and 2019, decreasing from 59,305 bridges (about 10 percent of all bridges) to 46,163 bridges (7.5 percent) [USDOT FHWA 2019b]. Poor bridge conditions affect freight transportation and passenger travel, especially if detours around a closed bridge[3] or weight restrictions[4] are in place. Under extreme circumstances, poor

[2] A "poor" bridge condition rating is determined by the lowest rating of the National Bridge Inventory (NBI) condition ratings for bridge deck, superstructure, substructure, or culverts.

[3] Closed bridges are not open to public traffic.

[4] A weight-restricted bridge cannot safely support the weight of any vehicles that exceed the posted weight limit even if they are otherwise legal on the adjacent roadways.

bridge conditions can lead to headline grabbing catastrophic failures and collapses. The percent of bridges in poor condition has been two-and-a-half to almost three times greater for non-NHS bridges than for NHS bridges.[5,6]

As shown in figure 2-4, the greatest percentage of bridges in poor condition in rural and urban areas is on local roads. Bridges in poor condition on rural roads in 2019 account for about 8.4 percent of the total number of rural bridges and 3.6 percent of the throughput (average daily traffic[7]) on rural highways. In comparison, bridges in poor condition on urban roads comprise approximately 5.3 percent of urban bridges and 3.8 percent of urban road throughput (average daily traffic) [USDOT FHWA 2019h]. The most used bridges are in better shape than their less-used counterparts, just as interstate and NHS bridges are in better shape than their smaller, non-NHS counterparts.

Bridges are an important component of rural transportation infrastructure. Of the 46,163 bridges considered to be in poor condition nationwide,[8] about 80 percent of them are in rural areas [USDOT FHWA 2019g]. Bridges in poor condition are concentrated in rural areas in the Midwest and Northeast (figure 2-5), while the Midwest accounted for 34 percent of the Nation's bridges and the Northeast 11 percent. Moreover, 4 out of 5 closed

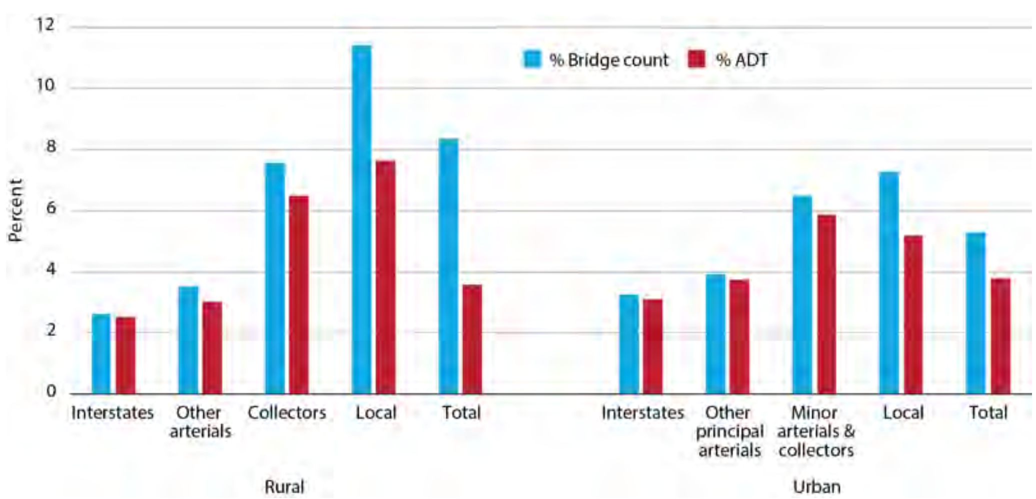
[5] NHS bridges are those national highway system bridges located on the network of strategic highways and roads in the United States that comprise the NHS and includes the interstate highway system.

[6] 2012 is the first year available reflecting the Federal Highway Administration's new condition-based performance measures, such as "the percent of NHS bridges by deck area classified as in poor condition."

[7] Average daily traffic is the average 24-hour volume, calculated as the total volume during a stated period divided by the number of days in that period. Normally, this would be periodic daily traffic volumes over several days, not adjusted for days of the week or seasons of the year.

[8] Bridges in poor condition may have deficiencies, such as deck deterioration, section loss (loss of a cross-sectional area of a bridge member caused by corrosion or decay), spalling (depression in concrete), and scour (erosion of the stream bed or bank material around the bridge due to water flow).

FIGURE 2-4 Bridges in Poor Condition and Average Daily Traffic on Bridges: 2019

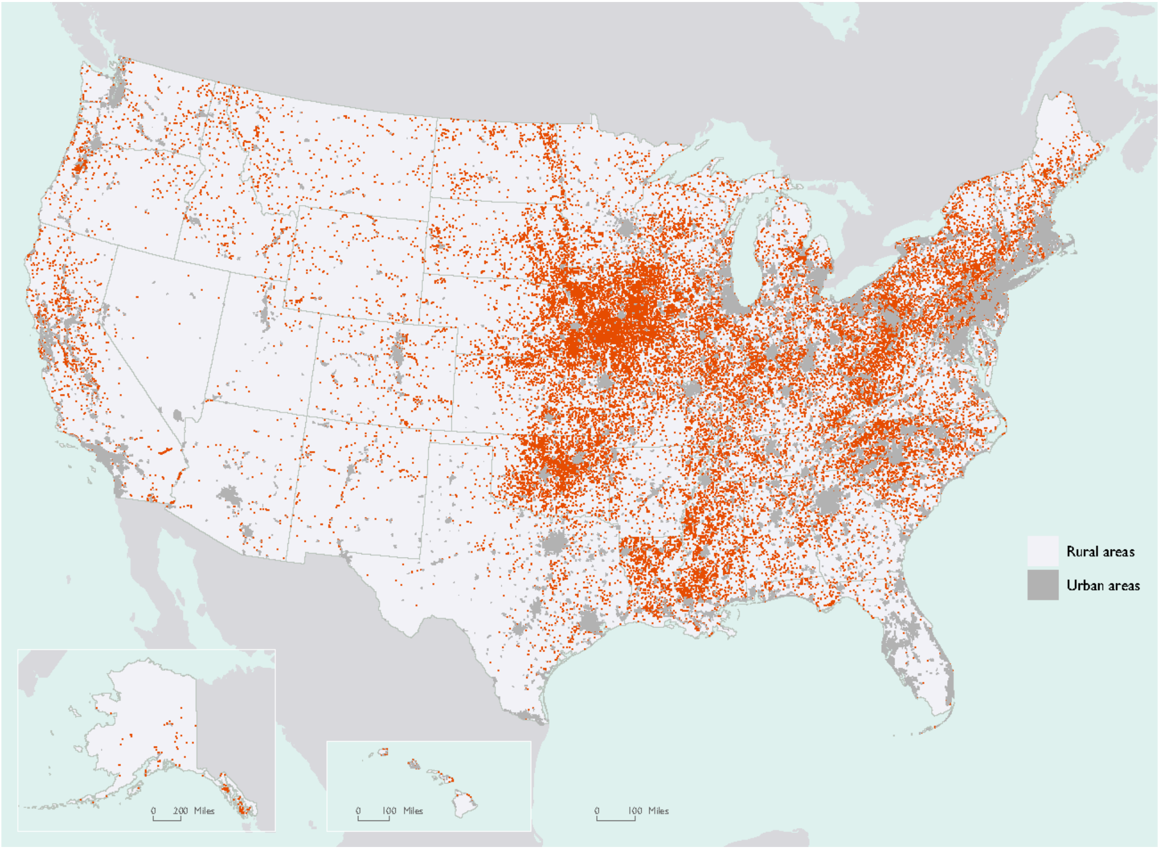


KEY: ADT = average daily traffic.

NOTES: A "poor" bridge condition rating is determined by the lowest rating of the National Bridge Inventory (NBI) condition ratings for bridge deck, superstructure, substructure, or culverts. Roads are usually classified by the volumes carried and travel speeds for which they are designed. Thus, interstate highways are considered the highest functional classification, whereas local streets are considered the lowest.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Bridge Condition by Functional Classification, available at https://www.fhwa.dot.gov/bridge/fc.cfm as of January 2020.

FIGURE 2-5 Bridges in Poor Condition in Rural Areas: 2018



NOTE: Bridges in poor condition include any bridge that has any of the four condition attributes of bridge deck, superstructure, substructure, and culverts, rated poor or worse, as defined by the Federal Highway Administration.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, National Bridge Inventory, available at www.transportation.gov as of November 2019.

bridges and 9 out of 10 bridges with posted load restrictions are in rural areas [USDOT FHWA 2019a]. In addition, detours around a closed bridge in rural areas averaged more than three times the distance of bridge detours in urban areas (17.75 vs. 5.55 miles) [USDOT FHWA 2019i; USDOT FHWA 2019a]. Load restrictions on bridges can increase costs (e.g., delivery delays, costly detours, and the need for lighter trucks or loads). Bridges with higher throughput (average daily traffic) and functional classes receive focused bridge preservation and rehabilitation efforts to ensure adequate load capacity and capability to continue to meet the traffic demands, which is usually greatest on bridges in urban areas [USDOT FHWA 2018].

In 2019, 64,213 out of the 613,148 bridges open to traffic had some type of load restriction[9] or a temporary bridge[10] in place, comprising about 10 percent of all bridges [USDOT FHWA 2019i]. The percentage of the Nation's bridges open to traffic with restricted postings alone was about 11 percent in 2010 and 10 percent in 2019, showing some improvement in bridge condition. Of the 62,109 bridges having some form of posted restriction[11] in 2019, about 31 percent (19,154 bridges) were in poor condition. Load restrictions can cause commercial vehicle operators to carry smaller payloads or take circuitous routes, either of which can increase delivery costs.

[9] State and local law enforcement agencies enforce weight restrictions on trucks and heavy vehicles traveling public roads. Under normal conditions, vehicles over 40 tons are not permitted on interstate highways. Additional restrictions apply based on the legal load combination, which is a function of vehicle weight and axle spacing. Federal Highway Administration, "Bridge Load Rating and Posting" available at https://www.fhwa.dot.gov/federal-aidessentials/companionresources/119bridgeload.pdf as of March 2020.

[10] Temporary bridges are used as an alternative to costly detours and may be utilized to divert traffic during bridge repair, rehabilitation, construction, or replacement. These bridges are installed as a temporary structure during construction and then disassembled and stored until needed again.

[11] A bridge may be in good condition and have a posted restriction, especially if it was designed for a lower maximum weight than roadways leading to it.

With respect to who owns and is responsible for upkeep of the 46,163 bridges in poor condition, about 32 percent of these bridges (14,528) in 2019 were owned by States, around 51 percent (23,451) were owned by counties, about 6.8 percent (3,157) by towns, 7.2 percent (3,318) by cities, and 1.8 percent (819) by the Federal Government. The remaining bridges are owned by park agencies, tollways, and railroads [USDOT BTS 2019a; FHWA 2019f].

Condition of the Vehicle Fleet

Age of Vehicles Increasing

The average age of the Nation's light vehicles (which includes passenger cars and light trucks), which has steadily been increasing over time, was nearly 12 years as of 2019. In comparison, the average age of this fleet in 2009 was about 10 years and 9 years in 1999 [USDOT BTS 2019e]. The 2017 National Household Travel Survey (NHTS) found that an estimated 10 percent of the Nation's household vehicles were at least 20 years old and an estimated 49 percent were at least 10 years old [DOE ORNL 2018]. Vehicle condition can decline with use and age.

Various factors have been offered to explain the increasing age of the vehicle fleet: longer vehicle life due to improvements in vehicle manufacturing, an increase in the number of vehicles per household (e.g., older vehicles passed on to children of driving age when parents get a new car), changes in driving habits, and deferring vehicle purchases during economic recessions. As to the latter, the average age increase in the light-duty vehicle fleet was 12 percent between 2008 and 2013, a period of economic recession and recovery, compared with the non-recession periods immediately before and after, about 4 percent between 2002 and 2007; and 4 percent between 2015 and 2019 [USDOT BTS 2019e].

The average age of aircraft, locks, urban transit vehicles, and passenger locomotives and railcars are discussed below.

Highway Congestion

Worsening Conditions in Most U.S. Cities

Congestion measures are reported for the 52 largest metropolitan statistical areas (MSAs)—those with a population over 500,000—in the FHWA *Urban Congestion Report* (UCR), which is based on vehicle probe data.[12] Three measures are used to gauge congestion, which results in speeds that are slower than normal (free flow) speeds:

1. daily congested hours,
2. Travel Time Index (TTI) that compares peak period travel time to low-volume travel time, and
3. Planning Time Index (PTI) for freeways that calculates the time needed to arrive on schedule with a probability of 95 percent for any particular time of the day relative to the free-flow travel time (a measure of travel time reliability).

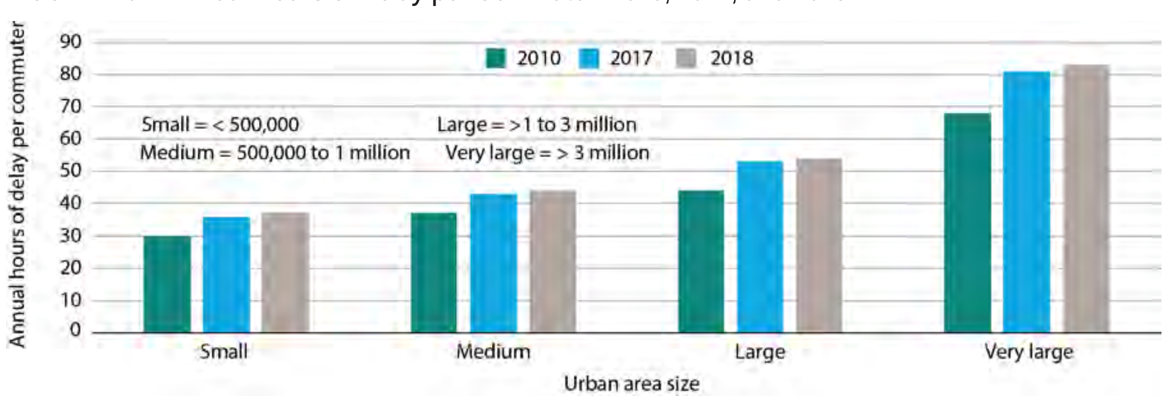
Each of these measures represents a different aspect of congestion. As reported by the FHWA, from 2017 to 2018, 8 (15 percent) of the metropolitan statistical areas reported improvement in all 3 indices; 20 (38 percent) reported deterioration in all 3 indices; and 27 (52 percent) reported worsening Travel Time Index values [USDOT FHWA 2019k].

The Texas A&M Transportation Institute's *Urban Mobility Report* (UMR) provides a comprehensive look at highway congestion [SHRANK, EISELE, LOMAX 2019]. This biennial report, which relies on INRIX[13] data, includes both NHS and non-NHS freeways and arterial roads. The *Urban Mobility Report* reports show metrics for 101 MSAs with additional data for another 393. As shown in figure 2-6, congestion has increased on the Nation's urban freeways and arterial streets for the years when data was collected, with a 15 percent increase over the 2010–2017 period. This is true for urban areas of all sizes, resulting in dramatic increases in the cost of congestion to the Nation. Congestion cost urban Americans an extra 8.8 billion hours and an extra 3.3 billion gallons of fuel to travel, for a total congestion cost of $166 billion in 2017 [SHRANK, EISELE, LOMAX 2019].

[12] Vehicle probe data consists of locational data collected from the global positioning systems on vehicles using the road network.

[13] INRIX data is collected every 15 minutes of the average day of the week for almost every mile of major road in urban America, resulting in about a billion data points on speed on about 1.5 million miles of U.S. streets and highways. More than 90 percent of the travel delay in the 2019 report is based on a measured traffic speed.

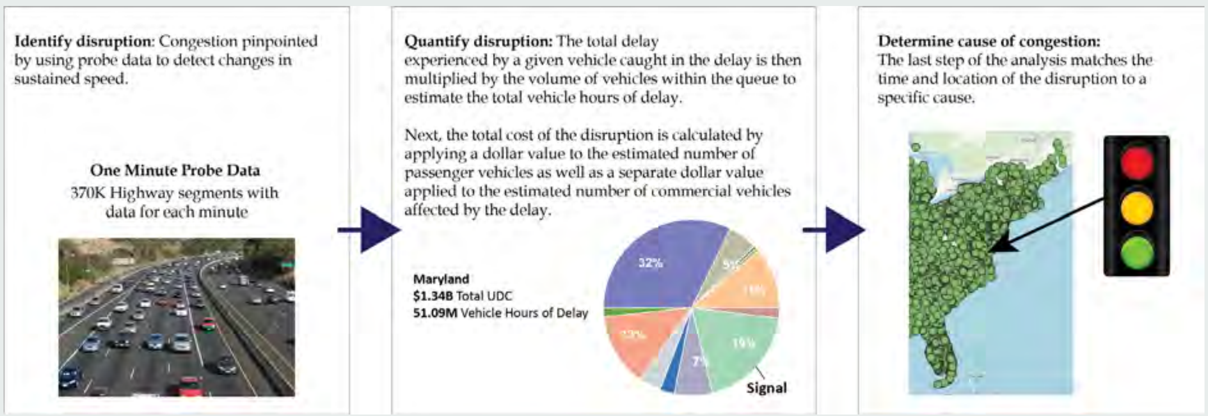
FIGURE 2-6 Annual Hours of Delay per Commuter: 2010, 2017, and 2018



SOURCE: Schrank, Eisele, and Lomax. Texas A&M Transportation Institute, *Urban Mobility Report 2019*. available at https://mobility.tamu.edu/umr/ as of January 2020.

Box 2-A Transportation Disruption and Disaster Statistics (TDADS)

Many modern transportation technologies generate data that can be used to measure timely congestion and disruption to travel. For example, vehicle probes, crowdsourcing apps such as Waze, and modern weather radar can help identify, quantify, and determine the magnitude and duration of any disruptions to highway travel. Specifically, the Transportation Disruption and Disaster Statistics (TDADS) measures the magnitude and the duration of congestion due to bottlenecks, weather, work zones, incidents, signals, and holiday travel:



SOURCE: University of Maryland, Center for Advanced Transportation Technology lab, *Transportation Disruption and Disaster Statistics* (TDADS), available at https://www.cattlab.umd.edu/ as of March 2020.

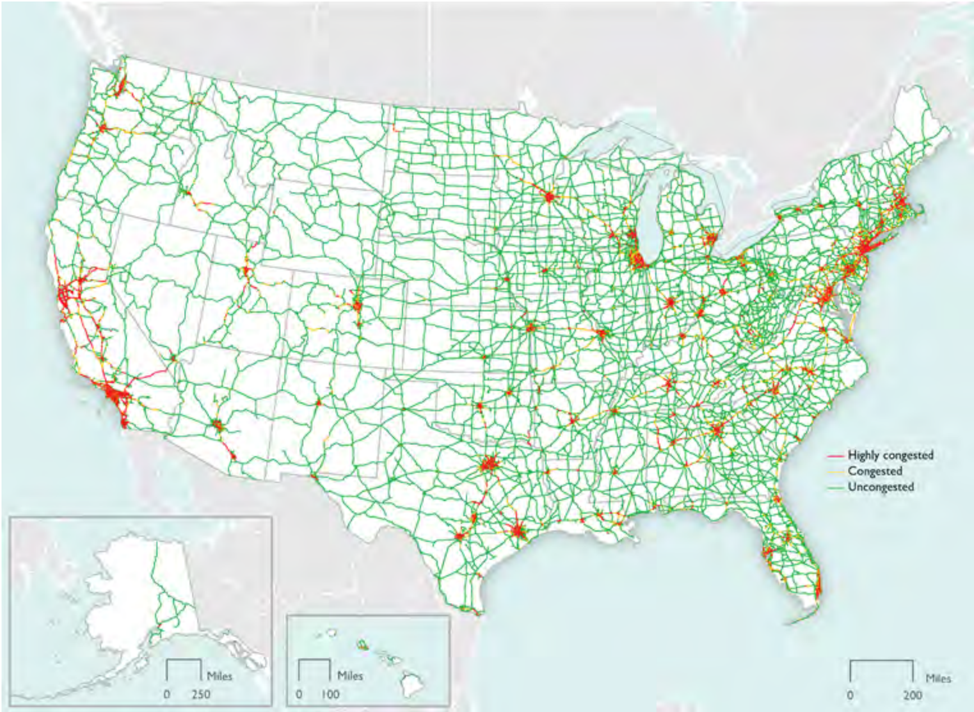
Figure 2-7 shows the peak period congestion on high-volume truck routes on the NHS in 2015 and the projected peak-period congestion in the entire NHS in 2045. Not surprisingly, the major congested points are in metropolitan areas where truck traffic mixes with other traffic and along major interstate highways connecting major metropolitan areas. The rankings by peak average speed for the top 25 freight-significant, congested locations (e.g., Fort Lee, Atlanta, and Nashville) in the Nation have stayed about the same over the past 10 years, although some locations have shown minor movements up or down the list [ATRI 2019]. Between 2018 and 2019, however, 23 of the top 25 congested locations experienced a decline in peak average speeds. Incremental efforts and system improvements have helped to mitigate congestion, but peak-period demand continues to exceed highway capacity.

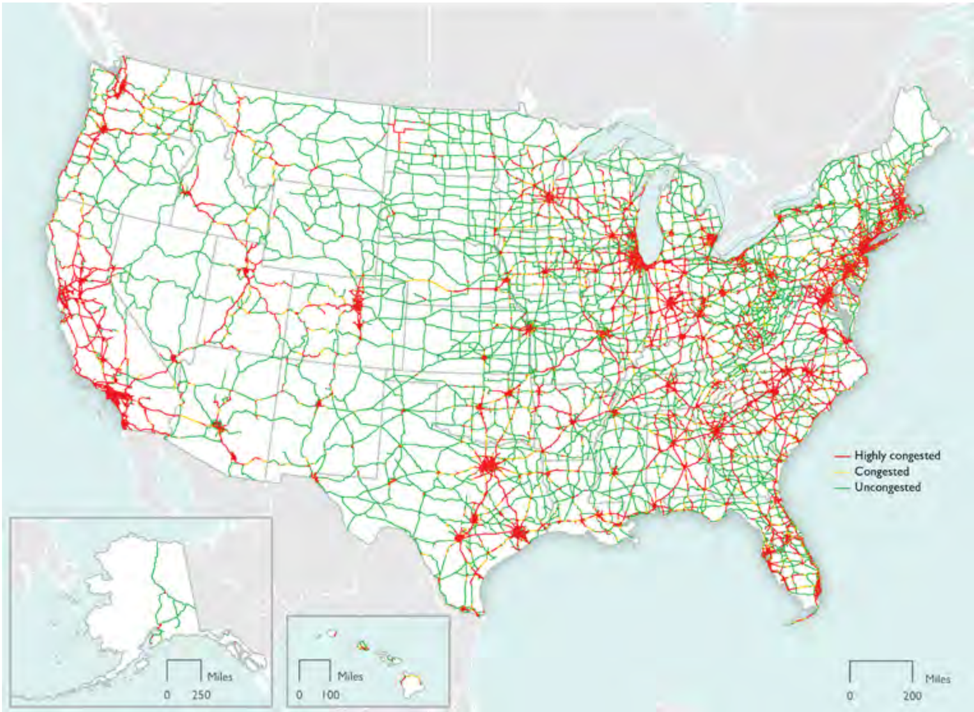
Transit Systems

For the most part, the average age of the Nation's transit fleet increased between 2000 and 2018. Two exceptions include ferryboats where investments in new vessels occurred in the late 2000s, and in buses which have shorter useful life and thus a faster fleet turnover rate (figure 2-8). The average age of heavy rail passenger cars, at about 23 years, makes them the oldest part of the Nation's transit system. This is followed by ferryboats, and commuter rail passenger coaches, each with an average age of about 22 years. The greatest increase in average age between 2000 and 2018 was for commuter rail locomotives, which increased from about 13 to 21 years [USDOT BTS 2018a].

The transit industry has made progress in improving reliability of service, primarily through preventative maintenance and investments in state-

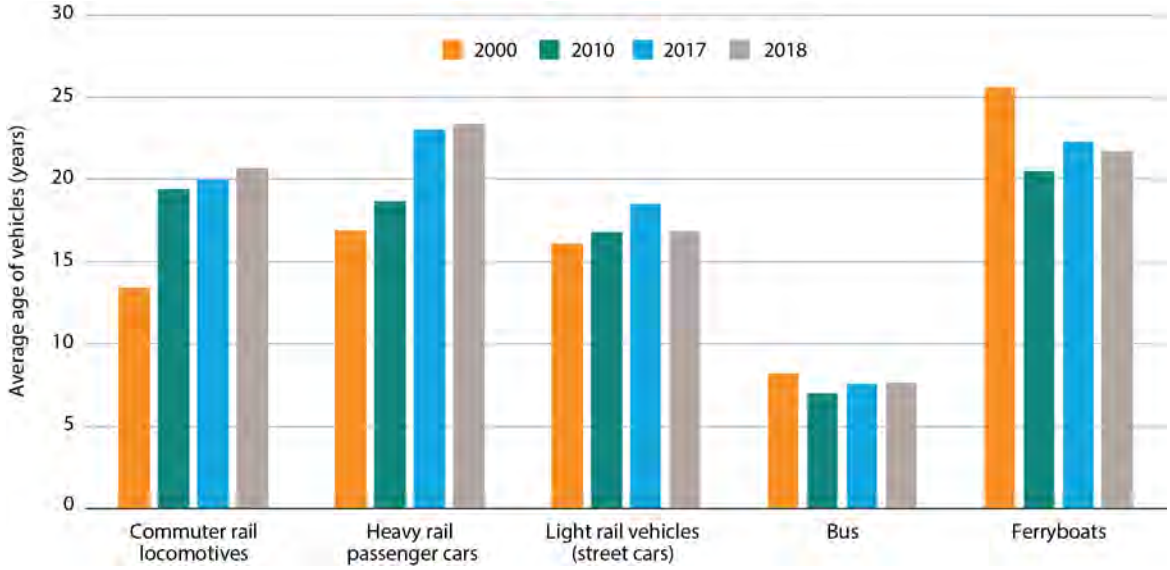
FIGURE 2-7 Peak-Period Congestion on the High-Volume Truck Routes on the National Highway System, 2015 and Projected 2045





SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.3.1, special tabulation as of March 2020.

FIGURE 2-8 Average Age of Urban Transit Vehicles: 2000, 2010, 2017, and 2018



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, table 1-29, available at https://www.bts.gov/content/average-age-urban-transit-vehicles as of March 2020.

of-good-repair. For example, the number of major mechanical failures[14] for bus vehicles decreased from 248,243 in 2010 to 193,445 in 2018—a 22 percent decrease [USDOT FTA 2018]. Vehicle age is used as a surrogate for condition with the average lifetime mileage by asset type[15] reflecting the respective condition of different transit modes, with older transit vehicles more likely to breakdown than newer ones.[16]

[14] A major mechanical failure is one that that prevents the vehicle from completing a scheduled revenue trip or from starting the next scheduled revenue trip because movement is limited or safety compromised.

[15] Average lifetime mileage per active vehicle is the total miles accumulated on all active vehicles since date of manufacture divided by the number of active vehicles. Typically, this is found by taking the average of all odometer readings at the end of the fiscal year.

[16] For information on passenger transportation fares, see Bureau of Transportation Statistics' Transportation Economic Trends, "Cost of Transportation", available at: https://datahub.transportation.gov/stories/s/TET-cost-3-test-/5h3f-jnbe#transportation-fares.

Transit availability, modal choice, and ridership are discussed in chapters 1 and 3. Also, transit vehicle fleets are discussed in more detail in chapter 1.

Airports and Commercial Aviation

Condition

The Nation's aviation system consists of numerous airport assets, including runways/taxiways, tarmacs, terminals, air traffic control systems, and support structures. The latest 5-year *National Plan of Integrated Airport Systems* (NPIAS)[17] estimates the need for approximately $35.1 billion in Airport Improvement Program (AIP)-eligible projects at the 3,321 public use airports during fiscal years 2019 to 2023 [USDOT FAA 2018]. Although there

[17] The National Plan of Integrated Airport Systems (NPIAS) contains all commercial service airports, all reliever airports, and selected public-owned general aviation airports identified by FAA Order 5090.3C. An airport must be included in the NPIAS to be eligible to receive a grant under the Airport Improvement Program.

is some overlap in how the types of investments are categorized, about 71 percent ($24.7 billion) of the AIP-eligible projects are for reconstruction or bringing assets into compliance with the latest best practices for safety, capacity, security, and environment [USDOT FAA 2018].

The average age of U.S. commercial airline aircraft declined slightly between 2000 and 2018 [USDOT BTS 2019b]. In 2018 the average aircraft age for the largest airlines (called majors[18]) was 13 years. For the next level of airlines (called nationals[19]), the average aircraft age was about 11 years, and for regional airlines about 26 years[20]—roughly twice the age of the larger planes used by major and national airlines. No public data is currently available to indicate the condition of the aircraft fleet.

[18] Major airlines are those with more than $1 billion dollars of annual revenue.

[19] National airlines include those with over $100 million to $1 billion dollars of annual revenue.

[20] Regional airlines are those with annual revenue of $100 million and under.

Performance

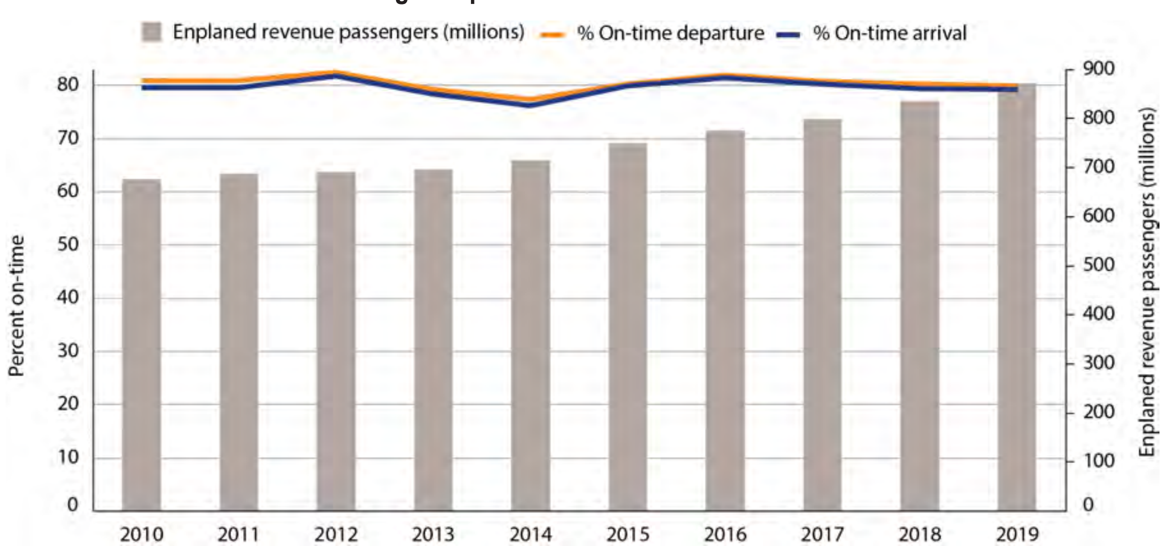
Showing Gradual Improvements

Flight delays can ripple through the U.S. aviation system as late arriving flights tend to delay subsequent flights throughout the day. The on-time departure and arrival performance of the Nation's aviation system has been relatively flat since 2010, with an uptick in delays in recent years (figure 2-9). The percent of on-time arrivals for the largest U.S. carriers declined from 80.5 percent in 2010 to 80.3 percent in 2019. The percent of on-time departures experienced a similar decline, from 80.7 percent in 2010 to 80.2 percent in 2019 [USDOT BTS 2019c].[21]

The causes for flight arrival delays have remained relatively constant since 2010. The largest cause for arrival delay continues to be the aircraft arriving late from its previous destination, which

[21] A flight is considered delayed when it arrives at the gate 15 or more minutes later than the scheduled arrival time or departs from the gate 15 or more minutes later than the scheduled departure time.

FIGURE 2-9 Percent On-Time Flight Departures and Arrivals: 2010–2019



NOTE: A flight is considered delayed when it arrived 15 or more minutes later than the scheduled arrival time or departed 15 or more minutes later than the scheduled departure time.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, On-time Percentage Arrivals and Departures, available at https://www.transtats.bts.gov/ as of February 2020.

can cause delay to reverberate throughout the plane's remaining schedule (depending on the recovery time built into the schedule). The latest full year data reported by the Bureau of Transportation Statistics for 2019 show the following (terms describing different causes for delay are defined in the note for figure 2-10):

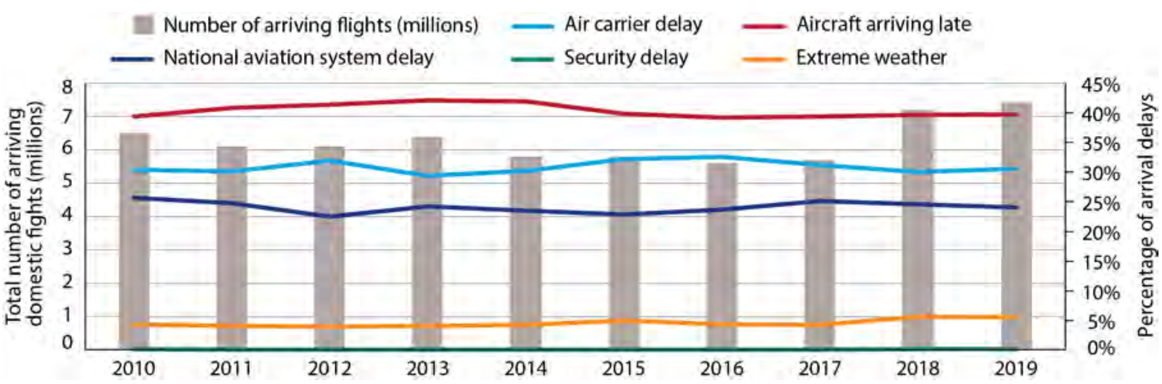
- about 40 percent of the delay in the Nation's air travel system was caused by aircraft arriving late,
- about 31 percent was due to air carrier delay,
- 24 percent was due to the National Aviation System (NAS)[22] delay (which, as noted below, also includes a non-extreme weather component),
- about 6 percent was due to extreme weather, and
- 0.1 percent was due to security delays.

As shown in figure 2-11, the average delay per delayed flight arrival grew by more than 15 minutes, from about 54 minutes in 2010 to about 70 minutes in 2019.[23] Between 2010 and 2019, there was a 68 percent increase in the number of total minutes of delay in comparison to a 26 percent increase in the number of flight operations. From 2010 to 2019, the percent of flight operations with greater than a 2-hour arrival delay increased from about 2 to 3 percent of total operations, affecting 14.2 million passengers in 2019. Similarly, there was a 167 percent increase in the number of flights experiencing a 3-hour delay or more, affecting nearly 6.9 million passengers in 2019. Aviation system performance statistics can also be derived almost immediately by BTS and others using the System Wide Information

[22] National Aviation System-related delays and cancellations refer to a broad set of conditions, such as moderate or non-extreme weather conditions, airport operations, heavy traffic volume, and air traffic control. Extreme weather is significant meteorological conditions (actual or forecasted) that, in the judgment of the carrier, delays or prevents the operation of a flight, such as tornado, blizzard, or hurricane. Moderate or non-extreme weather within the National Aviation System category reflects situations when weather slows the operations of the system but does not prevent flying with corrective action by the airports or the FAA.

[23] The "unknown" data were removed in this analysis.

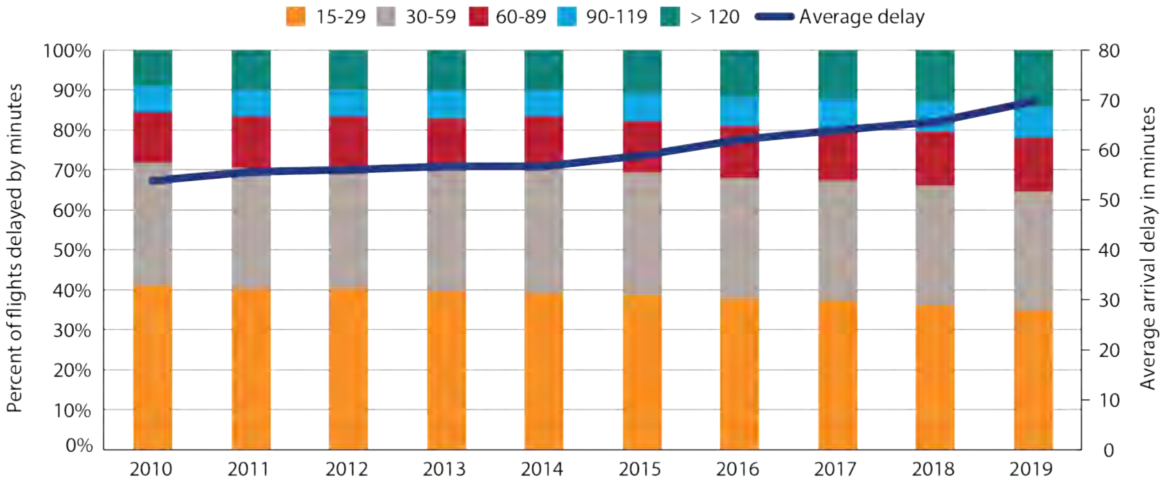
FIGURE 2-10 Percent of Flight Delay by Delay Cause: 2010–2019



NOTES: Air carrier delay— the cause of the cancellation or delay was due to circumstances within the airline's control (e.g., maintenance or crew problems, etc.). Aircraft arriving late—previous flight with same aircraft arrived late which caused the present flight to depart late. Security delay—delays caused by evacuation of terminal or concourse, re-boarding of aircraft because of security breech, inoperative screening equipment and long lines in excess of 29 minutes at screening areas. National Aviation System (NAS) delay—delays and cancellations attributable to the national aviation system refer to a broad set of conditions, including non-extreme weather conditions, airport operations, heavy traffic volume, air traffic control, etc. extreme weather delay—significant meteorological conditions (actual or forecasted) that, in the judgement of the carrier, delays or prevents the operation of a flight.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Airline On-Time Statistics and Delay Causes, available at https://www.bts.gov/ as of February 2020.

FIGURE 2-11 Percent of Flights by Length of Time Delayed and Average Flight Delay: 2010–2019



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Airline On-Time Statistics and Delay Causes, available at https://www.bts.gov/ as of August 2020.

Management (SWIM) dataset, increasing data timeliness and quality as described in box 2-B. Air safety is covered in chapter 6, air passenger travel is covered in chapter 3.[24]

Wait times at terminal security checks are a necessary, and often lengthy, part of the air traveler experience. Although the Transportation Security Administration (TSA) provides real-time data on wait times at selected airports, no archival data are reported on security average wait times nationally or trends over time. However, the number of passengers and airport crew going through airport security is reported. In 2014, about 654 million people passed through the Nation's security checks; by 2018 this number had increased to 814 million people, an increase of about 25 percent [USDHS TSA 2019]. After spread of the COVID-19 pandemic, TSA people screenings (which are used as a proxy for "throughput" or air travel demand) dropped to about 90,000 per day by the middle of April, representing a drop of 2.2 million passenger screenings or 96 percent from the same days a year ago (see figure 2-12). TSA security check points screened about 1.6 million fewer people on September 27th in 2020 than on the same day in 2019 [USDHS TSA 2020].

Railroads

Passenger Rail (Amtrak)

Condition

As discussed in chapter 1, most passenger train services outside the Northeast Corridor (NEC) are provided over tracks owned by and shared with Class I (the Nation's largest) freight railroads—about 72 percent of Amtrak's train-miles. Hence, Amtrak is largely dependent on the host railroads for the condition of its infrastructure. Amtrak is responsible, however, for 2,408 track-miles and infrastructure within the Northeast Corridor plus a few other locations used by both Amtrak and other users, including commuter rail and freight rail. In fiscal year (FY) 2019 Amtrak identified a backlog of $33.3 billion state-of-good-repair assets assessed to be at or nearing the end of their useful lives—in addition to the necessary $1.2 billion annual steady state investment required to prevent further infrastructure deterioration [AMTRAK

[24] For information on passenger transportation fares, see Bureau of Transportation Statistics' *Transportation Economic Trends*, "Cost of Transportation", available at: https://www.bts.gov/product/transportation-economic-trends.

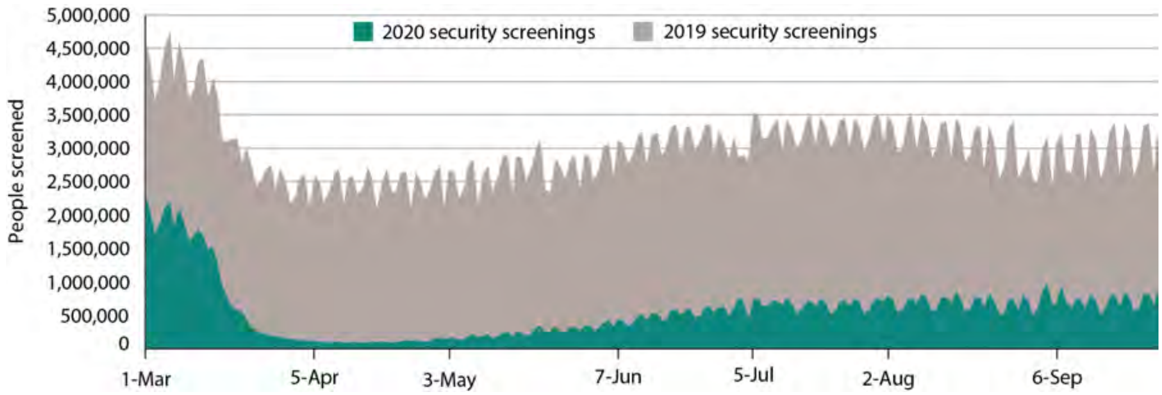
Box 2-B NextGen System Wide Information Management (SWIM)

The Bureau of Transportation Statistics is embarking on a new initiative to enhance and expand its offering of airline statistics. The NextGen System Wide Information Management (SWIM) platform, acquired from the Federal Aviation Administration, provides a singular source for live updates on the National Air System (NAS). It transmits a continuous data stream of real-time information on flight movements, weather conditions, and airport operations. The live feed is comprised of all computerized messages communicated between the airports, aircraft operators, ground operations specialists, and air traffic control centers and can be tapped to extract critical, timely information on air travel in the United States. All messages belong to one of several dozen topical categories, each representing updates from a different component of the National Air System. For instance, some messages pertain to individual flights (e.g., track updates, arrival times, departure times, flight plans, re-routes, cancellations, diversions, and ground movements), while others relate to the system at large (e.g., runway usage, terminal updates, weather conditions and forecasts, airspace restrictions, and flow management for congested airspace). Essentially all flights, passengers, cargo, and general aviation movements are represented in the SWIM platform.

These data provide an unprecedented opportunity to explore and analyze the operations, performance, and spatial extent of the U.S. air transportation system. As a result, BTS will be able to make use of near real-time aviation data to produce more timely air statistics.[1] One of the first SWIM-derived products will be a commercial flight database, which includes estimated on-time performance of all passenger airline flights operating in, from, and to the United States in near-real time. Given that the stream of messages is continuous, performance statistics can be reported almost immediately—a significant improvement in data timeliness over the current airline data system.

[1]BTS's legislative mandates are found at https://www.bts.gov/learn-about-bts-and-our-work/about-bts/legislative-mandates.

FIGURE 2-12 Daily Number of People Screened at TSA Checkpoints: Mar. 1, 2020–Sept. 27, 2020 (compared to 2019)



SOURCE: U.S. Department of Homeland Security, Transportation Security Administration (TSA), People Screened, available at https://www.tsa.gov/coronavirus/passenger-throughput as of August 2020.

2019a]. Factors identified by Amtrak that could affect its ability to deliver service include deferred investment, infrastructure condition, severe weather conditions, terrorism, and major accidents.

The average age of locomotives rose from 19 years in 2010 to 21 years in 2018 [USDOT BTS 2018b]. The average age for Amtrak passenger cars was 26 years in 2010 and reached just under 33 years in 2018 [AMTRAK 2019a]. The increasing average age of the fleet has had an impact on fleet availability and vehicle reliability. The average miles between service disruption in FY 2015 for cars and locomotives was 390,865 and 25,889, respectively. Both measures had declined by FY 2018 to 313,494 and 20,302 miles, respectively [AMTRAK 2019b]. Amtrak has developed a multiyear strategy to improve the condition of its infrastructure and reliability of its equipment. In FY 2019, for example, Amtrak invested $1.6 billion in its system, primarily in infrastructure ($717 million) and in its fleet ($437 million) [AMTRAK 2019c].

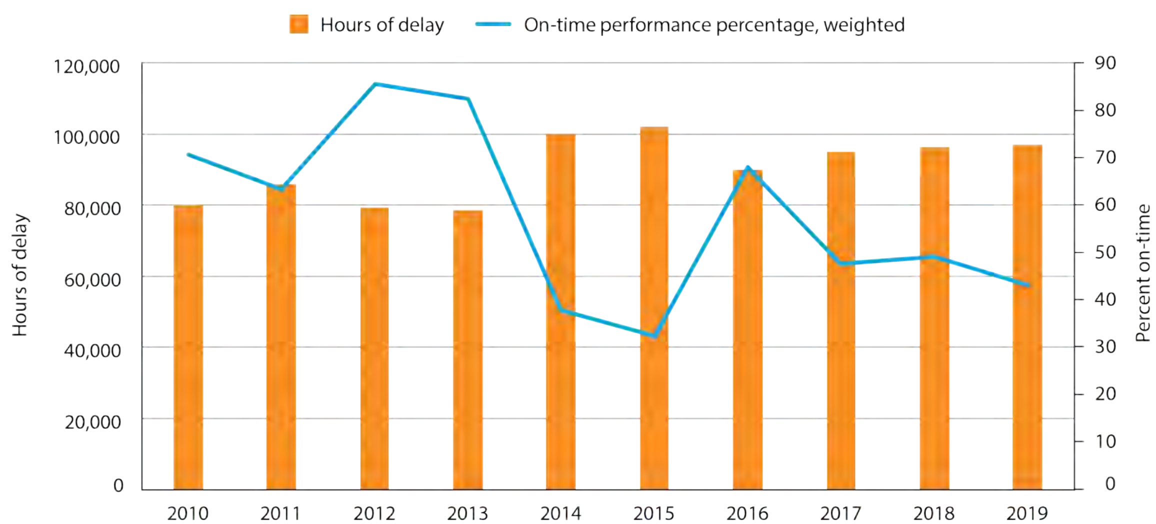
Performance

The hours of delay experienced on Amtrak services fluctuated between 2010 and 2018 (figure 2-13). The percent of on-time arrivals systemwide improved from 71.2 percent in 2015 (the worst performance shown in figure 2-13) to 73.2 percent in 2019, down from a 10-year high of 83 percent in 2012. With respect to long-distance trips, the on-time performance for trips greater than 400 miles in 2018 was 43 percent compared to 72 percent in 2013. On-time arrivals in the Northeast Corridor on tracks Amtrak owns was 70 percent in 2018, down from 86 percent in 2012 [USDOT BTS 2018c].[25]

[25] 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)	Minutes late at endpoint
0–250	10 or less
251–350	15 or less
351–450	20 or less
451–550	25 or less
> 551	30 or less

FIGURE 2-13 Hours of Delay and On-time Performance of Amtrak: 2010–2019



NOTE: On-time performance is weighted by distance category because a longer trip increases the probability of a delay when compared to a shorter trip.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Amtrak On-Time Performance, National Transportation Statistics, Table 1-73, available at https://www.bts.gov/content/amtrak-time-performance-trends-and-hours-delay-cause as of February 2020.

Amtrak also measures on-time departure performance from the initial terminal, which in FY 2019 was 93 percent systemwide, with a high of 97 percent in the Northeast Corridor departing from Washington, DC [AMTRAK 2019b]. The difference between the initial terminal on-time departure performance and the systemwide performance reflects the buildup of delays as the train runs along its route.

National databases report several sources of delay for passenger operations. These include delays caused by Amtrak itself (e.g., operational delays and breakdowns), those caused by the host freight railroad, and other non-railroad causes, such as customs inspections.[26] Delay caused by host railroads remains the major source of Amtrak delays, accounting for 57 percent of total delay in 2018. Delays caused by the host railroads increased by 14 percent (from 44,090 to 55,217 hours) between 2010 and 2018. Delays associated with other factors, such as customs and immigration inspections, also increased about 14 percent (from 12,482 to 14,194 hours). Delays attributed to Amtrak increased 25 percent over that period (from 23,404 to 26,967) [USDOT BTS 2018c].

Freight Rail

Automated Track Inspection Improves Track Condition and Safety

Freight rail carriers are not required to report freight track conditions to public agencies. Thus, universal track condition reports are unavailable. However, railroads regularly inspect their track and perform necessary repairs to ensure track safety. Federal Railroad Administration (FRA) regulations do 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. FRA publishes an annual enforcement report, summarizing the civil penalty claims for violations.

[26] These are delays due to U.S. and/or Canadian customs and immigration procedures for trains crossing the U.S.-Canadian Border.

In FY 2019, FRA inspectors or other railroad regulators reported 686 track violations, compared to 3,353 in FY 2015 [USDOT FRA 2019]. The FRA upgraded the inspection and collection technology in the Automated Track Inspection Program (ATIP) fleet in 2013, which increased its ability to detect track deficiencies. FRA has been continuously improving ATIP technology, including better data quality, enhancing data value, and facilitating better data usage. Because of these upgrades, earlier results may not be comparable to those for the most recent years. Since 2013 the incidence of all nine track inspection exceptions[27] has decreased—with the number of rail track defects per 100 miles of rail track dropping from about 15 in 2013 to 5 in 2018. The number of locations and miles inspected vary by year due to the limited number of surveying cars and are prioritized by factors, such as safety risk analysis and operation types. Therefore, these results are not a representative sample of the Nation's freight rail track condition.[28]

Waterways, Ports, and Vessels

Time Delays at Locks Increase by 3-Fold

Water is the leading transportation mode for U.S.-international freight trade by weight and value. The U.S. Army Corps of Engineers (USACE) civil works program maintains approximately 12,000 miles of inland and intracoastal waterways, approximately 300 deep-draft and 600 shallow-draft Great Lakes and coastal harbor channels, and more than 900 coastal navigation structures [USACE 2019].

[27] Exceptions mean track did not meet normal operation standards. The Automated Track Inspection program does not provide a comprehensive evaluation of the national rail network on an annual basis due to the limited number of surveying cars. Inspection locations vary by year and are prioritized by factors, such as safety risk analysis and operation types. 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.

[28] For additional information on innovations in track inspection, please see chapter 1 of the 2020 TSAR.

Waterways

Table 2-1 shows performance metrics for the 239 lock chambers at 193 lock sites for which the U.S. Army Corps of Engineers has responsibility for lock operation and condition. The average delay in minutes and the percent of vessels delayed has risen three-fold. The Illinois River, with the worst performance of all the highly traveled waterways, experienced an average delay of about 411 minutes per tow in 2019 [USACE 2019a]. For context, in 2019 there were 506,838 lockages,[29] allowing the passage of 662,314 vessels through the USACE lock system. Continuing a long-term downward trend, this was an 8.4 percent decrease in the number of lockages, leading to a domestic internal tonnage decrease in 2018. However, the decrease in domestic internal tonnage of 7 percent was proportionally lower than that of lockages, which led to barges carrying greater loads.

When a lock or dam reaches a state of poor repair, waterborne traffic must stop to allow for frequent scheduled maintenance or unscheduled repairs. Although scheduled delays impose a cost on industries that rely on waterborne commodities, an even greater cost is imposed when an unscheduled delay occurs. Unscheduled delays interrupt business operations for entire supply chains dependent on waterborne shipments. In 2019 locks experienced 12,497 periods of unavailability, of which 8,138 were scheduled shutdowns and 4,359 were not scheduled [USACE 2019d].

The U.S. Army Corp of Engineers is responsible for dredging navigation channels to foster safe and efficient use of the Nation's ports and waterways. USACE dredges removed about 215 million cubic yards of material in FY 2010 and about 223 million cubic yards in FY 2018. Ninety-two percent of this removal was done for navigational maintenance purposes [USACE 2019b].

Ports [30]

A total of 181 ports handle over 250,000 short tons annually. The top 25 U.S. ports by tonnage handled 77 percent of the short tons in 2018 [USACE 2019c]. The average 2018 dwell time of container vessels at the top 25 U.S. container ports was 27 hours, up from approximately 26 hours in 2017. As figure 2-14 shows, the month-to-month U.S. average dwell time tends to vary within a 1-hour to 2-hour range, although vessels often dwell longer in a port during winter months, particularly in December and January when ice and snow slows port operations. For example, the U.S. average

[29] A lockage is the movement through the lock by one or more vessels or extraneous matter, such as manatee, debris, ice, etc. through a single lock cycle.

[30] The BTS Port Performance Freight Statistics Program provides nationally consistent performance measures on the capacity and throughput for the Nation's largest tonnage, container, and dry bulk ports. For the latest annual report to Congress or to view our online Port Profiles, visit the website at https://www.bts.gov/ports.

TABLE 2-1 Select Waterway Transportation Characteristics and Performance Measures: 2010, 2018, and 2019

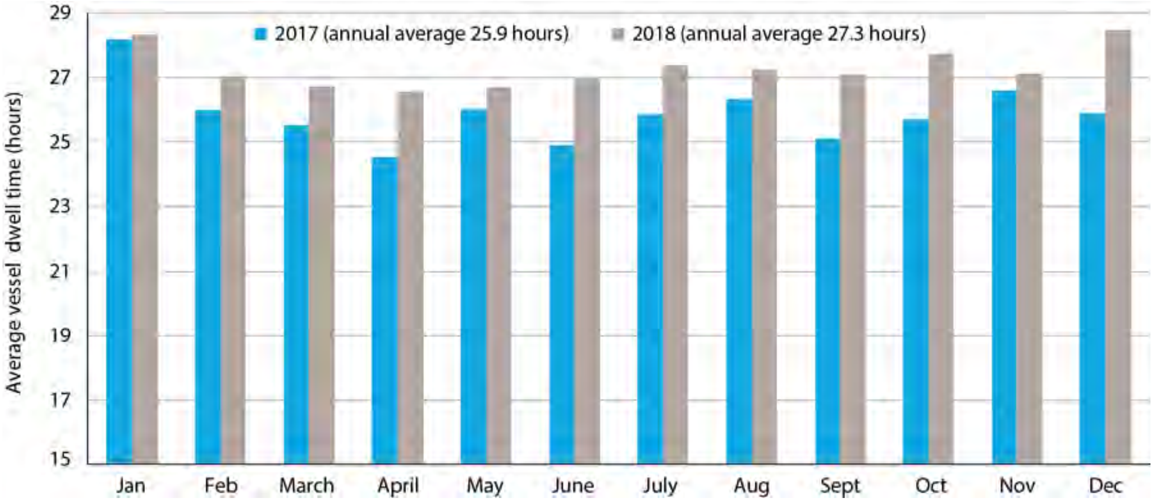
	Total lockages	Total number of vessels	Percent commercial lockages of all lockages	Average delay in minutes	Percent of vessels delayed
2010	641,846	855,121	74.5	79.8	36
2018	563,442	722,929	78.9	210.1	50
2019	506,838	662,314	78.7	246.9	52

NOTES: A lockage is the movement through the lock by a vessel or extraneous matter such as manatee, debris, ice, etc. Commercial lockages are all those that service vessels operated for purposes of profit and include freight and passenger vessels.

SOURCE: U.S. Army Corps of Engineers. Public Lock Usage Report Files. Calendar years 1993–2019. Institute for Water Resources (IWR). Updated Apr. 27, 2020, available at https://www.iwr.usace.army.mil/ as of August 2020.

FIGURE 2-14 Average U.S. Container Vessel Dwell Times at the Top 25 Ports by Month: 2017 and 2018

Average container vessel dwell times in hours



NOTES: Observed vessel calls were 16,585 for 2017 and 15,249 for 2018. Vessel calls of less than 4 hours or more than 120 hours were excluded as representing calls either too short for significant cargo handling or too long for normal operations.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, calculated using AIS data provided by U.S. Army Engineer Research and Development Center as of December 2019.

dwell time for container vessels was 29 hours in December 2018. Record precipitation affecting a large portion of the eastern two-thirds of the United States may have contributed to an increase in the annual U.S. average dwell times in 2018.[31] Average container vessel dwell times for individual ports are shown in the online Port Profiles, which is available at www.bts.gov/ports.

U.S. Flagged Vessels

The U.S. flagged fleet consisted of 4.0 percent more vessels in 2018 (42,138) than in 2010 (40,512). The U.S. Army Corps of Engineers classifies vessels primarily as self-propelled vessels or nonself-propelled vessels.[32] The number of self-propelled vessels increased from 9,078 to 9,310 vessels (about a 3 percent increase). The number of barges and other nonself-propelled vessels increased from 31,412 in 2010 to 32,828 in 2018—a 5 percent increase [USACE 2018b]. The age distribution of the self-propelled versus the nonself-propelled fleets is notable (figure 2-15), with just over 61 percent of the self-propelled fleet over 25 years of age, while just over 24 percent of the nonself-propelled fleet is that old. Self-propelled vessels require greater initial investments and periodic repair or overhaul, which allows them to remain economically viable and stay in service longer.

System Resiliency

14 Natural Disasters in 2019

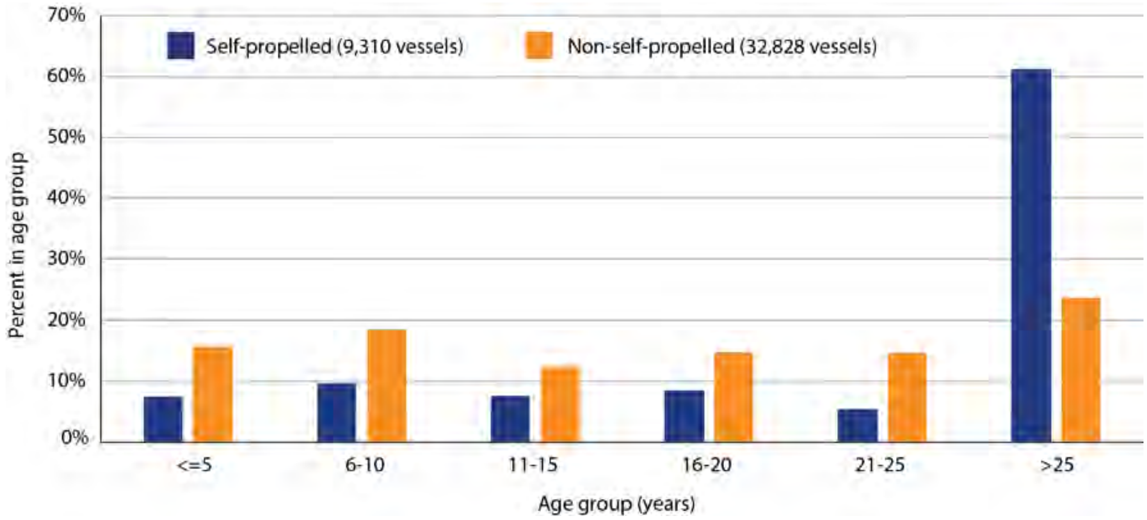
Disruptions to Transportation Infrastructure

The U.S. Department of Commerce (USDOC), National Oceanic and Atmospheric Administration (NOAA) tracks weather and climate disasters, including hurricanes, tornadoes, floods, droughts,

[31] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climate Report (multiple issues), available at https://www.ncdc.noaa.gov/ as of January 2020.

[32] Self-propelled vessels include dry cargo, tanker, and offshore supply vessels, ferries, and tugboats. Non-self-propelled vessels primarily include barges.

FIGURE 2-15 Number of U.S.-Flagged Vessels by Age Group and Propelled Type: 2018



SOURCE: U.S. Army Corps of Engineers. *U.S. Flagged Vessels by Type and Age*, table 4, vols. 1–3 consolidated, available at https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll2/id/4717 as of March 2020.

and wildfires where overall damages reached or exceeded $1 billion. In 2019 there were 14 weather and climate disaster events with losses exceeding $1 billion each across the United States. These events included 3 floods, 8 severe storms, 2 tropical cyclones, and 1 wildfire [USDOC NOAA NCEI 2019a]. Part of the physical recovery costs and overall economic impact were due to damage and disruption of the transportation system.

Examples of major transportation system disruptions in 2019 include:

- Hurricane Dorian (August/September, 2019) closed down 15 ports from Puerto Rico to Virginia. Dorian also affected air operations in the Southeast United States, with 4,150 flights canceled. Three major Florida airports—Daytona, Melbourne, and Orlando—were closed for short periods.
- The Midwest flooding of spring 2019 (beginning March 2019) washed out miles of rail track that took railroads days to repair or replace. Twelve locks on the upper Mississippi River were closed due to high water, causing major disruptions to barges and the movement of agricultural goods. Rail, truck, and barge traffic was stopped in inundated locations because of failed infrastructure or conditions that prevented movement (e.g., water levels prohibited barge movement under bridges).

Extreme weather events are becoming more frequent and costlier. This is changing how transportation systems are planned, designed, operated, and maintained, especially as system operators focus toward building resilience to extreme weather. Key to the resiliency cycle is the ability to prepare for changing conditions and then withstand, respond to, and recover rapidly from major system disruptions.

Cybersecurity

Vulnerabilities for Transportation Infrastructure

The Nation's transportation system is also vulnerable to cyber and electronic disruptions. This is particularly true in the aviation system, which is dependent on electronic and digital navigation aids, communication systems, command and control technologies, and public information systems. The National Commission to Assess the Threat to the United States from Electromagnetic Pulses (EMPs)[33]—intense pulses of energy that can be released by the blast of a nuclear weapon, by portable devices like high power microwave weapons, or by some natural phenomenon, such as geomagnetic storms—has warned that such catastrophic events could cause large-scale disruptions to the electrical grid and communications networks, which in turn would affect the transportation system. The cascading effects of such an event would seriously disrupt airline flights, satellite networks, and GPS services used for transportation [USDOC NWS UNDATED]. The National Aeronautics and Space Administration has estimated the likelihood of a solar super-storm hitting the Earth to be 12 percent per decade. The Commission concluded that the Nation's critical infrastructure faces a present and continuing threat from manmade as well as natural Electromagnetic Pulses disruptions. The commission recommends that measures be taken to protect electric grids and other critical infrastructures from Electromagnetic Pulses to make these systems more resilient against cyberattacks, sabotage, and severe weather [GRAHAM 2017]. Cybersecurity will be a critical component of future transportation safety and security standards, especially since transportation systems, devices, components, and communications must be protected from malicious attacks, unauthorized access, damage, or anything else that might interfere with safety functions.

[33] Established by Congress in the FY2001 *National Defense Authorization Act*, Title XIV, and continued per the FY2016 *National Defense Authorization Act*, Section 1089.

Data Gaps

Needs for the Future

Data gaps exist where transportation data are in the hands of private operators and are not readily available to the public. For example, freight rail carriers are not required to report freight track conditions nor are marine terminal operators required to report on their operations to the Federal Government. Even if the private operators publicly report data, the data are not nationally consistent or standardized. Operators may report data by different periods of time (e.g., calendar v. fiscal years, which may begin and end in different months from others). Also, operators may use different or unique metrics or units of measures. For example, private marine terminal operators may use different throughput measures, such as container volumes, tonnage, or twenty-foot equivalent units. Data are also missing to relate asset condition to performance.

References

American Transportation Research Institute (ATRI), *Congestion and Mobility Completed Research*, Available at https://truckingresearch.org/ as of March 2020.

Amtrak:

—2019a. *Amtrak Five Year—Infrastructure Asset Line Plan: Base (FY 2019) + Five Year Strategic Plan (FY 2020–2024)*, February 7, 2019. Available from https://www.amtrak.com/ as of January 2020.

—2019b. *Amtrak Five Year—Service Line Plans Base (FY 2019) + Five Year Strategic Plan (FY 2020–2024)*. Available from https://www.amtrak.com/ as of January 2020.

— 2019c. *Improved Safety and Customer Experience Drive Record Amtrak Ridership*, November 8, 2019. Available from https://media.amtrak.com/ as of January 2020.

Graham, William. 2017. *Chairman's Report*, *Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack*. July. Available at http://www.empcommission.org as of January 2020.

IHS Markit. 2019. *Average Age of Cars and Light Trucks in U.S. Rises Again in 2019 to 11.8 Years*. June 27, 2019. Available at https://news.ihsmarkit.com/ as of January 2020.

Schrank, D., B. Eisele, and T. Lomax. 2019. *Urban Mobility Report 2019*. Texas A&M Transportation Institute. Available at https://static.tti.tamu.edu/ as of January 2020.

U.S. Army Corps of Engineers (USACE):

—2019a. Public Lock Usage Report Files. Lock Usage, Calendar Years 1993 - 2019. Institute for Water Resources (IWR). Updated April 27, 2020. Available at https://www.iwr.usace.army.mil/ as of August 2020.

—2019b Number of Cubic Yards and Total Bid dollars by Corps of Engineers District and Fiscal Year. Available at https://publibrary.planusace.us/ as of January 2020.

—2019c. *The U.S. Waterway System: 2018 Transportation Facts and Information*. Available at https://publibrary.planusace.us/ as of January 2020.

—2019d. Public Lock Usage Report Files. Lock Unavailabilities, Calendar Years 1993 – 2019. Updated June 04, 2020. Available at https://www.iwr.usace.army.mil/ as of August 2020.

—2018a. *Fiscal Year 2018 U.S. Army Annual Financial Report*. Available at https://comptroller.defense.gov/ as of January 2020.

—2018b. U.S. Flagged Vessels by Type and Age. Table 4 as of December 31, 2017. Waterborne Transportation Lines of the United States, Calendar Year 2017. Volumes 1 through 3 consolidated. October. Available at https://publibrary.planusace.us/ as of January 2020.

U.S. Department of Commerce (USDOC). National Oceanic and Atmospheric Administration (NOAA):

—2015. When Solar Storms Attack: Space Weather and our Infrastructure. NESDIS News & Articles, October 19.

—2019a. 2018's Billion Dollar Disasters in Context. February 7. Available at https://www.climate.gov/ as of January 2020.

—Undated. Space Weather and Safety. National Weather Service. Available at https://www.weather.gov/safety/space as of January 2020.

U.S. Department of Energy (DOE), Oak Ridge National Laboratory (ORNL):

—2018. 2017 National Household Travel Survey. Available at https://nhts.ornl.gov/vehicles as of November 2019.

—2019. *Transportation Energy Data Book: Edition 37.2*, August 30, 2019. Available at https://tedb.ornl.gov/data/ as of January 2020.

U.S. Department of Homeland Security. Transportation Security Administration (TSA):

—2020. TSA checkpoint travel numbers for 2020 and 2019. Available at https://www.tsa.gov/ as of April 2020.

—2019. TSA by the Numbers. Transportation Security Administration (TSA). Available at https://www.tsa.gov/ as of January 2020.

U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS).

—2020. Port Performance Freight Statistics Program. *Annual Report to Congress and Port Profiles.* January 2020. Available at www.bts.gov/ports as of January 2020.

—2019a. Condition of U.S. Highway Bridges, Table 1-28. Available at https://www.bts.gov/ from January 2020.

—2019b. Average Age of Aircraft. Available at https://www.bts.gov/ as of January 2020.

—2019c. On-Time Performance - Flight Delays at a Glance. TranStats. Data as of September 2019. Available at https://www.transtats.bts.gov/ as of January 2020.

—2019d. Bridge Condition. Available at https://www.bts.gov/bridge-condition as of August 2020.

—2019e. Average Age of Automobiles and Trucks in Operation in the United States. National Transportation Statistics, Table 1-26. Available at https://www.bts.gov/ from August 2020.

—2018a. Average Age of Urban Transit Vehicles, Table 1-29. Available at https://www.bts.gov/ as of January 2020.

—2018b. Amtrak On-time Performance, Table 1-73. Available at https://www.bts.gov/ as of January 2020.

U.S. Department of Transportation (USDOT), Federal Aviation Administration (FAA):

—2018. *National Plan of Integrated Airport Systems (NPIAS) 2019–2023*. Available at https://www.faa.gov/ as of January 2020.

U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA):

—2019a. *Linking Performance and Asset Management: A White Paper Produced by the Federal Highway Administration Transportation Asset Management Expert Task Group*, July 2019. Available at https://www.fhwa.dot.gov/ as of January 2020.

—2019b. Bridge Condition by Year Built. Bridge counts as of 12/31/2018. Available at https://www.fhwa.dot.gov/ as of January 2020.

—2019c. National Highway System Length, Miles by Measured Pavement Roughness, Table HM-47. Data as of August 30, 2019. Available at https://www.fhwa.dot.gov/ as of January 2020.

—2019d. Traffic Volume Trends, Various years. Available at https://www.fhwa.dot.gov/ as of January 2020.

—2019e. Daily Travel by Measured Pavement Roughness, NHS. Table HM-47A. Various years. Available at https://www.fhwa.dot.gov/ as of January 2020.

—2019f. Bridges & Structures, Bridge Condition by Owner. Available at https://www.fhwa.dot.gov/ as of January 2020.

—2019g. Bridge Condition by System, Various Years. Available at https://www.fhwa.dot.gov/ as of January 2020.

—2019h. Bridge Condition by Functional Classification ADT 2018. Available at https://www.fhwa.dot.gov/ as of January 2020.

—2019i. National Tunnel Inspection Program Compliance Review Manual. Available at https://www.fhwa.dot.gov/ as of April 2020.

—2019j. Urban Congestion Reports. Quarterly Reports. Available at https://ops.fhwa.dot.gov/ as of January 2020.

—2019k. Special Federal-aid Funding; Emergency Relief Program. Available at https://www.fhwa.dot.gov/ as of January 2020.

—2019l. National Tunnel Inventory (2019 data). Available at https://www.fhwa.dot.gov/ as of January 2020.

—2019m. Bridge Condition by Posting Status (2019 data). (12/31/2019). Available at https://www.fhwa.dot.gov/ as of January 2020.

—2018. *Bridge Preservation Guide Maintaining a Resilient Infrastructure to Preserve Mobility*. Spring 2018. Available at https://www.fhwa.dot.gov/ as of May 2020.

U.S. Department of Transportation (USDOT), Federal Railroad Administration (FRA):

—2018. Fiscal Year 2018 Enforcement Report. Available from https://railroads.dot.gov/ as of January 2020.

U.S. Department of Transportation (USDOT), Federal Transit Administration (FTA):

—2018. Annual Database Vehicle Maintenance, National Transit Database. Available from https://www.transit.dot.gov/ as of January 2020.

U.S. Department of Transportation (USDOT), Maritime Administration (MARAD):

—2019a. *Capacities of Containerships Calling on U.S. Ports (2015-2018), Available at* https://www.maritime.dot.gov/ as of March 2020.

U.S. Department of Transportation (USDOT), Pipelines and Hazardous Materials Safety Administration (PHMSA):

—2019a. Crude Oil/Refined Petroleum/Biofuel, Miles Inspected. Available at https://portal.phmsa.dot.gov/ as of January 2020.

CHAPTER 3

Passenger Travel

Introduction

The Nation's transportation system connects 331 million U.S. residents with jobs, services, schools, friends and families, and recreation; links 34 million U.S. businesses with employees and customers; and brings in 80 million international visitors. The American public invests a substantial percentage of their time and money on travel, averaging more than an hour per day per person and over $10,000 per year for each household.

A growing population of workers reaching retirement age; fewer workers replacing them; shifting demographics and travel choices; and the growing popularity of telecommuting, online shopping, and home delivery are all influencing trip patterns. However, the COVID-19 pandemic has disrupted many of these passenger travel patterns. Among the most obvious has been an increase in telework from home with a consequent drop in work trips, whereas the proliferation of online ordering has likely replaced many shopping trips while increasing home delivery traffic.

Local and long-distance travel ultimately respond to demographic and economic forces—forces that will continue to affect travel even after the pandemic passes. The full effect of COVID-19 on travel in 2020 and which responses to the pandemic eventually subside, while others do not, remain to be seen and will be discussed in future editions of this report.

Highlights

- U.S. population continues to age, and there is a lack of growth in working age persons in the labor force who account for about two-thirds of all household passenger travel.
- The share of households with personal vehicles continues to rise, reaching about 91 percent of all households and more than 98 percent of households with workers in 2018. Vehicle ownership rates by Hispanics and Blacks in 2018 were also trending towards that of national averages.
- Modal choices for work commutes have been largely stable since 2000, with notable exceptions of a continued decline in carpooling shares and losses in transit ridership that began in 2016.

continued on next page

Highlights *(continued)*

- Even before the COVID-19 pandemic and stay-at-home orders, one upward trend has been the number of people working from home, rising from about 4 percent in 2010 to about 5 percent of workers in 2018. Telework is a substitute for the daily commute/journey-to-work, and early indications show a substantial increase during the stay-at-home orders.
- In 2018 the United States was third in the world in visits by foreign tourists and first in tourism revenues, according to the United Nations World Tourism Organization. Tourism involves substantial use of domestic U.S. transportation services. U.S. residents traveling outside the United States reached 93 million in 2018, exceeding the 80 million arriving visitors.

Passenger travel includes people moving by airplane, bus, car, train, on foot, or by other conveyance (e.g., bicycles, electric scooters, and battery-assisted bikes). It has grown steadily over recent decades, driven by long-term demographic and economic trends, reaching record levels in 2018 as shown in table 3-1.[1] Airline passenger enplanements, passenger vehicle counts on highways, and other measures indicated strong growth in travel until stay-at-home orders and other responses to COVID-19 began in March 2020, illustrated by the sudden and dramatic increase in flight cancellations tracked in figure 3-1. Airlines have since better anticipated consumer demand and scheduled flights accordingly, reducing cancellations. The total effects of COVID-19 on passenger travel will not be clear for some time.

[1] 2018 is the most recent year for which complete passenger-miles data are available.

TABLE 3-1 Domestic U.S. Passenger-Miles (millions): 2010 and 2018

	Passenger-miles	
Mode	2010	2018
Air carriers	554,711	754,303*
Highway, total	5,009,806	5,545,845
Light-duty vehicle, short wheelbase	3,429,996	3,729,610
Transit, including rail, bus, other	52,627	53,830
Amtrak (intercity rail)	6,420	6,361

* Air carriers shows 2019 passenger-miles.

NOTE: Bus transit appears in both Highway and Transit totals.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, table 1-40, available at http://www.bts.gov/nts as of October 2020.

FIGURE 3-1 Weekly Flight Cancellations by U.S. Air Carriers: March–August 2020

NOTES: Canceled flight means a flight operation that was not operated but was listed in a carrier's computer reservation system within seven calendar days of the scheduled departure. Covers only scheduled service domestic flights operated by airlines that report on-time data.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, special tabulation, available at https://www.bts.gov/ as of October 2020.

Demographic Trends

Demographic conditions can have a large effect on travel. The next 10 years will likely play a pivotal role in America's demographic story due to three key factors:

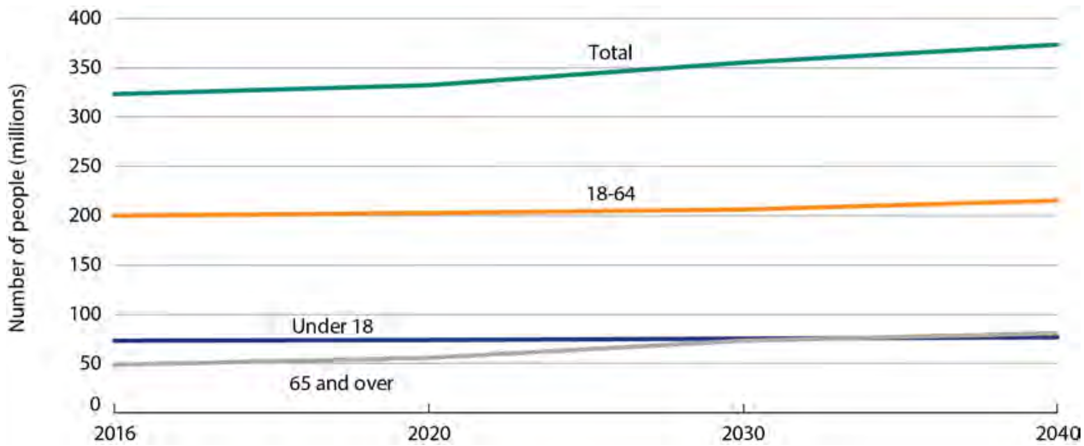
1. This is when the last members of the baby boom generation will reach age 65, with many entering retirement.
2. It is the period when the post-working-age population, those over the age of 64, is projected to exceed the pre-working-age population, those under the age of 18, for the first time in our Nation's history.
3. Finally, it is potentially a period when immigrant arrivals contribute more to population growth than will the births minus deaths of residents [USDOC CENSUS 2017].

All three of these factors have implications for transportation and the Nation's economic structure. All are crucial to transportation development, particularly the age of the workforce. The working-age population is the predominant generator of personal travel, not just for work trips but also those that support household activities, which comprise about two-thirds of person trips each day [USDOT FHWA 2018b].

From 2016 to 2040, the working population, age 18-to-64, is projected to increase by about 6 million people. In contrast, the under 18 age group is projected to increase by about 2 million (figure 3-2). The 65-year-old and over age group—projected to increase by about 24 million—will likely have a considerable effect on transportation. However, it remains to be seen how COVID-19 may affect travel by these population cohorts.

The aging of the baby boom generation, those born between 1945 to 1965, has had large effects on passenger travel, and this age group will continue to affect transportation. Although many of those 65 and older will remain in the workforce, those that do retire with the time and means to travel could contribute to a peak in tourism. Finally, where retirees choose to locate may generate significant shifts in travel to services, especially medical, which will also be among the fastest growing occupations (e.g., home health aides, physician assistants, nurse practitioners, etc.) and industries (e.g., medical and diagnostic laboratories, and other ambulatory health care services) [USDOL BLS 2018].

FIGURE 3-2 Population Projections by Age Group: 2016–2040



SOURCE: U.S. Department of Commerce, Census Bureau, 2017 Projections, available at https://www.census.gov/ as of October 2020.

Household Spending on Transportation

Transportation is a major expenditure for households. In 2015 the Consumer Expenditure Survey indicated that transportation spending averaged $9,503 per household. By 2018 that average had risen slightly to $9,761 per household while other categories of spending increased substantially. As a result, the transportation share of all spending declined from 17 to about 16 percent. However, it remains to be seen how income restraints will affect household travel as the Nation recovers from COVID-19.

The survey shows that household spending on transportation rises substantially with each additional earner[2]/worker in the household. In a one-person household, travel spending increases by about $2,700 when a non-earner becomes a worker as shown in the figure. A comparable increase, approximately $2,000–$3,000, can be seen for each additional worker in a multi-person household (figure 3-3). Multi-person households may include family members who are related, as well as two or more persons living together in shared housing (e.g., roommates). Notably, transportation spending by three or more earner households is only about double that of one-earner households. Also, no-earner and multi-person households increasingly include retired couples who spend substantially more on travel and tourism than in the past.

The National Household Travel Survey (NHTS) provides a summary of transportation-related trends, which is important for relating passenger travel and demographic factors. The 2017 NHTS shows that household size has declined to a roughly stable level of 2.6 persons per household, down from 3.2 in 1969 (figure 3-4). Licensed drivers per household and vehicles per household increased between 1969 and 2017, despite a decline in household size. Likewise, workers per household and vehicles per worker have increased over time. Despite a declining number of people per household, the number of vehicles per licensed driver, worker, and household have increased. This coincides with an increase in licensed drivers and workers per household as well as a growing number of households owning two or more vehicles as shown in figure 3-4.

[2] Technically termed "earners," but for most purposes are referred to by the more common term of workers (used herein). Earners include all 14-years old and over in the household with $1 or more in wage and salary, farm self-employment, or nonfarm self-employment in the past 12-months. For a detailed explanation, please see the Consumer Expenditure Survey at https://www.bls.gov/cex/csxgloss.htm.

FIGURE 3-3 Transportation Spending by Non-Workers and Workers: 2019

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Consumer Expenditure Survey, Table 1600, available at www.bls.gov/cex/tables.htm as of October 2020.

TABLE 3-2 Household Transportation, 65 and Older v. All Households: 2018

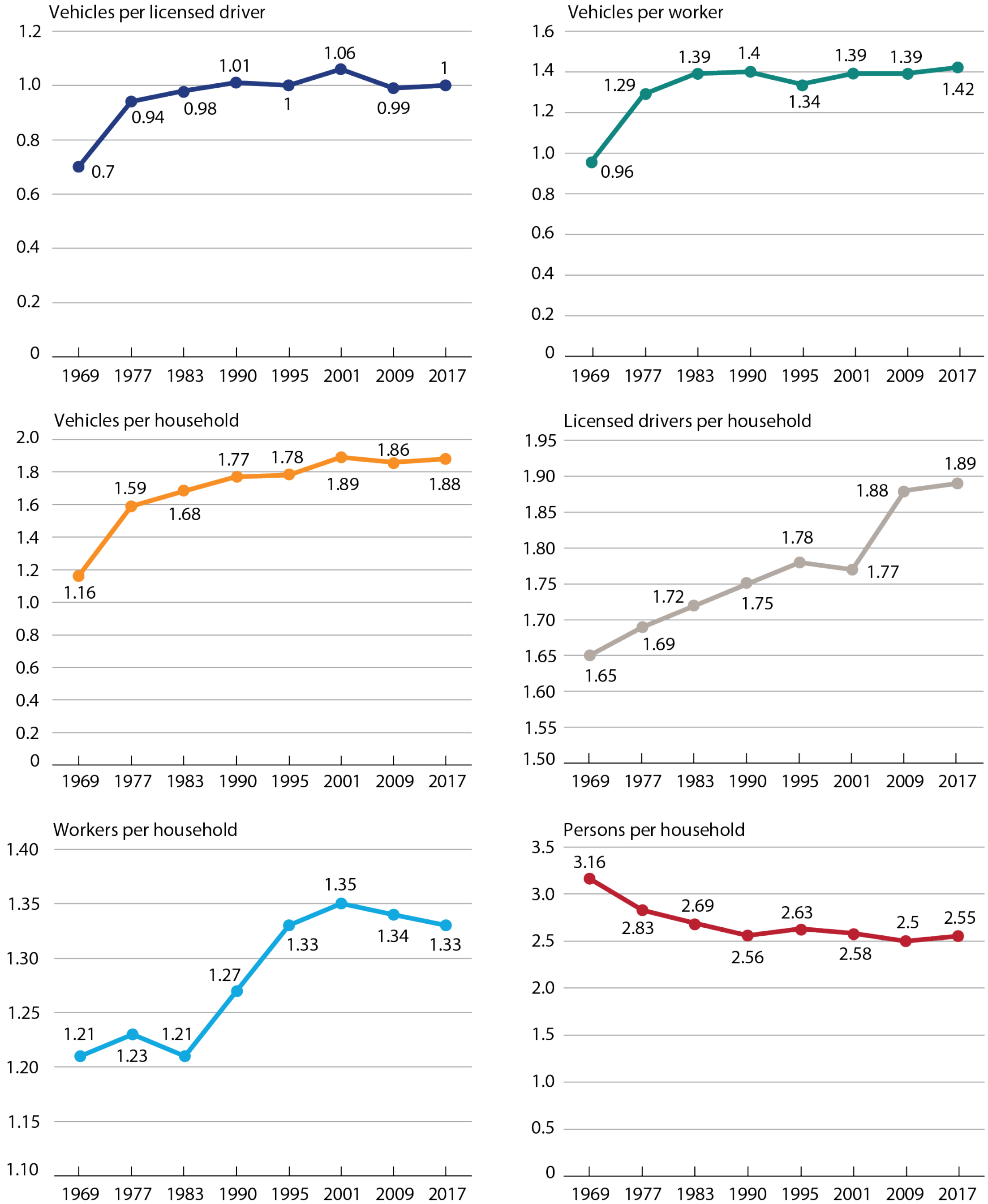
	All households	Households aged 65 and older	Ratio of households 65 and older to all households
Number of households (thousands)	131,439	33,023	25%
Persons/household	2.5	1.8	72%
Earners	1.3	0.5	38%
Vehicles/household	1.9	1.8	95%
Total spending	$61,224	$50,860	83%
Transportation spending	$9,761	$7,270	74%
Transportation share	15.90%	14.30%	
Home ownership	63%	80%	
Fuel spending/vehicle	$1,110	$801	72%
Intercity travel	$662	$639	97%

[1] This is values for over 65. Values for the 65-74 group exceeds spending by all consumers by 12 percent

NOTE: A Consumer Unit, for most purposes is very similar to the more common term of household. They differ where persons in a dwelling maintain separate economic responsibilities (e.g., college students), and therefore each person is considered a separate consumer unit. See BLS CEX Glossary for additional details.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Consumer Expenditure Survey, Table 1300, available at www.bls.gov/cex/tables.htm as of February 2020.

FIGURE 3-4 Long-term Trends in Demographics and Travel: 1969, 1977, 1983, 1990, 1995 NPTS; 2001, 2009, 2017 NHTS



KEY: NHTS = National Household Travel Survey; NPTS = Nationwide Personal Transportation Survey.

NOTE: National Household Travel Survey (NHTS) was previously called the Nationwide Personal Transportation Survey (NPTS) and is conducted approximately every 5 to 8 years.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *2017 National Household Travel Survey, Summary of Travel Trends*, available at https://nhts.ornl.gov as of October 2019.

Vehicle Ownership

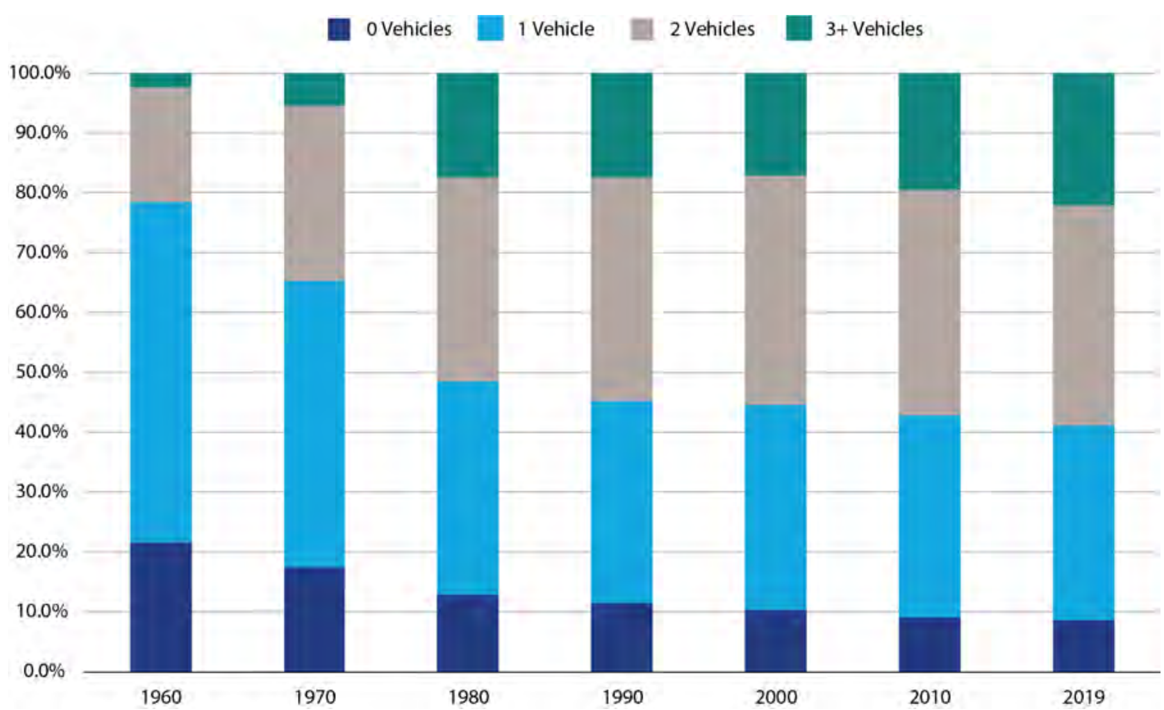
Vehicle ownership affects transportation choice and usage, especially with regards to use of public transportation. Households increasingly own more vehicles, with two- and three-vehicle households now comprising a larger share of the population than one-vehicle households (figure 3-5). The share of zero-vehicle households continues to decline, down to about 9 percent of all households in 2018. If only households with workers are considered, that share is about halved—to around 4 percent. An important part of the drop in zero-vehicle households has been generated by increased vehicle ownership among Blacks and Hispanics, ownership rates that are trending toward that of the overall population [USDOC ACS 2019].

Demographic Shifts

The net change in population migration between areas is significant in providing insight into longer term patterns that affect transportation demand. Approximately 31 million persons changed residence between 2018 and 2019. The overall trend in total moves reached as high as 40 million since the early 2000s but has since generally been in the 30 million range per year. Nearly 24 million out of the 251 million adult residents over 18 years of age moved between 2018 and 2019 [USDOC CENSUS 2018]. Figure 3-6 shows that U.S. population growth continues moving south and west as it has for decades.

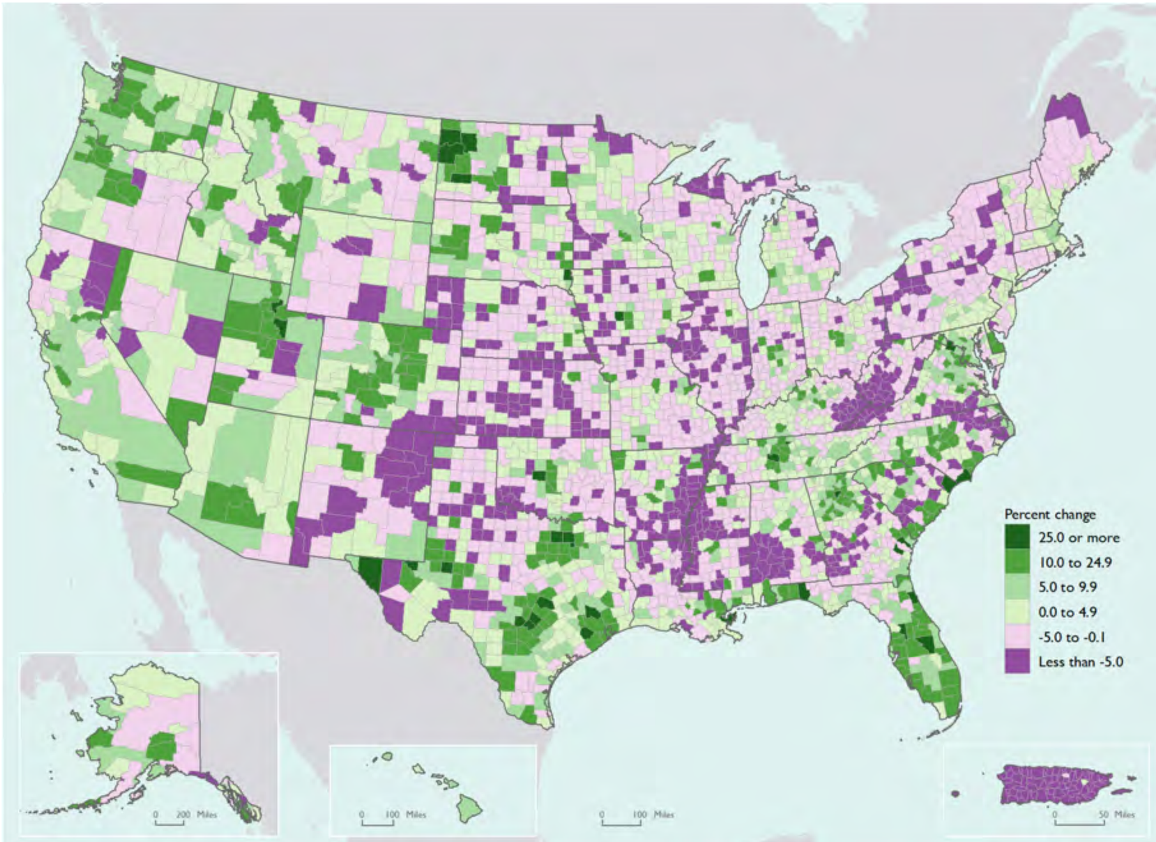
About 16 million moved within the same metropolitan areas, especially given that movers generally stay within the area where they formerly resided (i.e., center city dwellers shift within city limits and suburbanites move within the suburbs). The second largest moves were between metropolitan areas and the third among non-metropolitan areas. Between 2018 and 2019, migration between metropolitan and

FIGURE 3-5 Long-term Trends in Vehicles per Household: 1960–2019



SOURCE: U.S. Department of Commerce, Census Bureau, Decennial Census and American Community Survey, available at https://data.census.gov/cedsci/ as of February 2020.

FIGURE 3-6 Percent Change in Population by County: 2000-2018



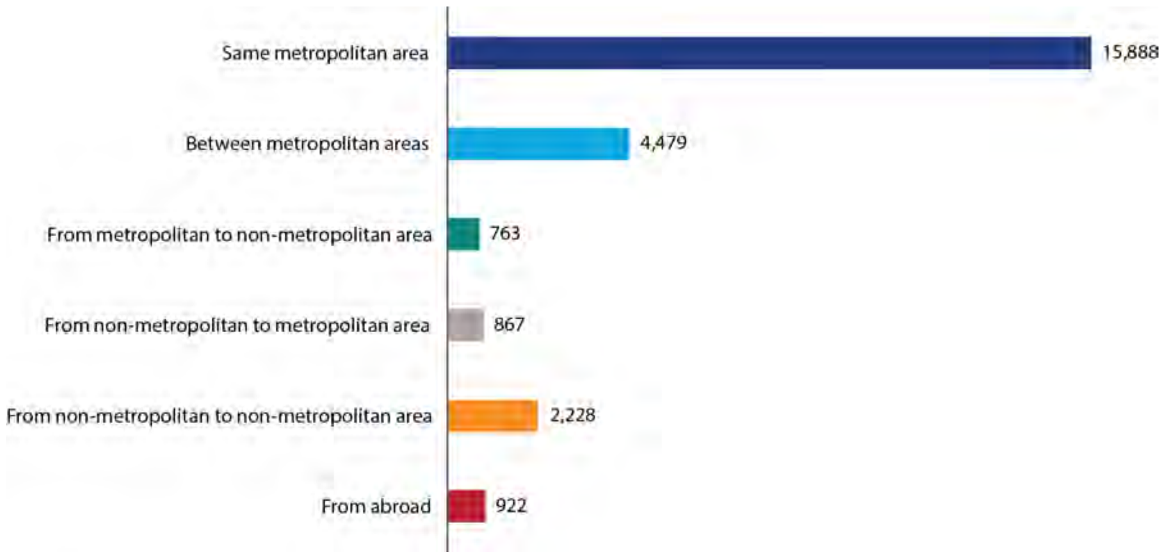
SOURCE: U.S. Department of Commerce, Census Bureau, County Population, available at https://www.census.gov/ as of October 2020.

non-metropolitan areas[3] was more limited, with metropolitan areas gaining about 100,000 persons from non-metropolitan areas. The broad picture of these population migrations includes the flow of more than 2 million people among non-metropolitan, or rural areas, and almost a million arriving from outside the country (figure 3-7).

At the national scale, the flows between the four Census regions—the Northeast, Midwest, South, and West—indicate which ones are gaining or losing population. As traditionally shown, the Northeast continues to lose population from resident out-migration, losing 284,000 people to all regions, and mostly to the South between 2017 and 2018. In a significant change from past patterns, the Midwest gained in the population exchange with the Northeast, broke even with the West, and sustained a relatively small loss to the South. The West, traditionally gaining population from domestic migration, suffered a decline in the number migrating from the South, broke even with the Midwest, and achieved a relatively small gain in population exchange with the Northeast. As a result, all regions except the South had negative national domestic migration results. Movers to and from the South, particularly to Florida, make

[3] Non-metropolitan area is any area not located in a metropolitan area, which are defined as areas that have at least one urbanized area of 50,000 or more population, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties.

FIGURE 3-7 Shifts in the Metropolitan and Non-Metropolitan Population (thousands): 2018 to 2019



NOTE: Non-metropolitan area means is any area not located in a Metropolitan area, which are defined as areas that have at least one urbanized area of 50,000 or more population, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties.

SOURCE: U.S. Department of Commerce, Census Bureau, Metropolitan Mobility Program, *Geographic Mobility: 2018 to 2019*, Table 16, available at https://www.census.gov/ as of February 2020.

up the largest domestic migration flows. Many of most popular places to retire are in the South. These regional migrations potentially influence transportation demand, especially when population inflows strain regional and local system capacity [USDOC CENSUS 2018]. As noted in Chapter 1, the growth of the interstate lane-miles has followed U.S. population growth in metropolitan areas of the South [USDOT FHWA 2017].

Local Travel

The National Household Travel Survey (NHTS) provides a long-term overview of daily patterns of mostly local travel, defined by the NHTS as less than 50-miles—the majority of which are made by private vehicle.[4] It provides key statistics on trips by purpose (see table 3-3), mode, and distance over a 40-year period of the survey.

Overall trip-making trends showed growth in total number of daily trips per person until 1995, at about four trips per day, and then began an accelerating descent, reaching about three daily trips per person in 2017. Substantial losses in this daily person-trip rates occurred between 1995 and 2017 for those making trips for shopping/errands, down 34 percent, while work trips declined 22

[4] Prior to expansion and renaming of the Nationwide Personal Transportation Survey (NPTS) to the National Transportation Travel Survey, local travel was defined as 75 miles or less or from home.

TABLE 3-3 Long-Term Trends in Daily Person Trip by Purpose and Rate: 1977, 1983, 1990, 1995 NPTS; 2001, 2009, 2017 NHTS

Person trip rates	Total	To/from work	Shopping /errands	School/church	Social/recreation
1977	2.92	0.57	0.91	0.35	0.71
1983	2.89	0.59	1.02	0.34	0.80
1990	3.76	0.62	1.71	0.35	1.01
1995	4.30	0.76	1.97	0.38	1.07
2001	4.09	0.65	1.79	0.40	1.09
2009	3.79	0.59	1.61	0.36	1.04
2017	3.37	0.59	1.30	0.37	0.93

KEY: NHTS = National Household Travel Survey; NPTS = Nationwide Personal Transportation Survey.
NOTE: National Household Travel Survey (NHTS) was previously called the Nationwide Personal Transportation Survey (NPTS) and is conducted approximately every 5 to 8-years.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *National Household Transportation Survey, Summary of Travel Trends*, 2017, Table 11. Available at https://nhts.ornl.gov/assets/2017_nhts_summary_travel_trends.pdf as of June 2020.

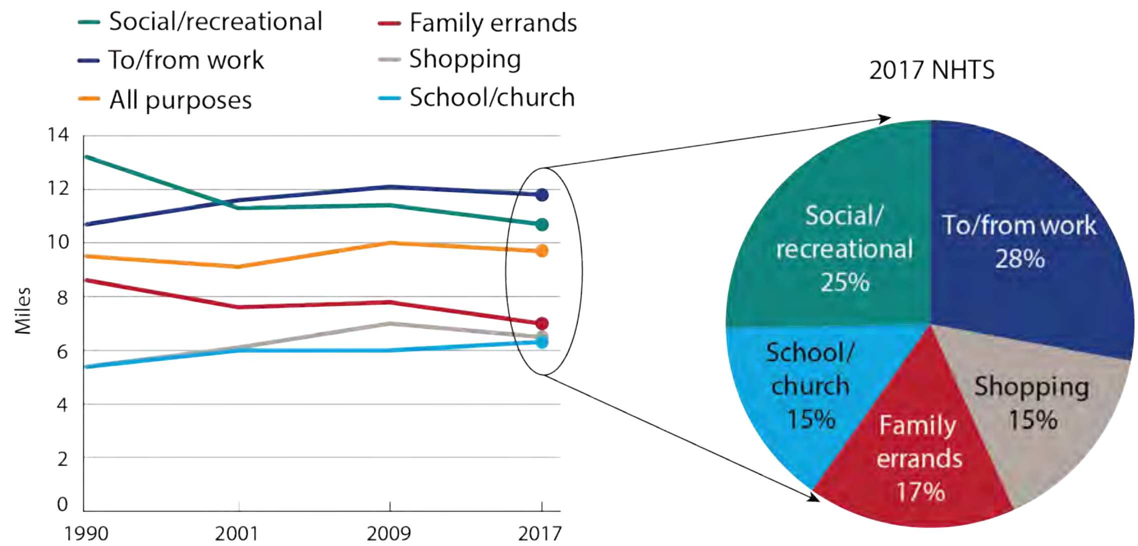
percent. Lesser losses occurred in daily social/recreation person-trip rates, down 13 percent, whereas school/church trip rates remained stable throughout the period. Other explanations for this decline may include the aging of the population, including retirees and persons who no longer have children to transport or who may be less active than younger generations. Also, online ordering and home delivery of goods can substitute for running certain errands and social media can replace in-person socialization.

Overall trip length patterns for different trip purposes varied significantly between 1990 and 2017 (figure 3-8). Social and recreational travel trip length decreased by about 14 percent in the decade of the 1990s before stabilizing at about 11 miles. Business travel trip length has shown the greatest stability, rising from about 11 to roughly 12 miles by 2001, where it remained through 2017. Shopping trip lengths increased in the period from 1990 to 2017, rising about 50 percent, from about 5 to 8 miles. Even school and church trip length travel showed growth of about 30 percent, from about 5 miles in 1990 to 7 miles in 2017. Trip lengths, particularly the daily commute to/from work, have increased as discussed below, while workers increasingly leave their home county or even home state to work.

Overall trip lengths vary by geographic location. Most notably, sharp distinctions between rural and urban resident trip lengths exist, with rural trips about 40 percent longer than urban trips [USDOT FHWA 2018a]. Urban school trips are an exception; they are about 20 percent longer than their rural counterparts.

As expected, overall national local trip making is dominated by the private vehicle. The average number of annual person-trips per household by private vehicles is between 2,600 and 2,700 for all metropolitan areas by size, with the exception of person-trips in metropolitan areas with populations in excess of 3 million, which average about 2,450 person-trips (table 3-4). Similarly, the number of transit and walking trips vary by area size. Average annual person-trips are greater in the largest metropolitan areas where transit usage is five times the average for all other areas due to the frequency and access to public transit services. Walking is also greater in high-intensity areas than the average for smaller areas.

FIGURE 3-8 Long-Term Trends in Daily Person Trip by Purpose and Length: 1990 NPTS; 2001, 2009, 2017 NHTS



KEY: NHTS = National Household Travel Survey; NPTS = Nationwide Personal Transportation Survey.

NOTE: National Household Travel Survey (NHTS) was previously called the Nationwide Personal Transportation Survey (NPTS) and is conducted approximately every 5 to 8 years.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *National Household Travel Survey, Summary of Travel Trends*, Table 5b, available at https://www.fhwa.dot.gov/ as of July 2020.

TABLE 3-4 Average Annual Person-Trips per Household by Mode and Metropolitan Area Size: 2017

Population size	All	Private vehicle	Public transit	Walk
All	3,140	2,592	80	329
Outside an MSA	2,966	2,623	6	204
Less than 250,000	2,984	2,620	33	217
250,000–499,000	3,103	2,718	34	228
500,000–999,999	3,141	2,698	42	274
1 million–2,999,999	3,178	2,678	50	303
3 million +	3,246	2,446	170	479

KEY: MSA = Metropolitan Statistical Area.

NOTES: National Household Travel Survey (NHTS) was previously called the Nationwide Personal Transportation Survey (NPTS) and is conducted approximately every 5 to 8 years. Other trip purposes are not categorized, e.g., work-related business and other trips.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *National Household Transportation Survey, Summary of Travel Trends, 2017*, Table 7, available at https://nhts.ornl.gov/assets/2017_nhts_summary_travel_trends.pdf as of June 2020.

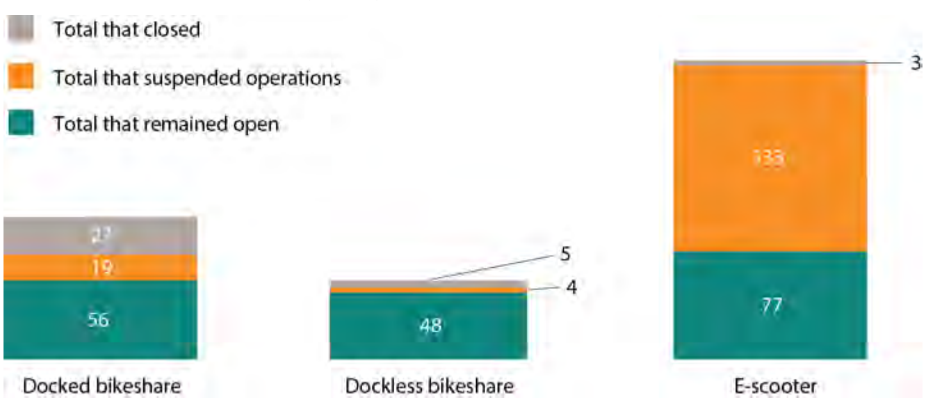
Box 3-A Estimated Household Travel Patterns at the Census Tract-Level

The National Household Travel Survey (NHTS) has data on types of personal trips but does not have enough data to provide that information for small geographic areas, such as by tract. The American Communities Survey has a larger sample size that can provide information at the tract level, but it does not have much information on travel. By leveraging both datasets, BTS has created estimates at the tract-level of the number of daily trips, number of daily vehicle trips, miles traveled by each person, and miles traveled by each vehicle.

Estimation models and track-level estimates can be found on the BTS website at https://www.bts.gov/latch.

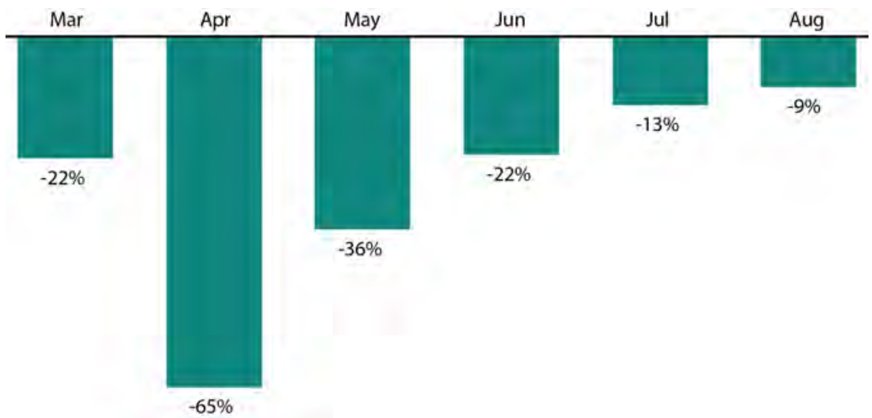
Shared micromobility, the use of lightweight, single-person vehicles (e.g., bicycles, electric scooters, and battery-assisted bikes) that can be shared with others is a new trend in local travel. Available largely in city centers, these modes of transport have grown from an estimated 300,000 trips in 2008 to about 84 million trips in 2018, according to the National Association of City Transportation Officials. Bike shares tend to be peak-hour oriented, whereas scooters tend to be more oriented to later in the day and weekend uses [NACTO 2018]. Since March 2020, 35 bikeshare (docked or dockless) or e-scooter systems (9 percent) closed permanently and 156 (42 percent) suspended operations. Figure 3-9 shows that docked bikeshare systems comprise most of the systems that closed permanently—27 of the 35 bikeshare (docked or dockless) and e-scooter systems that closed. E-scooter systems comprise most of the suspended systems—133 of the 156 bikeshare (docked or dockless) and e-scooter systems that suspended operations. Of the 133 systems that suspended operations, half remain suspended as of August 2020.

FIGURE 3-9 Bikeshare and E-scooter System Operation Changes in Response to COVID-19: March through August 2020



SOURCE: U.S. Department of Transportation, Bureau of Transportation, *Interactive Docked Bikeshare Ridership Application*, available http://www.bts.gov as October 2020.

FIGURE 3-10 Year-Over-Year Change in Docked Bikeshare Trips on Eight Largest Systems, March Through August 2020



SOURCE: U.S. Department of Transportation, Bureau of Transportation, *Interactive Docked Bikeshare Ridership Application*, available http://www.bts.gov as October 2020.

Ridership on eight of the Nation's largest docked bikeshare systems in the COVID-19 months of March through May 2020 declined by 44 percent compared to the same days of the same period in 2019. Figure 3-10 shows the largest year-over-year decline occurred in April (65 percent decline) when stay-at-home orders took effect or remained in effect. Ridership began increasing in May but as of August 2020 remains 9 percent below 2019 levels.

Journey-to-Work

The journey-to-work has been a cornerstone of local travel as shown in figure 3-6, with relatively stable trends in shares of driving alone, transit, walking, and bicycling (until the outbreak of COVID-19) (table 3-5). The number of commuters rose to 155 million in 2019, a gain of almost 2 million over 2018. Workers who drove alone and carpooled increased between 2010 and 2019 while their shares decreased slightly. Those who worked at home increased by more than 3 million during the same period.

Working from home (a work trip substitute), as shown in figure 3-11, has risen not only in number but also in share from just above 2 percent in 1980 to about 6 percent in 2019. Based upon the American Time Use Survey, nearly 44 percent of workers had the ability to telework, and given recent stay-at-home orders and social distancing measures put in place in response to the COVID-19 pandemic, many workers are now working remotely [USDOL BLS 2020].

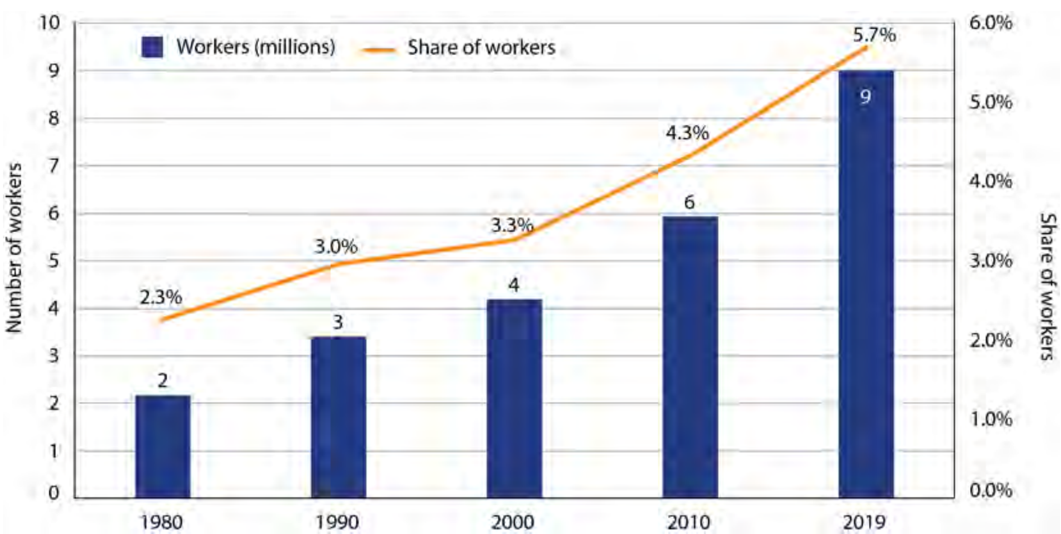
Even prior to the pandemic, the overall working at home level had quadrupled between 1980 and 2018, from about 2 million to over 8 million workers, as the percentage of those working at home more than doubled (figure 3-7). The definitions employed here are important. The measure defined by the Census Bureau identifies those with no regular workplace outside the home but does not include those who work from home occasionally or who may regularly work from home (i.e., telecommute) on one or more given days. It is difficult to measure those who telecommute part-time given extreme variability in telecommuting practices and schedules. The telecommuting workforce makes little if any footprint on our transportation systems when telecommuting and may prove a valuable resource in reducing congestion and pollution.

TABLE 3-5 Trends in Choice of Commute Mode: 2010 and 2019

	2010		2019	
	Estimate	Percent	Estimate	Percent
Total	135,609,986	100.0	155,438,782	100.0
Drove alone	104,549,674	77.1	118,757,588	76.4
Carpool	13,153,874	9.7	13,782,971	8.9
Transit	6,682,228	4.9	7,661,777	4.9
Walked	3,290,953	2.4	3,518,568	2.3
Other	2,292,402	1.7	2,946,863	1.9
Worked at home	5,640,855	4.2	8,771,015	5.6

SOURCE: U.S. Department of Commerce, Census Bureau, 2010 and 2019 American Community Survey, Table B08141, available at https://data.census.gov/cedsci/ as of September 2020.

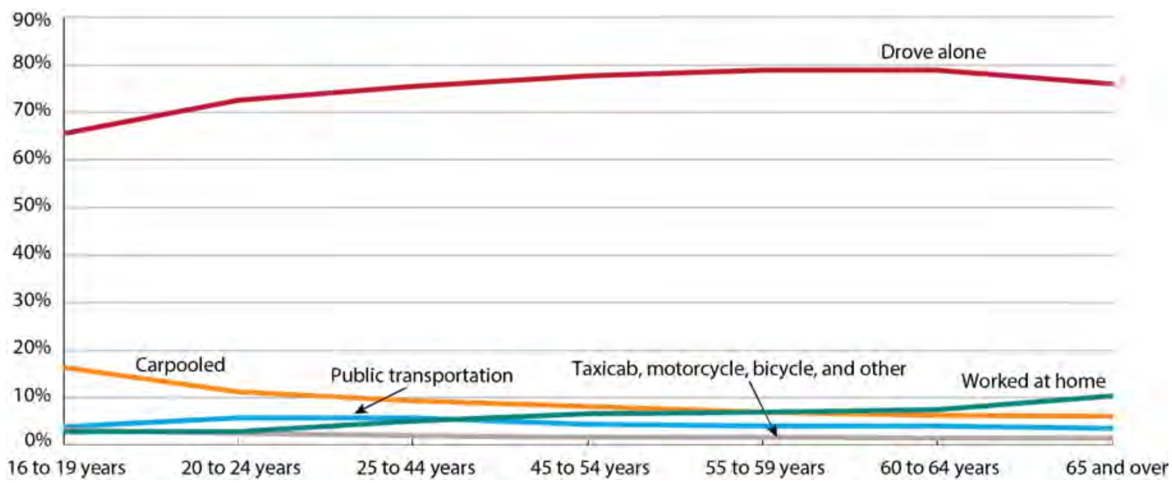
FIGURE 3-11 Trends in Working from Home: 1980, 1990, 2000, 2010, and 2019



SOURCE: U.S. Department of Commerce, Census Bureau, Decennial Census 1980–2000 and 2010 and 2019 American Community Survey, Table S0801, available at https://data.census.gov/cedsci/ as of September 2020.

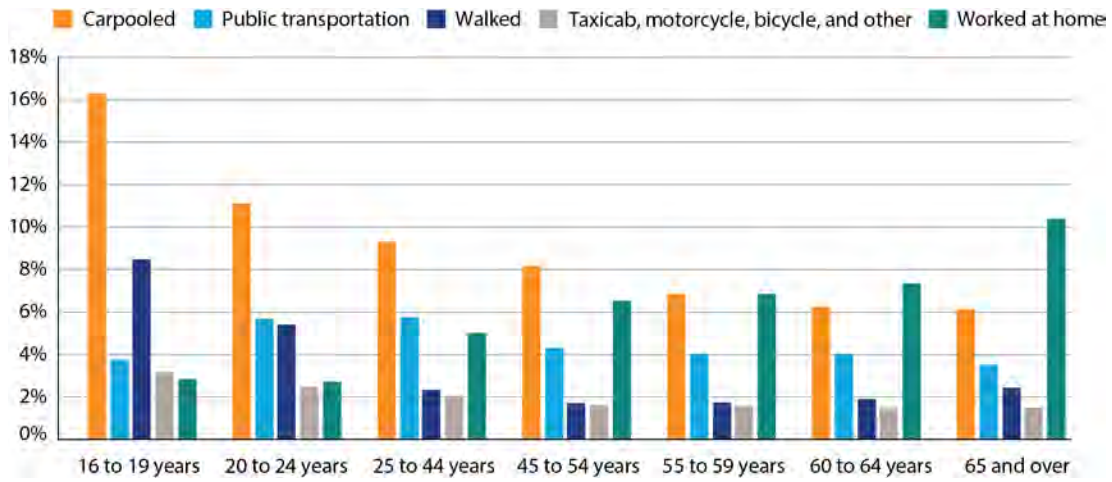
Driving alone dominates commute mode share across all age groups (figure 3-12). There is a strong correlation between mode choice and worker age. The teen years have a drive alone share of less than 70 percent. Driving alone rises slowly with age, peaking at nearly 80 percent for those aged 45 to 64 and then declines for those over age 65. Commute modes other than driving alone are significantly sensitive to worker age, with carpooling showing an obvious correlation. One work-related practice that increases with age is working from home—the work-trip substitute addressed earlier. Modes such as bicycling, motorcycling, and walking all peak during the users' early years as shown in figure 3-13.

FIGURE 3-12 Mode Usage for Commute Trips by Age Group (all modes): 2019



SOURCE: U.S. Department of Commerce, Census Bureau, 2018 American Community Survey, Table S0801, available at https://data.census.gov/cedsci/ as of June 2020.

FIGURE 3-13 Mode Use for Commute Trips by Age Group (excluding drove alone): 2019



SOURCE: U.S. Department of Commerce, Census Bureau, 2018 American Community Survey, Table S0801, available at https://data.census.gov/cedsci/ as of June 2020.

Time Spent Commuting

Average travel times to work have not changed much despite increasing system congestion and its effects on passenger travel. In the early 2000s, average travel times remained at almost exactly 25.5 minutes. After the recession of December 2007–June 2009, travel times began to grow, reaching 27.1 minutes in 2018, an increase of 1.6 minutes or 6 percent since 2000. About 40 percent of those commuting outside the home reach their destination in under 20 minutes [USDOC ACS 2019].

Figure 3-14 shows that among commuters with travel times to work of less than 30 minutes, women have an overall greater share than men. In parallel, men have a higher percentage of commutes over 30 minutes. Many of these distributional differences may be attributed to the nature of occupations and industries that men and women engage in, but the travel time increases over time for both men and women, and at both ends of the travel spectrum, indicate a decline in speeds across all modes [USDOC ACS 2019].

Local Travel by Rural Residents

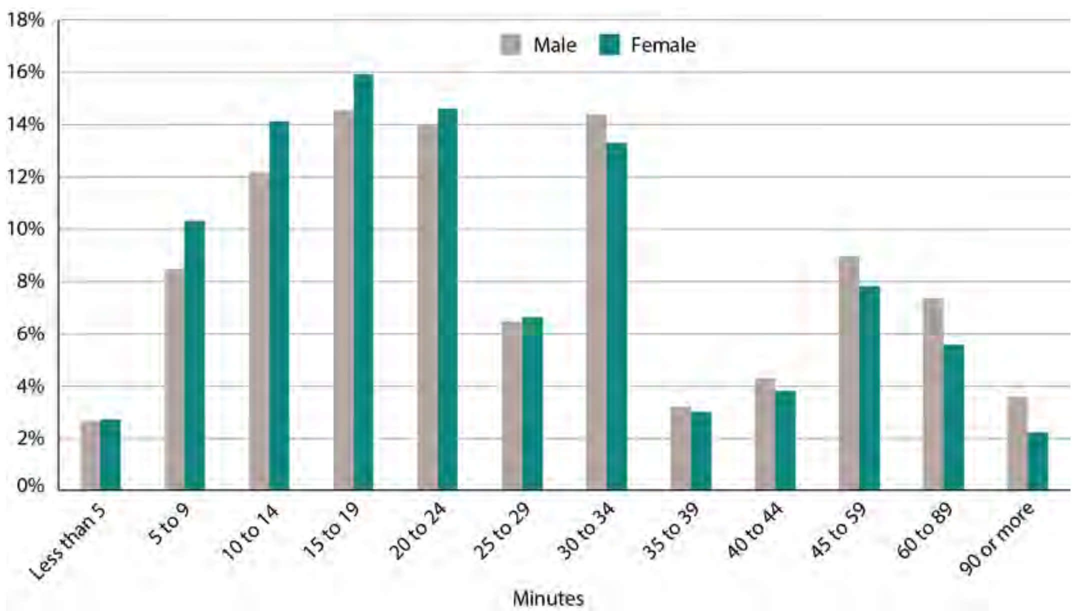
Local travel by rural Americans is difficult to measure because some metrics, such as vehicle counts, capture passenger movements between urban areas and because the definition of what is considered a rural area varies and is in constant flux. The Census Bureau recategorizes populations into the urban category as segments of the population become more densely settled on the metropolitan periphery or reach significant levels of commuting into urban areas. Effectively, the rural population is defined as what's left after urban entities have been demarcated.[5]

Long-Distance and International Travel

As 2019 ended, America was on the verge of entering a decade of expansion in long-distance

[5] Urbanized areas, as defined by Census Bureau, are continuously built-up areas with a population of 50,000 or more. Rural areas are defined as any population not in an urban area.

FIGURE 3-14 Average Travel Time to Work by Gender: 2018



SOURCE: U.S. Department of Commerce, Census Bureau, 2018 American Community Survey, Table B08012, available at https://data.census.gov/cedsci/ as of February 2020.

travel and tourism.[6] In 2019 the airline industry was tallying a billion-passenger year as both domestic and international travel rose 4 percent—a trend that, prior to COVID-19, continued into the following year with January 2020 travel data showing a 6 percent increase over January 2019 data [USDOT BTS 2020]. Amtrak was at its peak year for passengers and envisioned a breakthrough year without losses [AMTRAK 2018]. The intercity bus industry was instituting new approaches to services and linking colleges, airports, and new destinations. The increases in the older populations with the time and means to travel promised more domestic and international travel [USDOL BLS 2018]. All of that collapsed as COVID-19 emerged nationally in 2020. With demand constrained both domestically and at many country's borders, supply responded with dramatic curtailment of services.

Domestic Long-Distance Travel

The U.S. Travel and Tourism Association (USTTA) estimated that domestic travel and tourism activity, defined as trips with an overnight stay or farther than 50 miles from home, increased to a total of 2.3 billion trips in 2018. These were identified as 80 percent for leisure and the remainder for business travel. Further, the estimates reported by the USTTA also indicated that domestic tourism spending reached $933 billion in 2018. Coupled with international spending, tourism spending reached $1.1 trillion, with a third of that estimated to be transportation spending [USTTA 2019].

Completing the picture of national tourism, the United Nations' World Tourism Organization (UNWTO) placed the United States third, behind France and Spain, in the world in tourism arrivals, at 80 million visitors, and first in the world in tourism receipts, at $214 billion, in 2018 [UNWTO 2019].

[6] Long-distance trips as defined in the National Household Travel Survey are trips of 50 miles or more from home to the farthest destination traveled. Prior to expansion and renaming of the Nationwide Personal Transportation Survey (NPTS) to the National Transportation Travel Survey, long-distance travel was defined as 75 miles or more or from home.

The ability to describe intercity and long-distance travel activities in private vehicles for leisure, business, or other purposes is limited because the last national long-distance travel survey was conducted in 1995. Amtrak, intercity bus, and charter bus operations are also popular forms of travel in several long-distance markets.

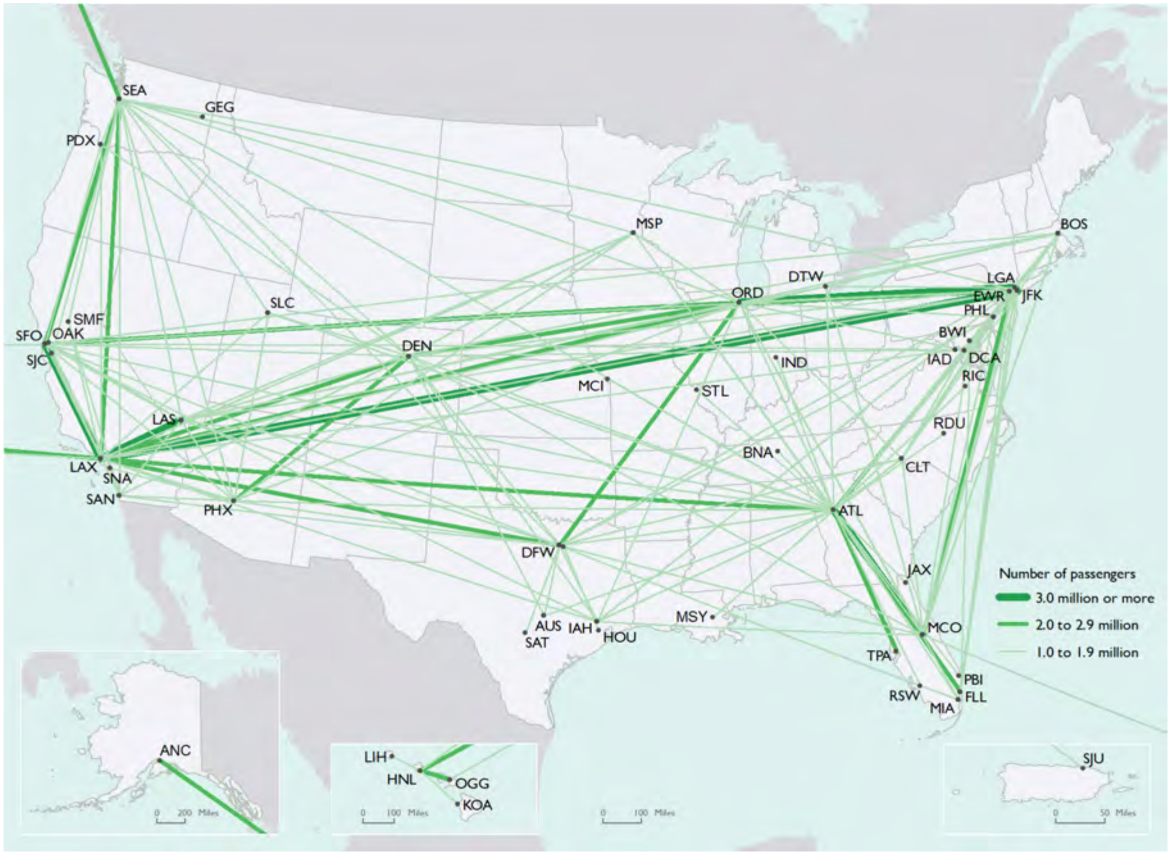
The best measured component of long-distance travel is by commercial aircraft. In 1971 roughly half the U.S. population had never flown in an airplane [SMITHSONIAN 2007]. Today about half the population flew in the last 12 months, with only 13 percent of the U.S. adult population never having flown, according to a 2018 survey [BOWDEN 2019].

Figure 3-15, showing routes with over a million passengers per year in 2019, illustrates the extent of air travel in the United States. Six airports (Hartsfield–Jackson Atlanta International Airport (ATL), Los Angeles International Airport (LAX), O'Hare International Airport (ORD), Dallas/Fort Worth International Airport (DFW), Denver International Airport (DEN), John F. Kennedy International Airport (JFK)) have routes of a million passengers or more.

Air travel had become increasingly popular with more than a billion air passengers flying in 2019, up 33.7 percent from 787 million in 2010 [USDOT BTS 2020]. Figure 3-16 shows how quickly the picture changed with the onset of the COVID-19 pandemic by using the Transportation Security Administration checkpoint screenings as a proxy for air trend demand.

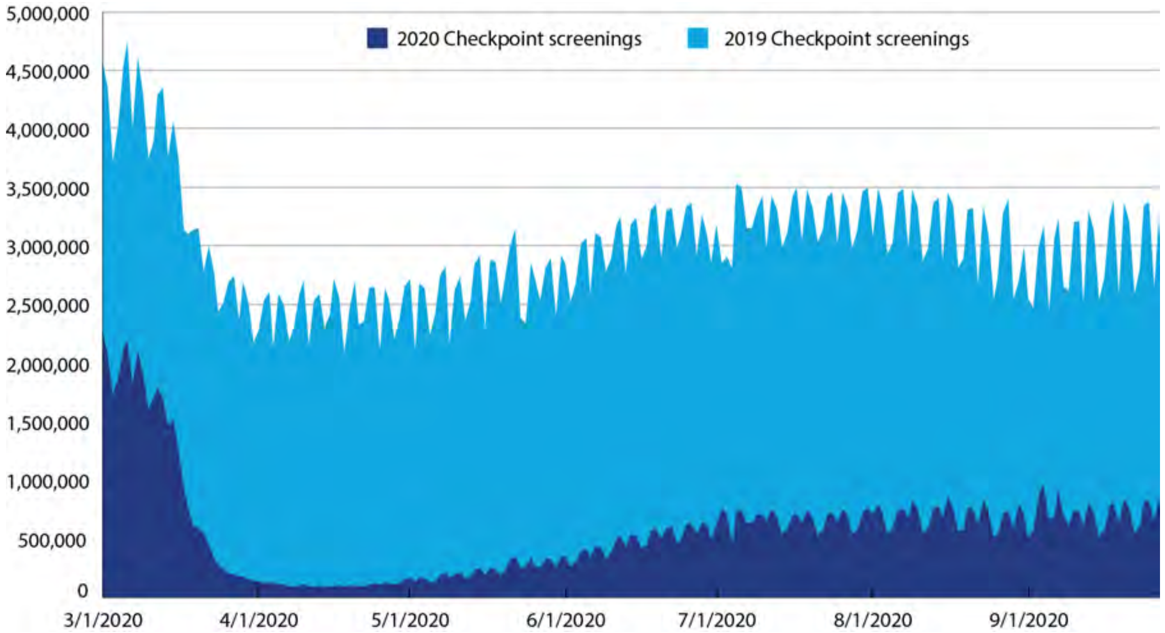
Figure 3-17 shows the scale and location of land border crossings with our land border neighbors, Canada and Mexico. In 2019 there were 188 million incoming person crossings along the U.S. border with Mexico and 53 million incoming person crossings along the Canadian border. The top 5 ports include San Ysidro, El Paso, Laredo, Hidalgo with Mexico, and Buffalo-Niagara Falls with Canada. In 2018 there were an estimated 14.2 million cruise passengers sailing from the United States, which accounts for half of the global cruise passengers [CLIA 2020]. However, the U.S. and global cruise industry has been negatively affected by the COVID-19 pandemic.

FIGURE 3-15 Airport Origin-Destination Pairs with More than 1 Million Passengers: 2019



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, special tabulation for Top Origin and Destination Air Travel Pairs, data accessed March 2020.

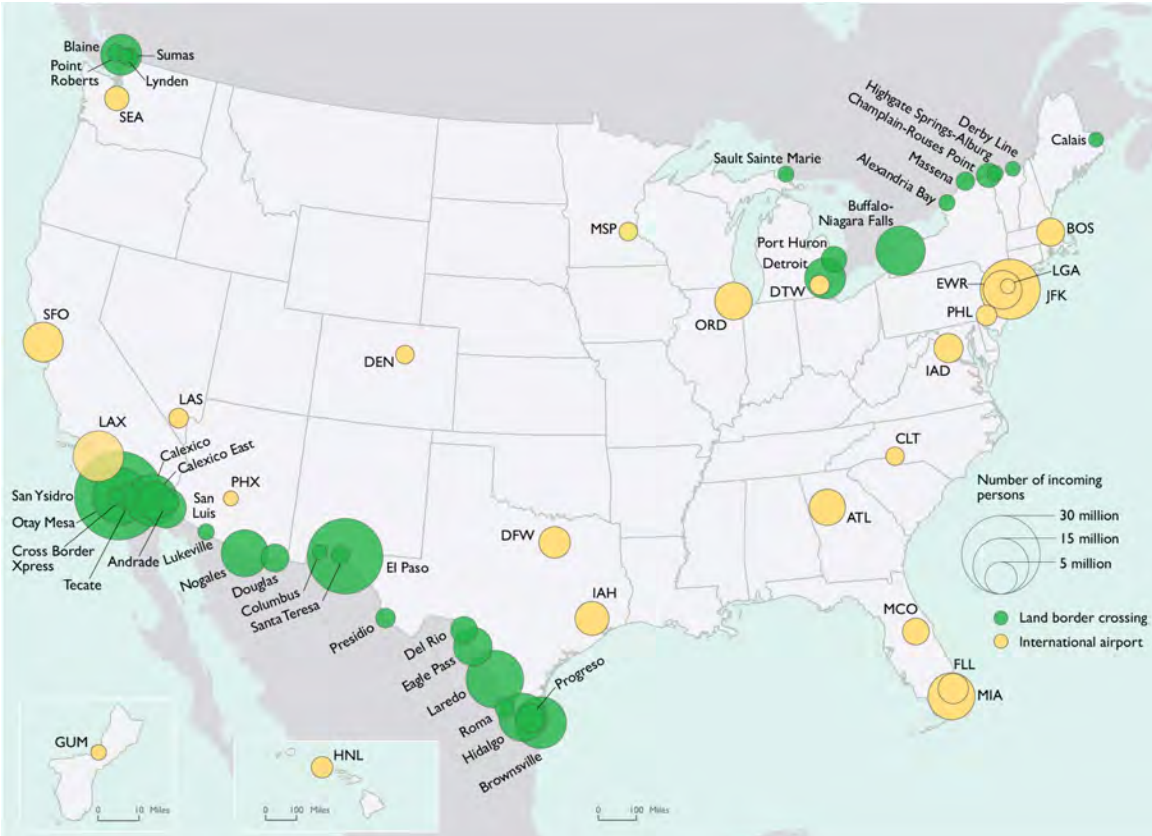
FIGURE 3-16 COVID-19 Effect on Daily TSA Checkpoint Screenings: March 1, 2020–September 27, 2020 (compared to 2019)



NOTE: The first COVID-19 related U.S. death occurred on Feb. 29, 2020 and a national emergency declared on Mar. 13, 2020.

SOURCE: U.S. Department of Homeland Security, Transportation Security Administration (TSA), People Screened, available at https://www.tsa.gov/coronavirus/passenger-throughput as of October 2020.

FIGURE 3-17 People Entering the United States via Land Border Crossing or International Airport: 2019



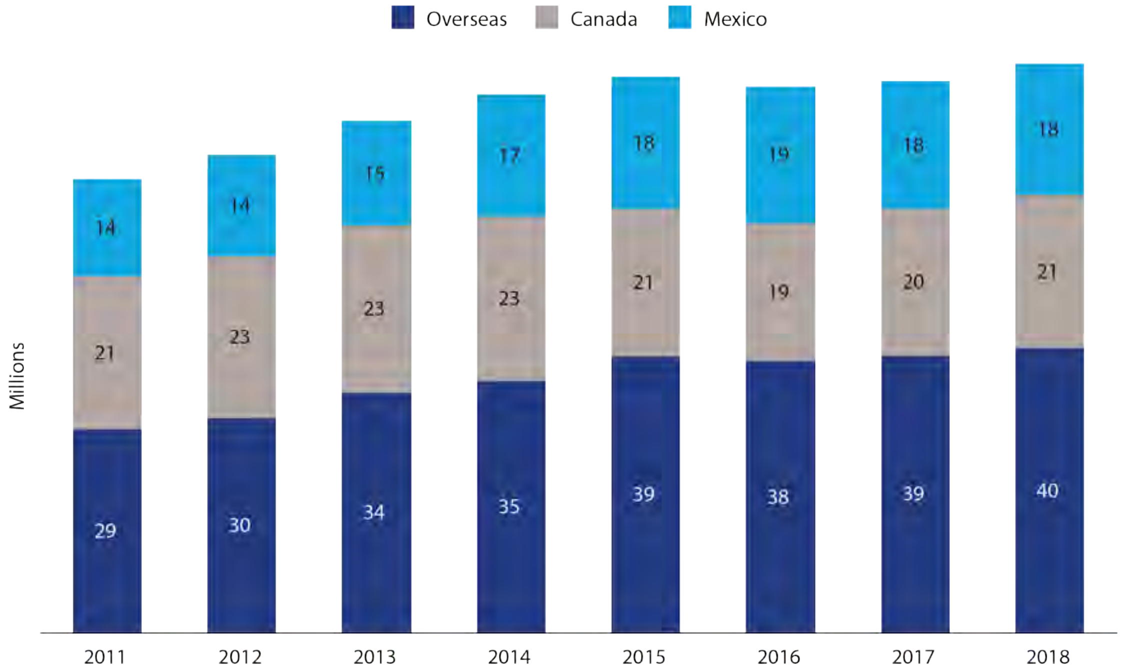
NOTE: Truck crossings are not included because they are primarily freight related.

SOURCE: Person crossings—U.S. Department of Transportation, Bureau of Transportation Statistics, Border Crossing/Entry database, available at https://www.bts.gov/transborder as of July 2020. Air passengers—U.S. Department of Transportation, Bureau of Transportation Statistics, T-100 International Market (all carriers) database, as of July 2020.

International Visitors

As noted earlier, the United States is among the world's top tourist destinations. Inbound international visitors reached roughly 80 million people in 2018 [USDOC NTTO 2019]. This number was projected to reach over 90 million inbound visitors to the United States by 2024. However, the COVID-19 pandemic has impacted the number of foreign visitors and U.S. residents traveling abroad. Mexican and Canadian visitors make up about half of the total inbound and outbound travel to and from the United States and have been the dominant sources of foreign visitors for years (figure 3-18). Canada, Mexico, and the United Kingdom together represent the largest number of visitors in 2018 (table 3-6).

FIGURE 3-18 Foreign Visitors to the United States by Select Country/Region: 2011–2018



SOURCE: U.S. Department of Commerce, National Travel and Tourism Office, Inbound Travel, I-94 Arrivals, available at https://travel.trade.gov as of February 2020.

TABLE 3-6 Leading Visitors to the United States: 2018

Rank	Country	Millions of visitors
1	Canada	21.2
2	Mexico	18.5
3	United Kingdom	4.7
4	Japan	3.5
5	China	3.0
6	S. Korea	2.2
7	Brazil	2.2
8	Germany	2.1
9	France	1.8
10	India	1.4

SOURCE: U.S. Department of Commerce National Travel and Tourism Office, Inbound Travel, I-94 Arrivals, available at https://www.trade.gov/visitor-arrivals-program-i-94-data as of February 2020.

Foreign visitor's use of transportation while visiting the United States can substantially affect our system. The Tourism Satellite Accounts of the Bureau of Economic Analysis provide insight into the nature and scale of tourism spending. Table 3-7 shows that international visitors consumed almost $200 billion on products and services in the United States in 2018, of which $40 billion was for international air transportation, $5 billion was for domestic transportation, and $3 billion was for other transportation services.

Table 3-7 International Visitor Spending on Transportation in the United States: 2018

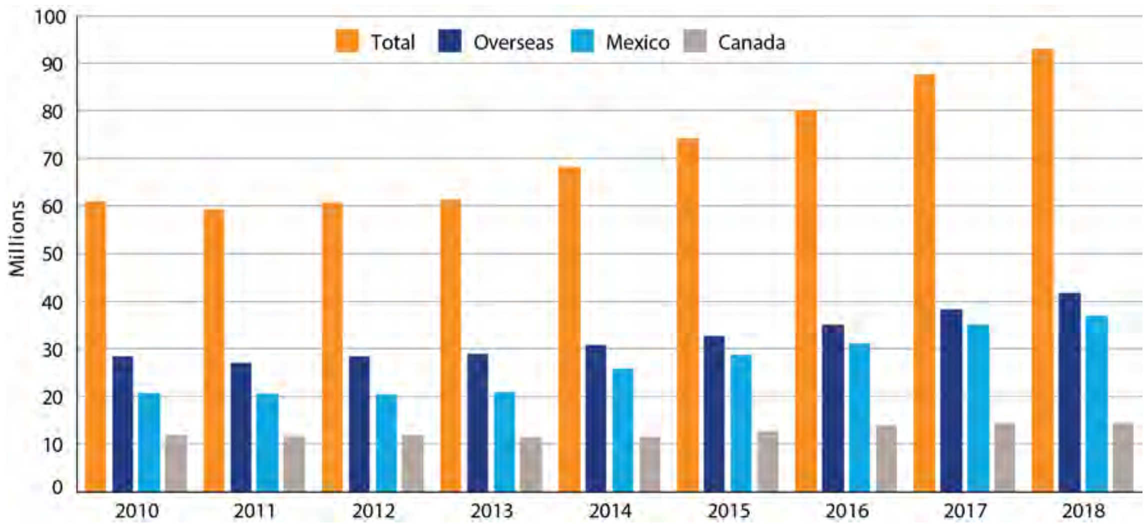
Transportation services and products	Millions of dollars spent by international visitors
International passenger air transportation services	$39,991
Domestic passenger air transportation services	$5,204
Gasoline	$719
Passenger water transportation services	$599
Automotive repair services	$480
Scenic and sightseeing transportation services	$183
Intercity charter bus transportation	$142
Automotive vehicle rental	$130
Intracity mass transit	$114
Other vehicle rental	$70
Taxicab and ride sharing service	$64
Passenger rail transportation services	$59
Intercity bus transportation	$58
Parking lots and garages	$54
Highway tolls	$36
Total spending on transportation services and products	$47,903
Total spending on all services and products	$198,264

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, *Tourism Satellite Accounts 2018*, Table 3, available at https://www.bea.gov/tourism-satellite-accounts-data-sheets as of October 2020.

As noted in figure 3-19, U.S. outbound travel reached 93 million in 2018, up from 88 million in 2017. Most of the growth occurred in overseas and trips to Mexico. National Travel and Tourism Office (NTTO) trend data indicate that the outbound market has been strong since 2014, with nearly 93 million U.S. outbound travelers exceeding inbound visitors by about 13 million in 2018 [USDOC NTTO 2019].

Average U.S. international airfare was $1,085 per trip in 2017, down 3 percent from 2016. The average expenditure (travel payments) per traveler, per trip, while overseas was $1,476, up slightly from 2016 [USDOC BEA 2019]. The U.S. carrier share of all international air travel with the United States led that of foreign flag carriers until 2018, when foreign carriers gained a greater share of the travel market than U.S. carriers [USDOT BTS 2020].

FIGURE 3-19 U.S. Resident Travel Abroad by Select Country/Region: 2010 to 2018



SOURCE: U.S. Department of Commerce, National Travel and Tourism Office, 2019 U.S. Travel and Tourism Statistics (U.S. Resident Outbound), available at https://travel.trade.gov as of February 2020.

Data Gaps

What We Don't Know About Passenger Travel

While the understanding of local travel is informed by 60 years of travel surveys in major metropolitan areas, by nationwide data on journeys-to-work collected by the Census Bureau since 1970, and by several iterations of the National Household Travel Survey and its predecessors, the understanding of long-distance travel is limited to airline passenger counts and itineraries and to sporadic national surveys last conducted in 1995. Consequently, BTS does not know how much travel on local transportation infrastructure is by visitors traveling through the area or visiting from a distant place.

While information on airline passenger counts and itineraries is extensive, airport managers and aviation planners lack basic information that is not currently required by law or regulation to collect on the demographics and trip purposes of their customers, which limits forecasting and effective understanding of airport markets.

Since the last long-distance travel survey was conducted in 1995, cruise ships have grown into a major generator of long-distance travel. Information is limited to vessel and passenger counts by port. As the industry recovers from the current cessation of operations from the pandemic, information on the demographic and economic characteristics of cruise ship patrons will become a significant element of port planning and marketing.

The intercity travel arena also needs a comprehensive design and development of annual statistical reporting on the use of national parks and recreation areas. Existing data are fragmentary in coverage and scope. At a minimum, an inventory of available reporting, including state statistics, would permit a way to better design ongoing reporting.

With respect to local travel, the arrival of new micromobility transportation, typically in the urban environment, such as bike-share and electric scooter rentals, appears to be significant and warrants better understanding. These modes have grown exponentially in some locations. Given their interactions with other more traditional modes as both a support tool and a competitor, annual reporting, beyond the anecdotal, would be beneficial to establish the roles played by these transportation providers.

There is no publicly available national data set with Transportation Network Company (TNC) driver, company, or coverage information. TNCs will only share data if required by law. TNCs will share a subset of data for specific purposes with agreements that restrict data usage. Data aggregation by geography and/or time is common theme for all TNC data, whether it is shared voluntarily or by law.

Working at home has become the third largest "mode" of work access after driving alone and carpooling. While Census data are effective at describing those who work at home with no other place of work location, it is likely that the number who work at home as a partial schedule each week or who work at home on an occasional or as-needed basis is far larger. Establishing the full scale of these activities on a sound statistical basis would greatly aid planning and policymaking. The COVID-19 experience has expanded interest in gaining knowledge of telecommuting and its opportunities and shortcomings.

For both local and long-distance travel, data on travel costs on per-trip and per-mile bases for all modes could help better inform travel decisions. The increased role of toll roads and variable toll lanes are an increasingly important element of travel costs.

The gaps in data on passenger travel are critical as the Nation's transportation system undergoes major changes from long term demographic trends to the immediate effects of the pandemic. Demands for transportation facilities and services are difficult to anticipate without information on travel by the aging population, the ongoing movement from cities to suburbs, the growth of working at home, and trends in international and domestic tourism.

References

Amtrak, *FY 2018 Company Profile Fiscal Year 2018* Highlights, Available at http://media.amtrak.com/ as of November 2019.

Bowden, John. *Survey: 11 Percent of Americans Have Not Traveled Outside Home State* (May 2019). The Hill. Available at https://thehill.com/ as of August 2020.

Cruise Line International Associations (CLIA). *State of Cruise Industry Outlook 2020*. Available at https://cruising.org/ as of July 2020.

National Academies of Sciences (NAS), Engineering, and Medicine 2019. Analysis of Recent Public Transit Ridership Trends. Washington, DC: The National Academies Press. Available at https://doi.org/10.17226/25635 as of June 2020.

National Association of City Transportation Officials (NACTO), Shared Micromobility in the U.S. 2018. Available at https://nacto.org/shared-micromobility-2018/ as of November 2019.

United Nations World Tourism Organization (UNWTO), UNWTO Tourism Data Dashboard 2019, Available at https://www.unwto.org/ and https://www.unwto.org/ as of November 2019.

U.S. Department of Commerce (USDOC); U.S. Census Bureau (CENSUS):

—*American Communities Survey (ACS)*(2019). Available at https://data.census.gov/ as of August 2020.

—*Population projections*, 2017 National Tables (Revised), Available at https://www.census.gov/ as of November 2019.

—*Geographical Mobility*: 2017 to 2018 (November 2018). Available at https://www.census.gov/ as of November 2019.

U.S. Department of Commerce (USDOC), Bureau of Economic Accounts, (BEA), Travel and Tourism Satellite, *U.S. Travel and Tourism Satellite Account 1998-2018, November 2019*, Available at https://apps.bea.gov/ as of November 2019.

U.S. Department of Commerce (USDOC), National Travel and Tourism Office (NTTO), Inbound and Outbound Travel of the United States, available at https://travel.trade.gov/about/overview.asp as of June 2020.

U.S. Department of Labor (USDOL); Bureau of Labor Statistics (BLS):

—Monthly Labor Review, *Ability to work from home: evidence from two surveys and implications for the labor market in the COVID-19 pandemic* (June 2020). Available at https://www.bls.gov/ as of August 2020.

—Occupation Projections, Table 1.1, 1.3, 1.7 Occupational projections, 2018–28, and worker characteristics, 2018. Available at https://www.bls.gov/ as of November 2019.

—Consumer Expenditure Surveys annual, 2018, Available at https://www.bls.gov/cex/tables.htm as of September 2019.

U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS):

—Airline Information (2020), Available at https://www.bts.gov/as of August 2020.

U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA):

—2018a, 2017 National Household Travel Survey. Available at https://nhts.ornl.gov/ as of September 2018.

—2018b, *2017 National Household Travel Survey Summary of Travel Trends* (STT). Available at https://nhts.ornl.gov/ as of September 2018.

—2017, Eisenhower Interstate Highway System-Interstate Density Map; The Changing Face of America. Available at https://www.fhwa.dot.gov/ as of November 2019.

U.S. Travel Association (USTTA), *U.S. Travel & Tourism Overview* (2019), available at https://www.ustravel.org/ as of August 2020.

Smithsonian Institution, *Air Travel in a Changing America* (2007), available at https://airandspace.si.edu/ as of October 2020.

CHAPTER 4

Freight

Introduction

In 2018 the Nation's transportation system moved about 51.0 million tons of goods worth $51.8 billion each day, or about 56.9 tons of freight per capita in the United States. Transportation supports the consumption of goods by households and government agencies, the worldwide export of American products, and the domestic and international supply chains that connect raw materials, farms, manufacturing facilities, wholesale establishments, and retailers to consumers and global markets.

As this report goes to press, the full effects of the COVID-19 pandemic on freight movement are not yet clear. It can be stated with certainty, however, that freight movement among manufacturers and wholesalers declines when sources of imports are disrupted by factory closures, when domestic manufacturing is disrupted by stay-at-home orders, and when declines in household income and pandemic-induced unemployment cut consumption of goods. Some of the decline in freight movement will likely be offset by increases in the demand for medical supplies and other goods and by innovations aimed at keeping goods moving. For example, anecdotal evidence suggests that home delivery of groceries and other consumer goods by local trucking has replaced a significant amount of personal shopping trips (see box 4-A). The net effect of COVID-19 on freight movements in 2020 and the years ahead will require careful review and analysis by the Bureau of Transportation Statistics and other agencies within the U.S. Department of Transportation as data becomes available.

Highlights

- The U.S. freight transportation system moved more than 18.6 billion tons of goods valued at $18.9 trillion (real dollars) in 2018, or an average of 56.9 tons of freight per capita in the United States in 2018, a 4.0 percent increase from 2016.
- Approximately two-thirds of freight shipped by rail in the United States originates in rural America, and about 25 percent of goods shipped by truck either originates in or is destined for rural domestic markets.

continued on next page

Highlights (*continued*)

- Effects of the pandemic on freight movement are not yet clear, but short-term changes resulting from the stay-at-home requirements have already emerged (e.g., recent upswings in e-Commerce and home deliveries). However, any lasting effects on annual measures and in long-term trends will only be revealed in future statistics.
- E-Commerce sales increased 20-fold between 2000 and 2019 as the retail portion of electronic commerce rose from 0.9 to nearly 10.9 percent. Estimated quarterly e-Commerce sales show accelerating growth between the first and second quarters of 2020, rising from 11.8 to 16.1 percent of total retail sales.
- Trucks carried 60.8 percent of the weight and 60.9 percent of the value of all goods shipped in the United States in 2018 and continue to be the primary mode for transporting goods less than 1,000 miles, while rail moves the most commodities by tonnage and ton-miles from 1,000 to 2,000 miles. Air and multiple modes accounted for 50.0 percent of the value of shipments moved over 2,000 miles
- Rail intermodal volumes have grown sharply in recent years due to growth in container trade and increased rail access both within and outside port boundaries. Class I railroads reported rail intermodal traffic accounted for 24 percent of revenues in 2018, more than any other single commodity group.

Box 4-A E-Commerce

E-Commerce was a growing component of freight transportation long before the pandemic accelerated the substitution of local truck movements for consumer trips to the store. E-Commerce sales increased by 20-fold from approximately $27.4 billion in 2000 to nearly $545.1 billion in 2019 as its share of total retail sales increased from 0.9 to 10.9 percent. Over the same period, total retail sales grew 83.5 percent, increasing from $2,979.4 billion in 2000 to $5,450.5 billion in 2019.

E-Commerce sales accelerated to $211.5 billion in the second quarter of 2020, an increase of $51.4 million (32.1 percent) over the previous quarter. These first two quarters show 14.8 and 44.5 percent increases over the same quarters a year ago. Second quarter 2020 e-Commerce sales accounted for 31.8 percent of total retail sales ($1,310 million) [USDOC CENSUS 2020b August]. The substantial increase in e-Commerce sales is linked to the more than doubling of the amount of deliveries to households in an average month between 2009 and 2017, according to the latest Federal Highway Administration's National Household Travel Survey. In addition, 55 percent of NHTS respondents indicated they had made at least one online purchase in the last 30 days, with most making, on average, five purchases. This is a 12 percent increase compared to the 2009 NHTS survey results, where only 43 percent reported similar behavior [USDOT FHWA 2018].

As measured by the Freight Analysis Framework (FAF, see box 4-b) and shown in table 4-1, the weight and value of freight movement has grown over time. From 2012 to 2018, both the value and tonnage of shipments increased by 6.6 and 9.8 percent, respectively. The pipeline mode recorded the largest growth rate of nearly 20.8 percent by value and 13.0 percent by weight over the same period. Based on economic conditions before the COVID-19 pandemic occurred, FAF projected continued growth.

TABLE 4-1 Weight and Value of Shipments by Transportation Mode: 2012, 2018, and 2045

Weight

	2012				2018				2045			
Millions of tons	Total	Domestic	Exports[1]	Imports[1]	Total	Domestic	Exports[1]	Imports[1]	Total	Domestic	Exports[1]	Imports[1]
Total	16,952	14,895	889	1,169	18,616	16,474	1,037	1,104	25,472	20,932	2,282	2,259
Truck	10,098	9,893	115	90	11,320	11,108	101	111	14,836	14,226	304	306
Rail	1,625	1,481	57	87	1,580	1,404	67	108	1,926	1,588	112	226
Water	959	502	76	380	1,020	542	218	261	1,183	609	201	373
Air, air & truck	11	2	5	4	12	2	5	5	41	4	19	18
Multiple modes & mail	1,317	309	584	425	1,368	328	601	440	2,895	431	1,435	1,028
Pipeline	2,901	2,672	50	179	3,277	3,061	39	177	4,559	4,058	205	296
Other & unknown	42	37	2	3	39	30	7	2	32	16	5	11

Value

	2012				2018				2045			
Billions of 2012 dollars	Total	Domestic	Exports[1]	Imports[1]	Total	Domestic	Exports[1]	Imports[1]	Total	Domestic	Exports[1]	Imports[1]
Total	17,729	13,965	1,545	2,219	18,907	14,838	1,658	2,412	37,064	22,469	6,511	8,084
Truck	10,929	10,251	366	311	11,520	10,784	361	375	18,682	16,219	1,244	1,219
Rail	582	411	63	109	613	434	64	115	1,080	646	157	278
Water	631	270	73	288	664	300	154	210	1,031	340	281	411
Air, air & truck	1,067	135	461	472	1,184	140	482	562	5,221	324	2,544	2,354
Multiple modes & mail	3,246	1,746	552	947	3,342	1,794	501	1,047	8,981	3,393	2,123	3,465
Pipeline	1,233	1,150	13	70	1,489	1,387	22	80	1,744	1,546	88	110
Other & unknown	40	1	17	22	96	1	74	22	325	0	76	248

[1] 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 2016 data are provisional estimates based on selected modal and economic trend data. Data in this table are not comparable to similar data in previous years because of updates to the Freight Analysis Framework. 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 in other published sources.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5.1., December 2019.

Box 4-B Freight Analysis Framework

The Freight Analysis Framework (FAF), produced through a partnership between the Bureau of Transportation Statistics and Federal Highway Administration, integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. Starting with data from the Commodity Flow Survey (CFS) and international trade data from the Census Bureau, FAF incorporates data from agriculture, extraction, utility, construction, service, and other sectors.

FAF version 4 (FAF4) provides estimates for tonnage, value, and ton-miles by regions of origin and destination, commodity type, and mode. Data are available for the base year of 2012, the recent years of 2013–2018, and forecasts from 2020 through 2045 in 5-year intervals. Data may be accessed through the FAF Data Tabulation Tool, a set of new interactive web-based dashboards, and downloadable summary files or complete databases.

Basic Characteristics of Freight Transportation

Freight moved to, from, and within the United States varies in weight and value, from low-value, heavy bulk commodities, such as stone and gravel, to high-value, light weight commodities, such as pharmaceuticals. Some commodities have special shipping requirements, such as refrigeration for perishable food and specialized equipment for hazardous cargo. The value and weight of shipments affect the choice of transportation modes used.

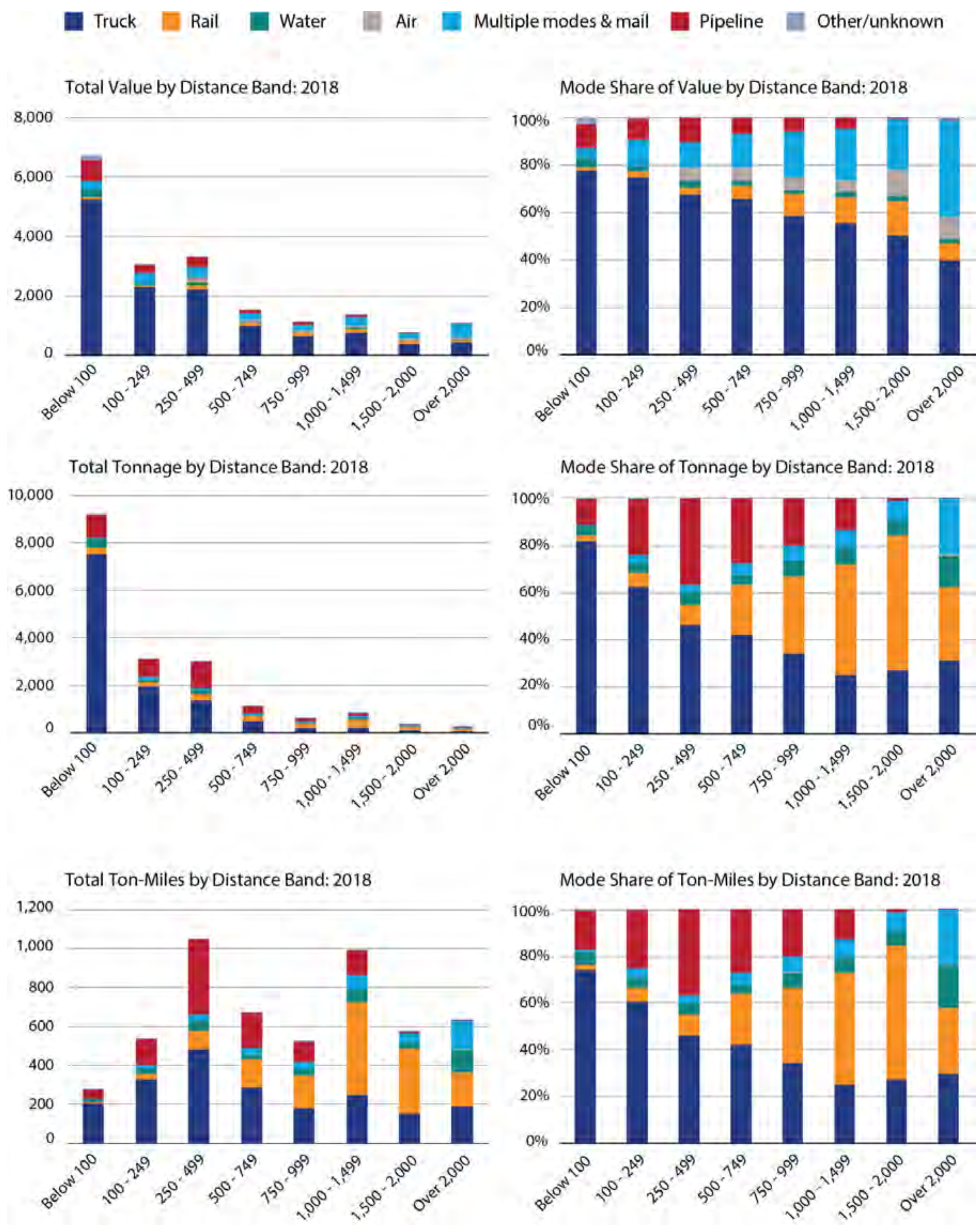
Distances of Freight Movement and Modes of Transportation Used

A large percentage of goods movement occurs close to home. More than 6,700 billion dollars' worth and about 9,200 million tons, or half of the weight and more than one-third of the value of goods, were moved less than 100 miles between origin and destination in 2018 (figure 4-1). By contrast, 1,401 million tons (7.6 percent) of the weight and $3,167 billon (16.8 percent) of the value of goods were moved 1,000 miles or more. Modal shares of freight vary considerably by distance. Trucks carry the largest shares by value, tons, and ton-miles[1] of all goods shipped in the United States and are the predominant mode for shipments under 1,000 miles. Rail leads in tonnage and ton-miles for goods shipped from 1,000 to 2,000 miles. Air and multiple modes accounted for 50.0 percent of the value of shipments moving over 2,000 miles [USDOT BTS and FHWA 2019]. The multiple modes category is defined as freight that is transferred between two or more modes on the journey between an origin and destination.

Trucks continue to carry the highest percentages of goods by weight and value in the United States, transporting 11.3 billion tons of the weight (60.8 percent) and $11.5 trillion of the value of freight (60.9 percent) in 2018 (table 4-1).

[1] A ton-mile is defined as 1 ton of freight shipped 1 mile. It reflects both the volume and distance shipped.

FIGURE 4-1 Value and Weight of Domestic Shipments by Mode: 2018

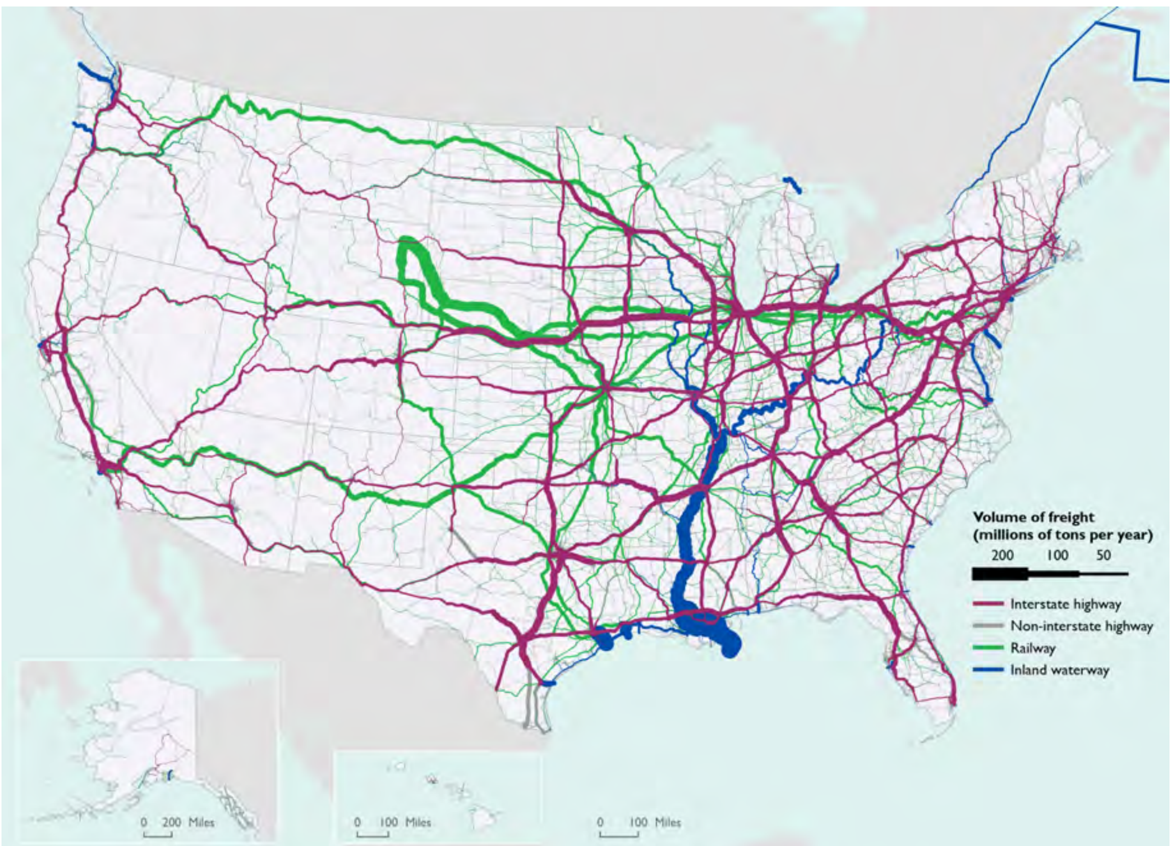


SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5.1, December 2019.

However, railroads and inland waterways carry large volumes of bulk commodities over long distances. Figure 4-2 helps to visualize the large volume of coal moved by rail between the Powder River Basin in Wyoming and the Midwest in addition to the grains and energy products moved by vessel and barge along the Lower Mississippi River. The sum of freight moved by rail and water combined accounted for 14.0 percent of the total tonnage and 6.8 percent of the total value of freight moved in the United States in 2018.

Shipments moving by water are typically low-value, bulk products, comparable to those moved by rail. In 2018 the water transportation industry moved 1.0 billion tons of freight worth $664 billion ($651 per ton), representing 5.5 percent of the tonnage and 3.5 percent of the value of all freight shipments [USDOT BTS and FHWA 2019]. In 2018 approximately 607.9 million short tons of cargo were moved by vessel along the inland waterways, including the Mississippi River—the Nation's busiest waterway [USACE WCSC 2020].

FIGURE 4-2 Freight Flows by Highway, Railway, and Waterway: 2018



NOTE: Highway flows depicted in this map are based on the Freight Analysis Framework (FAF) data for 2015—the latest year for which the FAF network flow data is available.

SOURCES: Highway—U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.3.1, 2015. Rail—Based on Surface Transportation Board, Annual Carload Waybill Sample and rail freight flow assignment done by Oakridge National Laboratory, 2018. Inland Waterways—U.S. Army Corps of Engineers, Institute of Water Resources, Annual Vessel Operating Activity and Lock Performance Monitoring System data, 2018.

Air carriers almost exclusively move high-value, low-weight products. This is underscored by a value-to-weight ratio of nearly $99,000 per ton for air cargo versus $1,016 per ton of cargo for all modes combined. In 2019 U.S. and international airlines[2] carried nearly 76.7 billion revenue ton-miles.[3] Of these, U.S. airlines handled about 16.4 billion revenue ton-miles in domestic cargo, an increase of about 2.8 percent over 2018 domestic totals [USDOT BTS 2019a].

In 2018 pipelines moved about 3.3 billion tons of goods—mostly crude oil, petroleum products, and natural gas—valued at nearly $1.5 trillion, a value-to-weight ratio of $454 per ton, while rail moved approximately 1.6 billion tons valued at $613 billion, a value-to-weight ratio of $388 per ton [USDOT BTS and FHWA 2019].

It is important to note that freight moved by more than one mode including exports and imports that change modes at international gateways, is included in the “multiple modes & mail category to avoid double counting. Thus, the rail and water totals are less than what they may be in other published sources.

[2] Based upon all T-100 schedule types, including scheduled and non-scheduled. Additional information available at https://www.transtats.bts.gov/traffic.

[3] A revenue ton-mile is defined as 1 ton of revenue cargo carried 1 mile.

While freight moved to, from, and within the United States via multiple modes[4] accounted for 7.3 percent of freight tonnage, it accounted for 17.7 percent of the value of goods in 2018. The total value of multiple modes and mail shipments is estimated to increase by more than two and a half times between 2018 and 2045, from $3.3 trillion in 2018 to nearly $9.0 trillion in 2045 [USDOT BTS and FHWA 2019].

The growth in intermodal[5] rail freight movement (e.g., containers moved by some combination of rail, truck, and water modes) is driven, in part, by global demand for goods and by expanded rail access both within and outside port boundaries. The Association of American Railroads (AAR) reported that U.S. rail intermodal volume has grown sharply in recent years, increasing by 61.1 percent between 2000 and 2018. Rail intermodal traffic accounted for 24 percent of U.S. Class I[6] railroad revenue in 2018, more than any other

[4] The FAF category for multiple modes and mail includes all multimodal movements, including parcel deliveries that might only be transported via truck and is not limited to traditional intermodal services, such as trailer-on-flatcar and container-on-flatcar rail.

[5] Rail intermodal includes the transportation by rail of shipping containers and truck trailers.

[6] According to the Association of American Railroads, Class I railroads had a minimum operating revenue of $489.94 million in 2018 (the latest year for which data are available).

single commodity group including coal, which had been the largest single source of rail revenue in previous years [AAR 2019a]. With the growth in container trade, the rapid rise of e-Commerce, and improvements in information and logistics technologies, greater reliance on intermodal connections is expected to continue.

Commodities Moved Domestically

Figure 4-3 shows the top 10 commodities moved on the U.S. transportation system in 2018. The leading commodities by weight, comprised mostly of bulk products, accounted for nearly 12.7 billion tons (68.0 percent) of total tonnage and more $4.87 billion (25.8 percent) of the Nation's freight value. Electronics was the top commodity moved by air (including truck-air) and multiple modes and mail modes in 2018.

The commodity mix is different when looking at the value of goods shipped. The top commodities by value are mostly high-value-per-ton goods that often call for rapid delivery, including electronics; motorized vehicles; mixed freight;[7] gasoline, kerosene, and ethanol; and machinery. That year the top 10 commodities by value accounted for 57.9 percent of total value but only 36.8 percent of total tonnage [USDOT BTS and FHWA 2019].

Characteristics of Freight Movement in Rural Areas

This section discusses how commodities produced in rural areas are moved to other locations for further processing, sale, or export. Natural resources and agricultural commodities are a mix of high-bulk, low-value resources, such as cereal grains and coal, and high-value commodities, such as perishable fruits and vegetables. Many of the requirements of transportation vary depending on the type of commodity being moved, the availability of transportation services, the distance from markets, and the cost of service.

An interconnected network of trucks, trains, barges, and pipelines transports our Nation's agricultural commodities, energy resources, and many manufactured goods from rural areas, where they are produced, to metropolitan areas and export markets. Commodities and raw materials are found in widely dispersed but fixed locations. Consequently, they require an extensive and efficient freight transportation system to support and facilitate their movement. This section focuses on the following three major commodities:

- grains,
- coal, and
- timber/lumber products.

The production and transportation of these three commodities are important inputs to the U.S. economy and to our Nation's competitiveness in the global marketplace. We depend on grains as a major food source for humans and animals and as a feedstock for fuels, coal is used to produce electricity to heat and light our homes, and lumber is used to build houses and furniture.

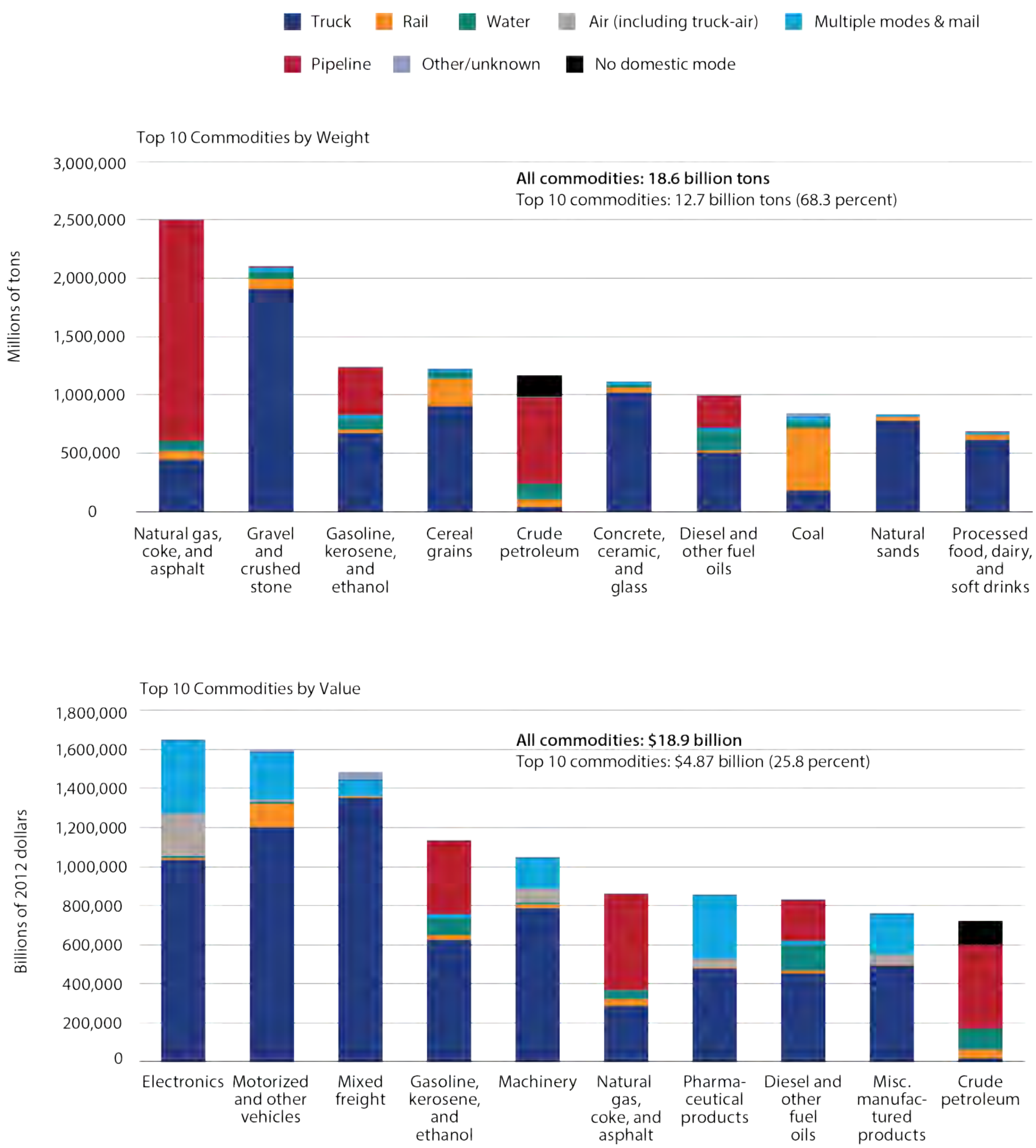
Rural areas depend primarily on rail and truck to transport heavy and bulky commodities, such as agricultural products, coal, and timber. Approximately two-thirds of freight shipped by rail in the United States originates in rural America. About 25 percent of the freight shipped by truck either originates or is destined for rural markets [USDOT BTS 2019d]. Barges and other vessels carrying bulk commodities along U.S. inland and intracoastal waterways are also an integral part of the rural transportation network, and U.S. seaports and ocean-going vessels link commodities to global markets.

Transportation of Agricultural Commodities (Grains)

Grains, the focus of this discussion, and other agricultural products are shipped primarily by an interconnected network of truck, rail, and water (barges and oceangoing vessels) routes. Trucks figure into almost every freight flow, moving crops from farms to grain elevators or other collection points where they can be transferred to other modes. According to the U.S. Department of

[7] Mixed freight includes groceries and convenience store goods, food for restaurants, office supplies, and hardware and plumbing items.

FIGURE 4-3 Weight and Value of Top 10 Commodities by Transportation Mode: 2018



NOTE: No domestic mode—includes shipments that have an international mode but no domestic mode and is limited to import shipments of crude petroleum transferred directly from inbound ships to a U.S. refinery at the zone of entry. This is done to ensure a proper accounting of import flows, while avoiding assigning flows to the domestic transportation network that do not use it.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5.1, December 2019.

Agriculture, trucks moved 61 percent of total U.S. grain production in 2016, the latest year for which data are available, rising from 50 percent in 2000. Specifically, grain shippers used trucks to move nearly 71 percent of their corn, 61 percent of their sorghum, and close to 50 percent of soybean crops (figure 4-4).

Rail is typically used for long-distance shipping, and barges are used to carry large amounts of bulk grain to inland water ports and seaports where oceangoing vessels move them to markets throughout the world. The rail and barge shares by tonnage of grain movements were 25 and 14 percent in 2016, respectively [USDA 2019]. For example, wheat growers in the Plains States use rail primarily, reflecting the long distances between their rural farms and waterways. However, in Iowa corn grown in areas that are accessible to the Mississippi River are often trucked to barges for inland markets and to ports for export. Trucks are also used to transport corn to ethanol plants for blending with gasoline or to local farms for animal feed.

Freight railroads carry more corn than any other type of grain, accounting for, on average, 69.7 million tons or 49 percent of total rail grain tonnage from 2009 to 2018. Illinois, Minnesota, Nebraska, and North Dakota together account for about one-half of all originated rail tons of grains, including wheat, corn, soybeans, sorghum, and barley. Washington, Texas, Illinois, and California are the top states for rail terminations of grain, also accounting for about half of the total [AAR 2019b].

Shippers also use barges to move 14 percent of all grains to both inland terminals and seaports to access domestic and international markets. Forty-eight percent of all U.S. grains moved by barge were destined for export.

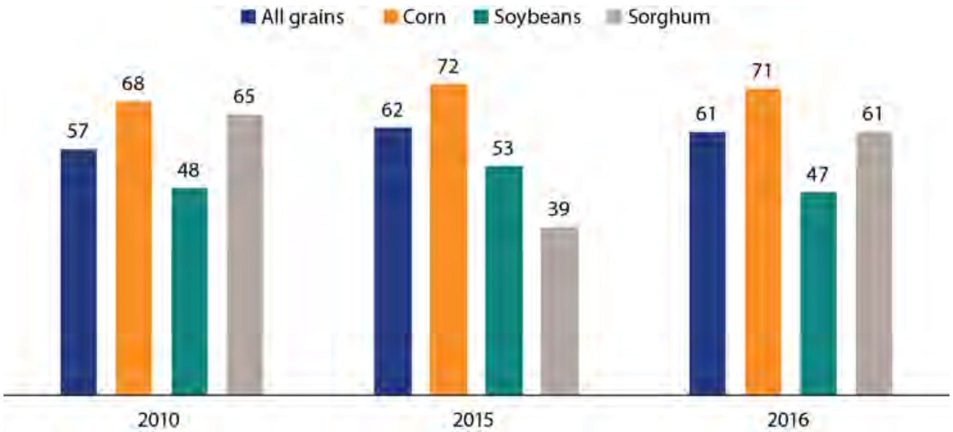
Transportation of Coal

While coal production has declined in recent years, it still maintains an important economic presence in the states where it is mined. According to the U.S. Energy Information Administration (EIA), in 2019 U.S. coal production was 705 million tons, down 39.8 percent from the all-time high of 1.17 billion tons recorded in 2008 [USDOE EIA 2020a]. Coal can be transported from mines and processing plants in rural areas to consumers in several different ways. Typically, trucks are used to haul coal over short distances, while trains and barges are used for longer hauls, with rail moving more coal tonnage than any other mode. Coal mined in Wyoming is transported almost entirely by rail. In 2018, 69.0 percent of coal moved from one location to another was moved by rail for at least part of the way, followed by water via barges at 12.0 percent, and by truck at about 9.4 percent [USDOE EIA 2019a].

The average length of haul for rail coal shipments is 887 miles, although destinations exceeding 1,500 miles are not uncommon, according to the American Association of Railroads (AAR). Most coal moves in open-top rail cars called hoppers or gondolas. While rail coal volumes have declined in recent years, coal is still an important commodity for freight railroads. Coal accounted for 518.4 million tons (31.4 percent) of Class I tonnage and $10.7 billion (16.1 percent) of Class I revenue in 2018 (figure 4-5). However, coal tonnage moved by Class I railroads in 2018 was down by 41.0 percent from a peak of 878.6 million tons in 2008. Measured differently, rail moved 3.3 million fewer carloads of coal in 2018 than in 2008 when 7.7 million carloads of coal moved by rail [AAR 2019c].

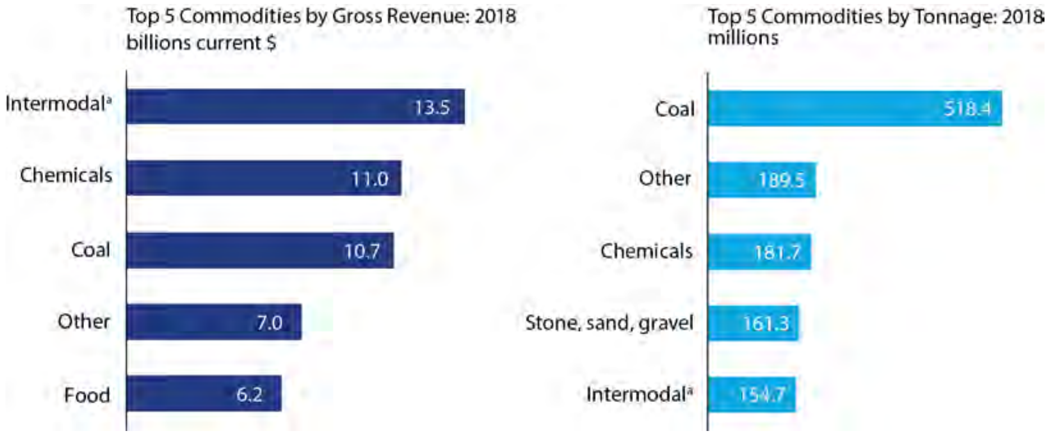
Inland waterways are another important option for shipping coal, but shipping by barge is limited by access to navigable waterways. The latest available data from the U.S. Army Corps of Engineers indicates about 4,146.2 million tons of coal, lignite, and coke were moved in 2018 on inland waterways, an increase of 39.9 percent from 2017 tonnage [USACE WCSC 2020]. Many coal mines in the Appalachian region are located close to a river system and can take advantage of both water and rail modes. Conversely, mines in the Powder River Basin in Wyoming and Montana are not near a river system and have few options for rail access other than the BNSF and Union Pacific (UP) railroads [USDA 2010]. Almost all the coal produced in Wyoming is transported by rail to electric power

FIGURE 4-4 Percent of U.S. Grain Tonnage Moved by Truck: 2010, 2015, 2016



SOURCE: U.S. Department of Agriculture, Transportation of U.S. Grains, A Modal Share Analysis: 1978-2016. April, available at http://www.ams.usda.gov as of October 2020.

FIGURE 4-5 Top Commodity Categories Transported by Class I Rail by Gross Revenue and Tonnage: 2018



[a] AAR defines rail intermodal as the transportation of shipping containers and truck trailers by rail. Some intermodal is included in other commodities.

SOURCE: Association of American Railroads. *Railroads and Coal*. May 2019, available at www.aar.org as of November 2019.

plants in the Midwest,[8] and some of the coal from the Powder River Basin is moved by rail to the Great Lakes for shipping to power plants.

Transportation of Timber

Commercial timber resources are almost always located in rural areas, including many remote locations with limited transportation options. The United States is the second largest exporter of wood in the world, with primary markets in Japan, Mexico, Germany, and the United Kingdom.

At logging sites located away from rivers, timber is loaded onto specially configured semi-trailer trucks for transport to processing mills or storage facilities. These first miles are usually on county roads not designed to carry heavy truckloads, resulting in increased road maintenance costs and traffic congestion in rural areas. In recent years, more lumber has been moved by truck because of the closure of rail branch lines and the cost of service, among other factors.

If the logging site is located near a river, the logs are assembled into log barges and either floated downriver or pulled upriver by a tugboat to either a processing mill or to inland water ports and major seaports for export. From the processing mill, timber is moved by either truck or rail to a manufacturing facility that converts the timber to wood and paper products or to an export distribution center.

The Association of American Railroads reported U.S. Class I railroads moved 1.2 million carloads of lumber and paper products in 2018, which is about 4 percent of total U.S. rail carloads [AAR 2019d]. By rail, lumber is moved by one of three types of rail cars: center-beam, boxcar, and bulkhead flatcars. Center-beam rail cars are preferred for transporting building supplies, lumber, and wallboard because they can be loaded and unloaded simultaneously from both sides, which allows them back in service more quickly.

International Freight

The value of total U.S.-international freight increased from nearly $2,704.0 billion in 2000 to $4,566.4 billion in 2019—a 68.9 percent real growth in freight merchandise trade (in 2012 dollars) [USDOC CENSUS FTD 2020a]. Table 4-2 shows total U.S.-international freight by geography and mode. Vessels transported $915,715 million (58.9 percent) between the United States and Asia, whereas air transported $544,911 million (35.1 percent). More comparable dollar amounts were transported by vessel and air (42.2 v. 50.1 percent) between the United States and Europe.

[8] Coal slurry pipelines were once used to transport coal mined in the West, but they have not been used for at least a decade due to concerns about water usage and costs.

TABLE 4-2 Value of U.S.-International Freight Flows by Geography and Transportation Mode: 2019
(millions of dollars)

	Mode						
Geography	Truck	Rail	Pipeline	Air	Vessel	Other	Total
Canada	343,075	96,299	67,362	33,315	30,938	40,870	612,061
Mexico	429,199	82,269	5,048	16,186	64,840	16,998	614,541
Asia	NA	NA	NA	544,911	915,715	93,450	1,554,075
Europe	NA	NA	NA	493,581	418,391	74,005	985,978
Other	NA	NA	NA	79,581	275,221	19,235	374,037

KEY: NA = Not Applicable.

NOTE: Transportation mode in this table represents the mode by which freight arrived to or departed from the United States, therefore truck, rail, and pipeline are only available for U.S. freight flows with Canada and Mexico.

SOURCE: Truck, Rail, and Pipeline—U.S. Department of Transportation, Bureau of Transportation Statistics, TransBorder Freight Data, available at www.bts.gov/transborder; Air, Vessel, and Other—U.S. Department of Commerce, Census Bureau, *USA Trade Online*, https://usatrade.census.gov/ as of October 2020.

U.S.–North American Freight Transportation

Our North American neighbors, Canada and Mexico, accounted for 29.4 percent (more than $1.2 trillion) of the value of U.S.-international freight in 2019, down 0.2 percent from 2018. For 2019 U.S.-Canada freight flows totaled $612.1 billion, and U.S.-Mexico freight flows totaled $614.5 billion. In 2019 the value of goods transported between the United States and Mexico was greater than the value of goods moved between the United States and Canada [USDOT BTS 2019b].

By value, truck and air carried more U.S. freight with Canada and Mexico in 2019 than in 2018, falling by 0.2 percent overall for all modes [USDOT BTS 2019b]. An increase in the volume of crude oil imported from Canada and Mexico in 2018 over 2017 totals played a role in the increase in the value of goods moved by vessel (27.6 percent) and pipeline [USDOE EIA 2020c]. Crude oil imports by volume from Canada and Mexico increased by 7.6 and 9.5 percent, respectively, between 2018 and 2019.[9]

[9] The monthly and annual volumes and prices of U.S. crude oil imports are available from the Energy Information Agency at www.eia.gov.

Trucks are a primary mover of goods to and from both Canada and Mexico, accounting for 62.9 percent of the value ($772 billion) and 25.1 percent of the tonnage (226 million tons) in 2019, an increase of 37.9 and 20.2 percent, respectively, compared to 2010 (table 4-3).

Freight Transportation Gateways

A large volume of U.S.-international freight passes through a relatively small number of gateways—the entry and exit points between the United States and other countries. Per the U.S. Census Bureau, 467 ports-of-entry, including airports, land border crossings, and seaports, handle U.S.-international cargo [USDOC CENSUS FTD 2019]. The latest available data show that in 2018 the top 25 gateways handled 64.4 percent of U.S.-international freight by value—about $2.71 trillion of the nearly $4.21 trillion (in current dollars) (figure 4-6). Twenty of the top 25 gateways handled more imports than exports in 2018.

Water is the leading transportation mode for U.S.-international freight trade both in terms of weight and value. Ships moved 41.9 percent of freight value (nearly $1.8 trillion) and 70.9 percent of

TABLE 4-3 Value and Weight of U.S. Freight Flows with Canada and Mexico by Transportation Mode: 2010, 2018, and 2019
(billions of current U.S. dollars and millions of short tons)

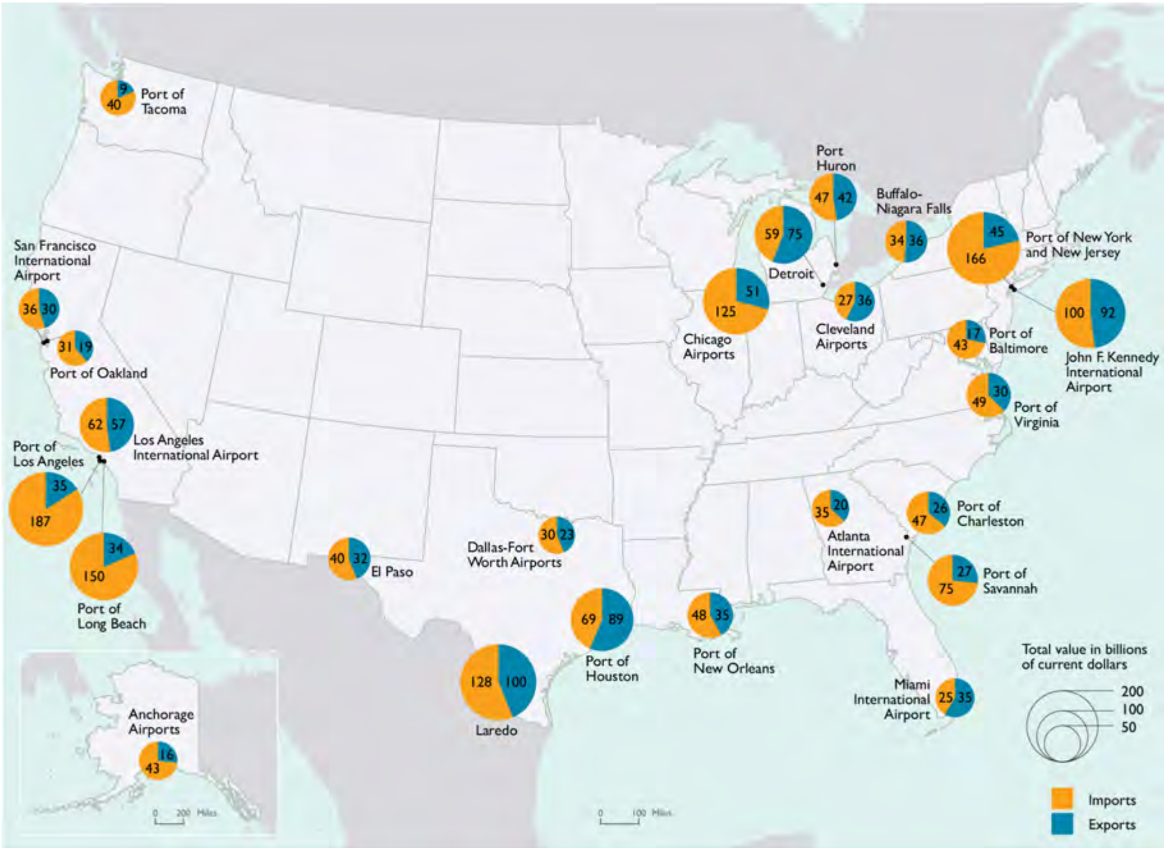
	2010		2018		2019	
Mode	Value	Weight	Value	Weight	Value	Weight
Truck[1]	560	188	772	235	772	226
Rail[1]	131	134	179	181	179	188
Air	45	0	47	0	50	0
Water	81	210	97	232	96	231
Pipeline[1]	65	106	73	210	72	230
Other[1]	37	11	61	22	58	24
TOTAL[1]	921	650	1,229	880	1,227	900

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

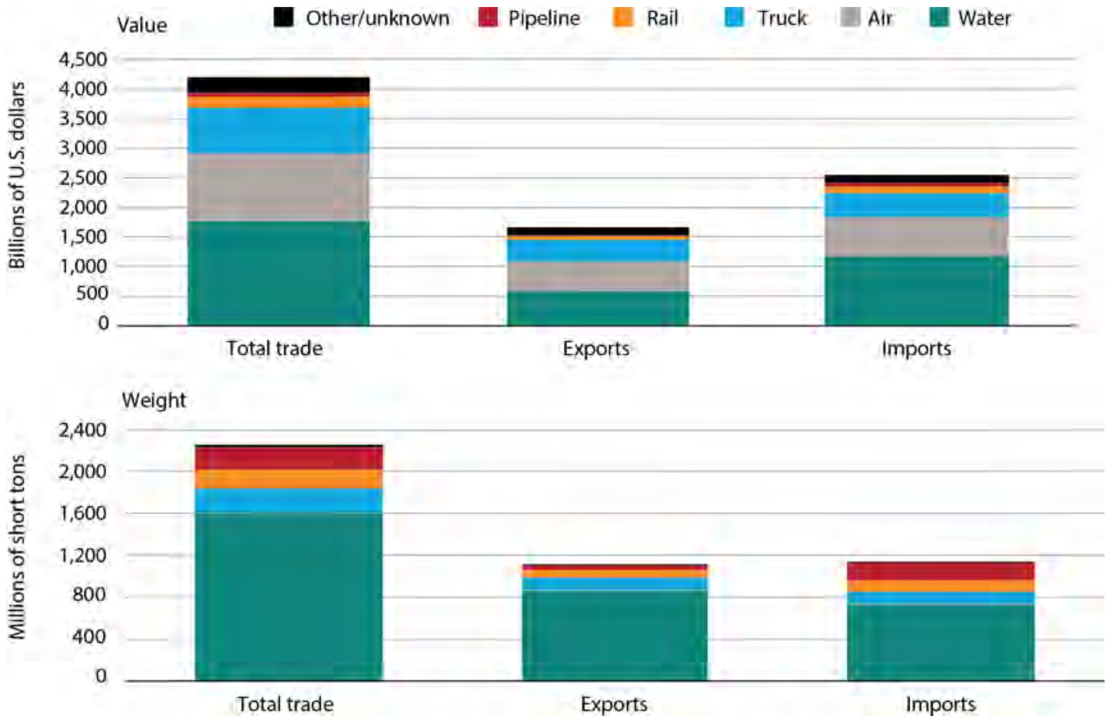
SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, TransBorder Freight Data, available at www.bts.gov/transborder as of March 2020.

FIGURE 4-6 Top 25 U.S.-International Freight Gateways by Value of Shipments: 2018



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, table 1-51, available at https://www.bts.gov/ as of February 2020.

FIGURE 4-7 Value and Weight of U.S.-International Freight Flows by Transportation Mode: 2018



NOTES: 1 short ton = 2,000 pounds. 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. "Other/unknown" includes shipments transported by mail, other and unknown modes, and shipments through Foreign Trade Zones.

SOURCES: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5.1, December 2019.

the total freight weight (1.6 billion tons) in 2018 (figure 4-7). By value, the Port of Los Angeles on the Pacific coast was the leading U.S. water gateway, handling more than $222.5 billion in freight, while the Port of New York/New Jersey on the Atlantic coast was the second leading water gateway, handling more than $211.6 billion in cargo. Both ports handled primarily imports.

Air handles less than one-half of one percent of international freight weight but 27.5 percent of freight value due to its focus on high-value, time-sensitive, and perishable commodities. In 2018 New York City's John F. Kennedy International airport was the top U.S.-international air gateway by value, handling $192.4 billion in exports and imports, followed by Chicago area airports ($176.6 billion) and Los Angeles International ($119.6 billion) (figure 4-7). By freight tonnage, Memphis International, TN, Ted Stevens Anchorage International, AK, and Louisville International, KY, were the top U.S.-international air gateways, handling about 24.4, 18.4, and 14.6 million short tons of cargo, respectively, in 2018. Memphis is a major hub for FedEx, while Louisville is at the center of United Parcel Service's air freight network. Anchorage is a major international gateway for trade with Asia. Between 2000 and 2018, all three airports recorded increases in cargo by landed weight[10]: Memphis—93.4 percent, Anchorage—13.9 percent, and Louisville—83.6

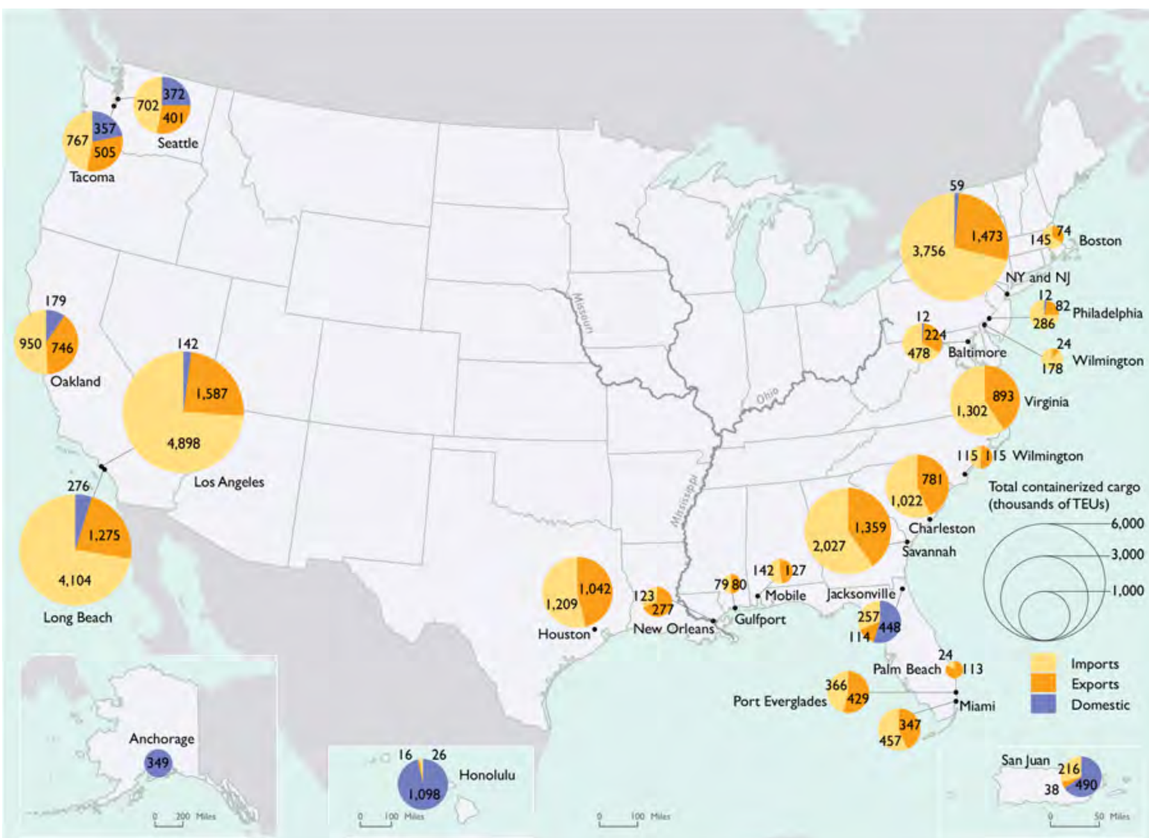
[10] Aircraft landed weight is the certificated maximum gross land weight of the aircraft as specified by aircraft manufacturers.

percent [USDOT FAA 2019]. Laredo, TX, continues to be the top land-border crossing, handling $228.0 billion in freight between the United States and Mexico, while Detroit, MI, ranked second with $134.0 billion (figure 4-6).

Waterborne Freight Transportation

Because of the growth in international trade, the number of vessels calling at the top 25 U.S. ports ranked by tonnage and twenty-foot equivalent unit (TEU) has increased slightly in recent years. Container vessel calls at the top 25 ports by TEU increased by 0.5 percent between 2017 and 2018, with 18,617 calls in 2018 [USACE WCSC 2019a]. Container ports are concentrated along the Atlantic and Pacific coasts, handling high-value, international cargo transported in shipping containers stowed on containerships, such as manufactured goods, electrical machinery, and textile products. On the Pacific coast, the ports of Los Angeles and Long Beach are the leading container ports, while the port of New York and

FIGURE 4-8 Top 25 Water Ports by TEU: 2018



KEY: TEU = twenty-foot equivalent unit.

NOTE: Domestic includes both inbound and outbound cargo shipped between U.S. ports. For example, TEUs shipped between Los Angeles, Long Beach, Honolulu, and other U.S. ports.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, based on 2018 data provided by the U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, special tabulation, as of November 2019.

New Jersey is the leading Atlantic coast container port (figure 4-8).

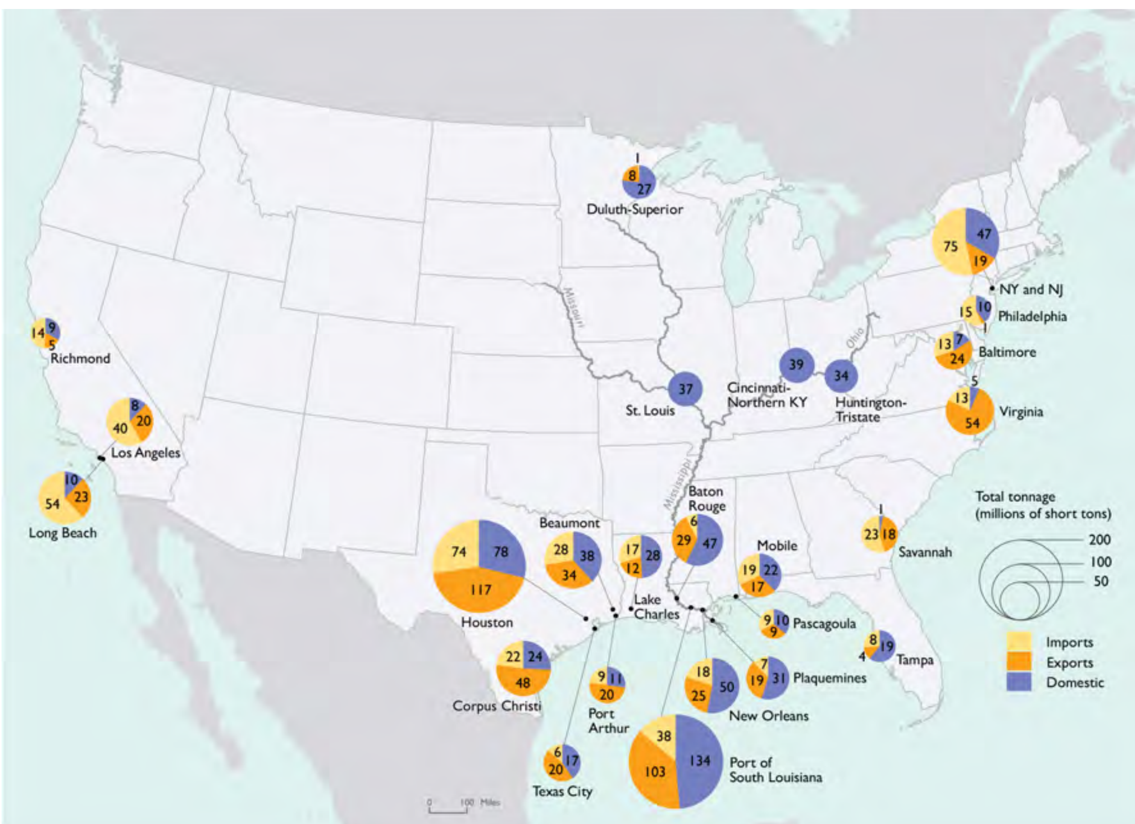
The size of containerships calling at U.S. ports has increased in recent years, due in part to intense competition within the shipping industry, the recent expansion of the Panama Canal locks to accommodate larger vessels, and efforts by ship owners to minimize costs through economies of scale. The trend toward larger containerships has led to a concentration of liner service[11] at ports with a deep-water draft, ample overhead clearance, and intermodal connections, such as double-stack rail service. In total, U.S. container ports handled approximately 40.2 million TEU of containerized cargo in 2018, an increase of 5.2 percent from the previous year [USACE WCSC 2019b].

The top 25 dry bulk tonnage ports recorded an increase in vessel calls[12] from a total of 183,030 in 2017 to 183,559 in 2018, a nearly 0.3 percent increase [USACE WCSC 2019a]. As shown in figure 4-9, tonnage ports concentrated on the Gulf coast and the inland waterway system, handling

[11] Vessels sail on a fixed schedule and routes, often calling at different ports while underway on each sailing.

[12] A vessel call is a single visit to a terminal or port by a waterborne vessel.

FIGURE 4-9 Top 25 Water Ports by Tonnage: 2018



NOTE: 1 short ton = 2,000 pounds.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, based on 2018 data provided by the U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, special tabulation, as of November 2019.

low-value, domestic dry bulk and foreign liquid bulk cargo, such as coal, crude petroleum, and petroleum products. The Port of South Louisiana was the top water gateway by weight, handling 275.5 million short tons, followed by the Port of Houston, moving 268.9 million short tons [USACE WCSC 2019c]. Waterborne crude petroleum exports more than doubled again from 41.4 million tons in 2017 to 87.5 million tons in 2018, while growth in exported waterborne petroleum products was more modest—increasing 7.5 percent to 243.7 million tons [USACE NDC 2019].

In recent years bulk cargo ports have been affected by changes in global demand for U.S. energy commodities. Growth in demand for U.S. coal, petroleum products, and liquefied natural gas (LNG) has resulted in the expansion of some port facilities or in plans for new facilities to support the increase in energy commodity exports, particularly LNG. Outbound waterborne coal tonnage, primarily handled by Atlantic coast ports, grew by 17.2 percent, from 85.2 million tons in 2017 to 99.8 million tons in 2018. Waterborne crude petroleum exports more than doubled, from 41.4 million tons in 2017 to 87.5 million tons in 2018, while growth in outbound waterborne petroleum products was more modest—increasing 7.5 percent to 243.7 million tons [USACE NDC 2019]. As noted in chapter 7, the United States remains a net importer of crude oil.

The export market for U.S. liquefied natural gas (LNG) continues to rise, driven by global demand, increases in U.S. natural gas supplies, and expansion of production capacity. U.S. LNG exports averaged 5.0 billion cubic feet per day (Bcf/d) in 2019, up from 3.0 Bcf/d in 2018, according to the Energy Information Administration (EIA). The substantial increase in production is the result of several new liquefaction units, called trains[13], coming online. Additional liquefaction units are scheduled to be placed in service in 2020 and 2021, which will bring total U.S. liquefaction capacity to 10.2 Bcf/d (baseload) and 10.8 Bcf/d (peak) [USDOE EIA 2020b].

The Bureau of Transportation Statistics Port Performance Freight Statistics Program provides nationally consistent measures of port capacity and throughput at the top 25 U.S. ports by tonnage, TEU, or dry bulk tonnage. This information is reported annually to Congress and is available on the BTS website at https://www.bts.gov/ports [USDOT BTS 2019c]. In addition, chapter 2 presents more information on port performance and chapter 1 provides information on port capacity and infrastructure.

Future Deployment of Transportation Innovative Technologies and Their Potential Effect on Freight Transportation

Drone and Robot Freight Delivery Options for Last-Mile Delivery

The use of drones and robots for last-mile package delivery has recently advanced from the experimental to early implementation stages. The last-mile, or last leg of the journey, is often the route from the warehouse to a customer's home or office. The use of drones and robots to deliver goods could be economically beneficial by increasing delivery speeds and improving operations efficiency while saving energy.

In recent years large transportation and logistics companies, such as the United Parcel Service, DHL, and Amazon, have been experimenting with robots for last-mile deliveries. Robots are now being used as an alternative package delivery option in some urban areas, such as Seattle, throughout the United States. Using global positioning system technology and embedded cameras, robots can deliver small packages, such as groceries, up to 3 miles [RBR 2018].

3D Printing and Freight Transportation Supply Chains

As 3D printing, or additive manufacturing, penetrates the market, several opportunities and

[13] A liquefaction unit (referred to as a train) is the processing unit at a liquefaction facility that removes impurities, dehydrates, and then cools the natural gas to a liquid. A liquefaction facility often has several liquefaction units on site. Each operates independently.

challenges for the freight transportation and logistics industries are presented. 3D printing is a process by which materials, such as plastics, ceramics, glass, and metal powders, are layered using computer-aided design or a laser scanner to create three-dimensional products.

Because of its ability to manufacture on demand and print custom products, manufacturers and distributers are less likely to stockpile inventory to meet intermittent or uneven demand, and thus can reduce warehousing requirements. Other possible outcomes of increased usage of 3D printing include changes in the types of materials shipped and the vehicles used to deliver goods, from large to smaller trucks and vans. Potentially, port traffic also could change because goods manufactured in China and other Asian countries could be near sourced to North America, reducing shipping volumes and costs. Less demand for air cargo to move high-value products may be another result of increased use of 3D printing [ENO 2014].

As 3D printing becomes more prevalent, its potential to affect the freight transportation and logistics industries will need to be studied so that planners and decision makers can plan for and manage transportation infrastructure needs and financial considerations.

Data Gaps

Needs for the Future

The principal data gaps related to the movement of freight include the following:

- **Domestic Movement of International Trade**. While much is known about the value and weight of commodities shipped, how they are transported into and out of our country, and their origin and destination within the United States, little is known about the domestic movement of international trade. Data on the domestic leg of imports and exports as well as movements between foreign origins and destinations that pass through the United States have not been measured since the 1970s. Consequently, national estimates of freight flows by mode and type of commodity, such as the FAF, rely on models and assumptions rather than observed data to fill this data gap. This information is needed to fully understand the role international freight plays in domestic transportation and its effects on infrastructure and services and its contribution to U.S. global competitiveness.
- **Better data to measure the potential changes in local and regional traffic and freight flows.** Rapidly growing e-Commerce and its reliance on express delivery to residences can result in an increase in vehicles used per ton-mile as smaller loads are carried to meet tight delivery deadlines. The increased use of both large courier companies and independent contractors who use their personal vehicles to deliver goods will need to be estimated to assess their impact on local transportation infrastructure and traffic. This information will be an important input for transportation planners and decision makers in planning for future transportation needs.
- **Data on the physical and operational characteristics of the Nation’s truck population.** While the FAF and its components include data on the commodities carried by truck, information relating commodities to types of trucks have not been collected since 2002. The variety of truck sizes and configurations are the subject of federal and state policies, and the economic consequences of those policies are difficult to gauge without understanding the commodities carried and the portions of the economy served by trucks.
- **Data on emerging modes of transportation needed.** While emerging modes of transportation, such as drones and robots, are still in the early stages of implementation, it is possible to identify, but not quantify, their potential benefits to and impacts on transportation industries, the environment, and consumers. This information will be needed to capture shifts in supply chains and changes in freight flows, among other potential effects.

References

Association of American Railroads (AAR):

—2019a. *Freight Rail & Intermodal*. Available at http://www.aar.org as of October 2019.

—2019b. *Railroads and Grain*. May. Available at http://www.aar.org as of November 2019.

—2019c. *Railroads and Coal*. May. Available at http://www.aar.org as of November 2019.

—2019d. *Overview of America's Freight Railroads*. June. Available at http://www.aar.org as of November 2019.

Eno Center for Transportation (ENO). 2014 *Eno Transportation Weekly* June 25. Available at www.encotrans.org as of February 2020. By Carter Templeton (ENO) and Bill Ankner (Transportation Solutions).

Robotics Business Review (RBR). 2018. *Robot Roundup: Delivery Robots Strive to Drive the Last Mile*. August 16. Available at www.roboticsbusinessreview.com as of February 2020.

U.S. Army Corps of Engineers (USACE), Navigation and Civil Works Decision Support Center (NDC). 2019. *The U.S. Waterway System, 2018 Transportation Facts and Information*. November. Available at https://publibrary.planusace.us as of March 2020.

U.S. Army Corps of Engineers (USACE), Waterborne Commerce Statistics Center (WCSC):

—2020. Waterborne Commerce Monthly Indicators. Available at https://publibrary.planusace.us as of March 2020.

—2019a. Vessel Calls 2017-2018, Special Tabulation. November 2019.

—2019b. Special Tabulation. Preliminary Version of U.S. Waterborne Container Traffic by Port/Waterway. September.

—2019c. Special tabulation. Preliminary Version of Tonnage for Select U.S. Ports. September.

U.S. Department of Agriculture (USDA):

—2019. *Transportation of U.S. Grains*. April. Available at www.ams.usda.gov as of November 2019.

—2010. *Study of Rural Transportation Issues*. April. Available at www.ams.usda.gov as of October 2019.

U.S. Department of Commerce (USDOC), Bureau of Economic Analysis (BEA). 2020. National Economic Accounts, Gross Domestic Product. February 27. Available at http://www.bea.gov as of March 2020.

U.S. Department of Commerce (USDOC), Census Bureau (CENSUS):

—2020a. Foreign Trade Division (FTD). FT920 – U.S. Merchandise Trade: Selected Highlights. February 5. Available at http://www.census.gov as of March 2020.

—2020b. *Estimated Quarterly U.S. Retail Sales (Adjusted: Total and E-Commerce*. February 19. Available at www.census.gov as of August 2020.

—2019. Foreign Trade Division (FTD). FT920 – U.S. Merchandise Trade: Selected Highlights. December. Available at http://www.census.gov as of October 2019.

U.S. Department of Energy (USDOE), Energy Information Administration (EIA):

—2020a. *Monthly Energy Review*. February. Available at www.eia.gov as of March 2020.

—2020b. *Today in Energy*. "EIA Expects U.S. Net Natural Gas Exports to Almost Double by 2021." January 23. Available at www.eia.gov as of March 2020.

—2020c. U.S. Imports by Country of Origin. Available at www.eia.gov as of March 2020.

—2019a. *Annual Coal Distribution Report*. October 3. Available at www.eia.gov as of November 2019.

U.S. Department of Transportation, Bureau of Transportation Statistics (BTS), and Federal Highway Administration (FHWA). 2019. Freight Analysis Framework, version 4.5.1. Available at https://faf.ornl.gov/ as of July 2020.

U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS):

—2019a. Transtats. Air Cargo Summary Data. Available at www.bts.gov as of October 2019.

—2019b. BTS Press Release 10-20: *2019 North American Transborder Freight Numbers* (March 6). Available at www.bts.gov as of March 2019.

—2019c. *Port Performance Freight Statistics Program, 2018 Annual Report to Congress*. January. Available at www.bts.gov as of October 2019.

—2019d. *The Rural Roadway Challenge*. Special tabulation. October 2020.

U.S. Department of Transportation (USDOT), Federal Aviation Administration (FAA). 2019. CY 2018 Final All-Cargo Landed Weights, Rank Order. September. Available at http://www.faa.dot.gov as of November 2019.

U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), Office of Highway Policy (HPI). 2016. National Household Travel Survey. Available at https://www.fhwa.dot.gov as of November 2019.

CHAPTER 5

Transportation Economics

Transportation plays a vital role in the American economy; it makes economic activity possible and is a major economic activity in its own right, contributing directly and indirectly to the economy. This chapter discusses these direct and indirect contributions in the following areas:

- contribution of transportation to gross domestic product;
- use of transportation by non-transportation industries (e.g., manufacturing) to produce goods and services;
- demand for freight transportation services as an economic indicator;
- persons employed by the transportation industry and in transportation occupations; and
- public (government) and private expenditures on transportation facilities, infrastructure, and systems, which enable the movement of both people and goods domestically and internationally.

This chapter also discusses the costs faced by producers and users (businesses and households) of transportation. The full scope of transportation's role in the economy and historical data are available in the Bureau of Transportation Statistic's (BTS's) *Transportation Economic Trends*.[1]

This chapter also includes early indicators of how the COVID-19 pandemic disrupted transportation supply and demand and furthered economic

[1] https://www.bts.gov/tet.

Highlights

- The economy entered a recession in February 2020, and many states issued stay-at-home orders and/or closed non-essential businesses starting in March 2020 due to the Coronavirus Disease 2019 (COVID-19). Combined, the recession and COVID-19 depressed freight and passenger movement in 2020.
- According to BTS' Transportation Services Index, total freight movement declined 7.7 percent from February (the start of the 2020 recession) through the low reached in April 2020—less than during the December 2007 through June 2009 Great Recession but at a faster rate (2.6 percent average monthly decline) than during the Great Recession. COVID-19 contributed to the faster per month decline in 2020.

continued on next page

Highlights (*continued*)

- Transportation accounted for 9.4 percent of gross domestic product in 2018, roughly the same percent as in 2017.
- In 2018 the wholesale and retail trade sector continued to require more transportation services than any other sector to produce 1 dollar of gross output.
- Transportation and transportation-related industries employed over 14.8 million people, accounting for an increasing share of the U.S. work force since 2012—9.8 percent in 2019.
- While the economy entered a recession in February 2020, transportation employment began to decline year-over-year in April when COVID-19 caused significant declines in freight and passenger movement.[1] Employment in transportation and warehousing declined year-over-year in April through June 2020 but by less than total employment.
- Among transportation occupations, taxi drivers and chauffeurs, including drivers working for ride-hailing services, such as Uber and Lyft, are projected to grow the fastest at 19.5 percent from 2018 to 2028.
- Workers with transportation occupations overall earned a lower median annual wage ($32,400) than workers of all occupations ($39,800) in 2019.
- Fuel prices in 2020 declined to nearly 2016 levels—the most recent low before fuel prices began to climb in 2017 and 2018.

[1] Year-over-year throughout this chapter refers to change from current year to previous year for same month. For example, "decline year-over-year in April" means the value declined from April 2019 to April 2020.

declines that started in February 2020 when the economy entered a recession. Full effects will be published when annual economic statistics for 2020 become available in 2021.

Transportation's Contribution and Role in the Economy

Transportation's Contribution to GDP

Gross domestic product (GDP) is an economic measure of all goods and services produced in the country. Figure 5-1 divides GDP into six categories (transportation, healthcare, housing, food, education, and all other goods and services). In 2018 transportation accounted for 9.4 percent of GDP, the same as in 2017. While transportation accounts for the second smallest share, transportation plays a vital role in the economy by making economic activity possible (e.g., by transporting the raw materials needed to manufacture and deliver goods).

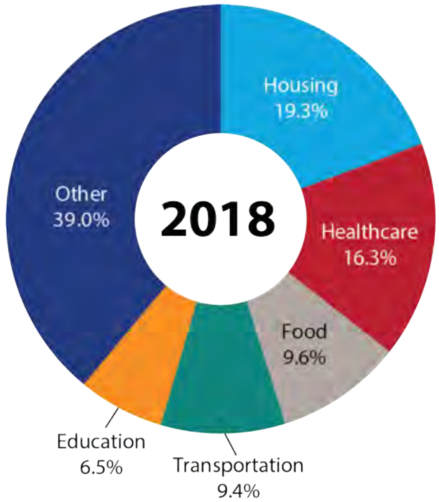
Contribution of Transportation Services to GDP

The previous section measures the total contribution of transportation to the economy, while this section measures the contribution of transportation services to GDP using the

Transportation Satellite Accounts (TSAs).[2] BTS developed the TSAs to estimate the contribution of in-house transportation services to the economy and the contribution of transportation carried out by households using household vehicles.[3] In addition, the TSAs provide the contribution of for-hire transportation—as estimated by the Bureau of Economic Analysis.

In 2018 transportation services' (for-hire, in-house, and household) total contribution to GDP was $1,240.8 billion (6.0 percent). The contribution to the economy, as measured by the TSAs, is less than final demand attributed to transportation (figure 5-1) because it counts only the contribution of transportation services and not transportation goods (e.g., the contribution from motor vehicle manufacturing). For-hire transportation contributed $662.5 billion (3.2 percent) to an enhanced U.S. GDP of $20.9 trillion.[4] In-house transportation services (air, rail, truck, and water) provided by non-transportation industries for their own use contributed an additional $229.8 billion (1.1 percent) to enhanced GDP. Household transportation, measured by the depreciation cost associated with households owning motor vehicles, contributed $348.5 billion (1.7 percent)—the second largest transportation mode contribution to GDP.

FIGURE 5-1 Shares of U.S. GDP: 2018



NOTES: "Other" is the sum of the change in retail dealer inventories of motor vehicles and parts and net exports of transportation-related goods and services. Percents may not sum to 100 due to rounding.

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts Tables, tables 1.1.5, 2.4.5, 3.11.5, 3.15.5, 4.2.5, 5.4.5, 5.5.5 and 5.7.5B available at apps.bea.gov/iTable/index_nipa.cfm as of September 2019.

Among all transportation modes, trucking contributed the largest amount, at $354.6 billion. In-house truck transportation operations contributed $190.9 billion, while for-hire truck transportation services contributed $163.7 billion (figure 5-2).

Use of Transportation Services by Industries

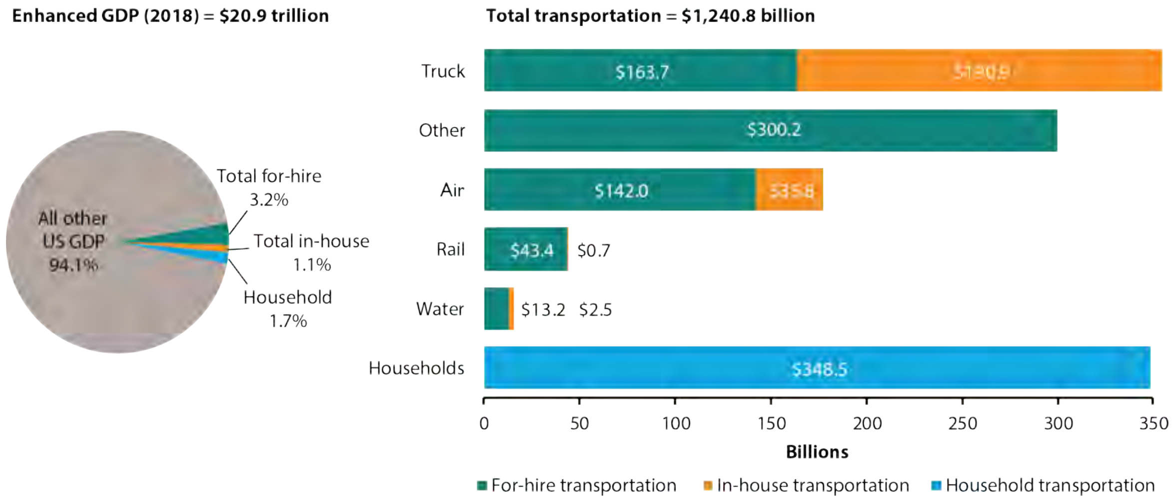
Transportation supports the economy by enabling the production of goods and services by non-transportation industries. The amount of transportation services required to produce each dollar of output indicates how much a sector depends on transportation services. In 2018 the wholesale and retail trade sector required the most transportation services, at 8.6 cents (4.4 cents of in-house transportation operations and 4.2 cents

[2] For further information on how to measure transportation's contribution to GDP, see the Contribution of Transportation to the Economy in BTS' T*ransportation Economic Trends*, available at https://www.bts.gov/tet as of August 2020.

[3] For-hire transportation services consist of air, rail, truck, passenger and ground transportation, pipeline, and other support services that transportation firms provide to industries and the public on a fee basis. In-house transportation services consist of air, rail, truck, and water transportation services produced by non-transportation industries for their own use (e.g., grocery stores owning and operating their own trucks to move goods from distribution centers to retail locations). BTS calculates the contribution of household transportation as the depreciation associated with households owning a motor vehicle. For more information about the Transportation Satellite Accounts, see https://www.bts.gov/satellite-accounts as of December 2020.

[4] Enhanced GDP is the sum of the GDP published in the National Accounts plus the contribution of household transportation as measured by BTS in the Transportation Satellite Accounts. Household transportation covers transportation provided by households for their own use through the use of a motor vehicle.

FIGURE 5-2 Enhanced Gross Domestic Product (GDP) Attributed to Transportation by Mode: 2018



NOTES: For information on the methodology on the Transportation Satellite Accounts (TSAs), see https://www.bts.gov/satellite-accounts. The GDP value in the TSAs (referred to as enhanced GDP) is larger than the GDP value published in the National Accounts because it includes the contribution of household transportation. "Household transportation" covers transportation that households provide for themselves with vehicles. "Other" includes: pipeline, transit, and ground passenger transportation; sightseeing transportation and transportation support; courier and messenger services; and warehousing and storage). Enhanced GDP = U.S. GDP $20,580.2 billion + contribution of household transportation $348.5 billion.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Satellite Accounts, available at http://www.bts.gov/satellite-accounts as of February 2020.

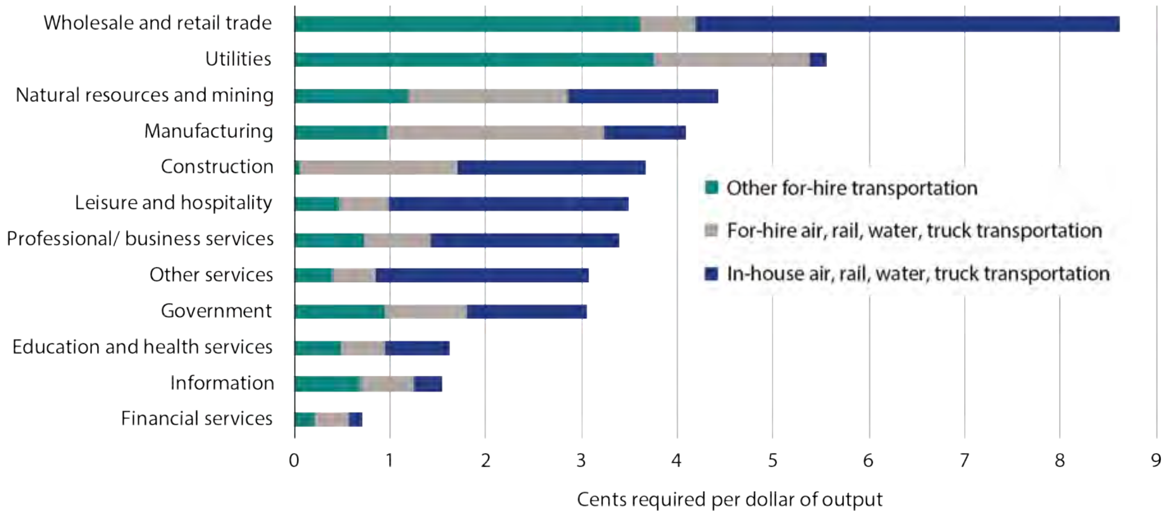
of for-hire transportation services), to produce one dollar of output (figure 5-3).

Transportation as an Economic Indicator

Transportation activities have a strong relationship to the economy. For example, increases in production create additional demand for freight transportation services. The BTS freight Transportation Services Index (TSI) measures the volume of freight transportation services provided monthly by the for-hire transportation sector in the United States. Freight TSI declined 7.7 percent from February—the start of the 2020 recession—through the lowest point reached in April 2020 (figure 5-4). A decline in manufacturers' shipments and industrial production—generators of demand for freight transportation services—from February through April 2020 (16.7 and 18.7 percent, respectively) suggests lesser demand for freight transportation. The declines are a result of the economy entering a recession in February 2020 and the closure of non-essential businesses in some states, starting in mid-to late-March 2020, due to the Coronavirus Disease 2019 (COVID-19). COVID-19 accelerated the decline in freight transportation volumes as shown by the Freight TSI, declining 7.2 percent in April—the first full month of non-essential business closures in some states. In March 2020, when most businesses remained open for at least part of the month, the freight TSI declined modestly at 0.6 percent.

The 2020 recession differs from the December 2007 to June 2009 recession (Great Recession) because of the impacts of COVID-19. However, the Great Recession serves as benchmark for understanding the extent of the 2020 declines. The end date for the 2020 recession has not been declared so the following looks at data from February 2020 (the start of the 2020 recession) through April 2020—the month the freight TSI reached its lowest level in 2020. The freight TSI declined less from the start of the 2020 recession (February 2020) through the April 2020 low (7.7 percent) than from the start (December 2007) to

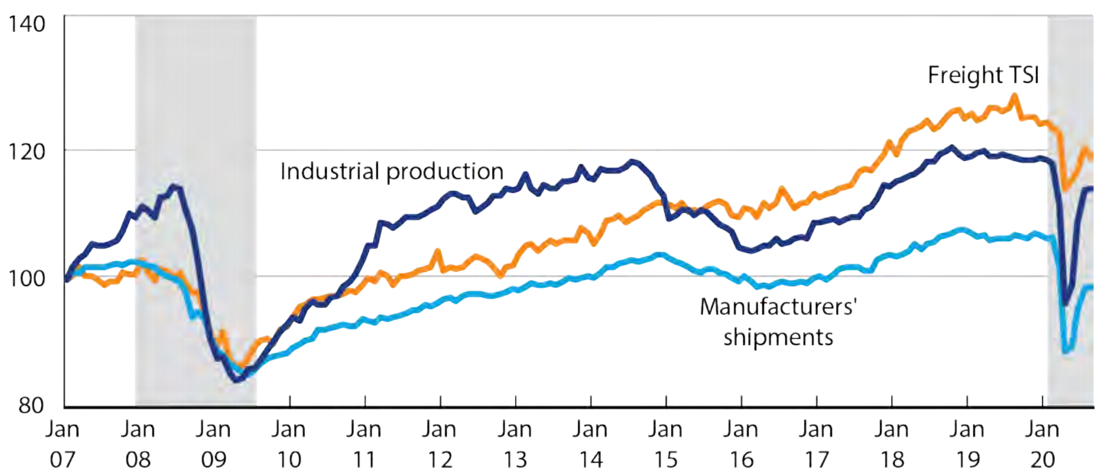
FIGURE 5-3 Transportation Services Required per Dollar of Output by Sector: 2018



NOTE: Other for-hire transportation includes: pipeline, transit and ground passenger transportation; sightseeing transportation and transportation support; courier and messenger services; and warehousing and storage.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Satellite Accounts, available at http://www.bts.gov/satellite-accounts as of January 2020.

FIGURE 5-4 Industrial Production, Manufacturers' Shipments, and Freight Transportation Services Index (seasonally adjusted): January 2007 to August 2020



NOTES: The Transportation Services Index is a weighted and chained index. All indexes re-indexed to January 2007 to facilitate visual comparison of the decline during the December 2007 to June 2009 recession and from February to April 2020 (start of the 2020 recession through the lowest point in 2020). Shaded areas are economic recessions.

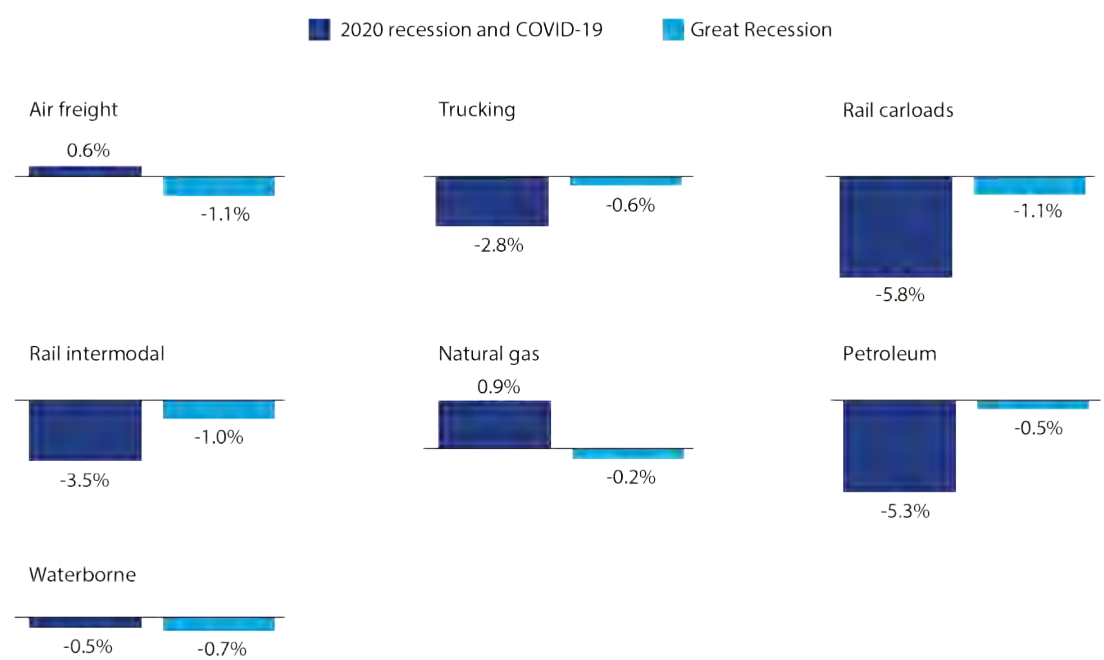
SOURCES: **Industrial Production**—Board of Governors of the Federal Reserve System, Industrial Production Index, available at http://www.federalreserve.gov/releases/g17/current/ as of October 2020. **Manufacturers' Shipments**—U.S. Bureau of the Census, Value of Manufacturers' Shipments for All Manufacturing Industries, available at http://www.census.gov/manufacturing/m3/index.html as of October 2020. **Freight TSI**—U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Services Index, available at http://www.transtats.bts.gov/OSEA/TSI as of October 2020.

the end (June 2009) of the Great Recession (13.2 percent decline). However, the freight TSI declined at a faster average monthly rate, at 2.6 percent, from February through April 2020 than from December 2007 to June 2009 (0.7 percent average monthly decline). The faster decline in 2020 is a result of the combined effects of the economic slowdown and the closure of many non-essential businesses as well as restricted travel due to COVID-19.

The freight TSI began to rise in May 2020, mirrored by increases in industrial production and manufacturers' shipments (figure 5-4). From May through August 2020, the freight TSI rose 4.4 percent from the April 2020 low. Industrial production rose 11.4 percent and manufacturers' shipments grew 19.0 percent over the same period. The growth corresponds with states lifting stay-at-home orders, if adopted, and/or re-opening any closed businesses.

For the period of decline from February through April 2020, figure 5-5 shows the change in freight movement by the transportation modes included in the freight TSI and compares it to the change during the Great Recession. Although the freight TSI declined at a faster monthly rate from February through April 2020 than during the Great Recession, waterborne declined slightly less per month from February through April 2020 (0.5 percent) than during the Great Recession (0.7 percent). Unlike other modes, air freight and natural gas movement increased from February through April 2020 (0.6 and 0.9 percent respectively). For natural gas, this may be a result of stay-at-home and shelter-in-place orders issued by many states, which may have increased

FIGURE 5-5 Average Monthly Change in Modal Data Included in Freight Transportation Services Index: February to April 2020 (start of 2020 recession through 2020 low and COVID-19) vs. December 2007 to June 2009 (Great Recession)



NOTE: Data are seasonally adjusted.

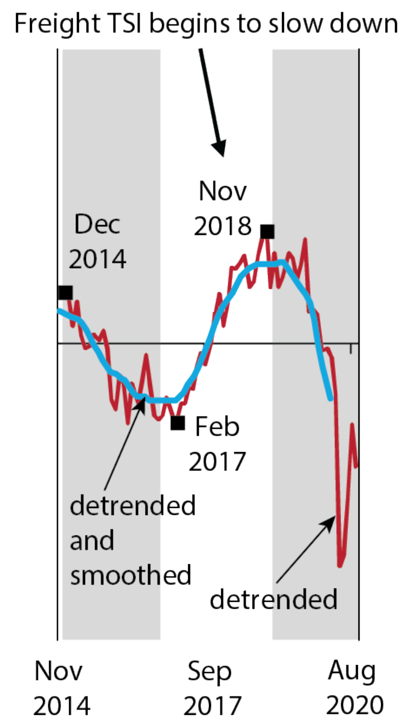
SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, seasonally adjusted transportation data, available at http://www.bts.gov/seasonally-adjusted-data as of July 2020.

residential demand. Further research is needed to understand the differences in freight transportation volumes during the 2020 recession and COVID-19 pandemic versus the Great Recession.

BTS research shows that changes in the TSI occur before changes in the economy, making the TSI a potentially useful economic indicator [USDOT BTS 2014].[5] This relationship is particularly strong for freight traffic as measured by the freight TSI.

Figure 5-6 illustrates the relationship between the freight TSI and the national economy from January 1979 through August 2020. The dashed red line shows the freight TSI with long-term changes removed (detrended). The solid blue line shows the freight TSI after removing both long-term trends and month-to-month volatility (detrended and smoothed). The shaded areas represent e*conomic slowdowns* and the areas between represent *economic accelerations*, or periods of economic growth. The freight TSI usually peaks and turns downward before a growth slowdown begins and hits a trough and turns upward before a growth slowdown ends.[6] The TSI turned in November 2018, marking the beginning of a slowdown. This economic slowdown deepened in 2020 due to COVID-19. The full effects of COVID-19 will be revealed when data become available for all of 2020 in early 2021.

FIGURE 5-6 Freight Transportation Services Index and the Economic Growth Cycle: December 2014 through August 2020



NOTES: Shaded areas indicate decelerations in the economy, and areas between are accelerations in the economy (growth cycles). Endpoint for deceleration begun in November 2018 has not been determined. Detrended line represents freight TSI with long-term trend removed. Detrended and smoothed line represents freight TSI with both long-term trend and month-to-month volatility removed. Detrending and smoothing the freight TSI makes it easier to observe upturns and downturns of the data.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Economic Trends, "Transportation as an Economic Indicator," https://data.bts.gov/stories/s/ab7y-wzpz as of October 2020.

Transportation-Related Employment and Wages

Industries in the transportation and warehousing sector and related industries outside the sector employed 14.8 million people (9.8 percent of the U.S. labor force) in 2019 in a variety of roles, from driving buses to manufacturing cars to building and maintaining ports and railroads [USDOT BTS 2020b]. The transportation and warehousing sector (North American Industry Classification System [NAICS] 48-49) directly employed 5.6 million workers in the United States in 2019—3.7 percent of the U.S. labor force [USDOT BTS 2020b].

[5] Indicator of regular business cycles. The freight TSI is not an indicator for events with sudden onset, such as COVID-19, which caused global economic decline beginning in early 2020.

[6] For complete historical data showing the Transportation Services Index and its relationship to the economy, see U.S. Department of Transportation, Bureau of Transportation Statistics, *Transportation Economic Trends*, "Transportation as an Economic Indicator," https://data.bts.gov/stories/s/ab7y-wzpz as of October 2020.

While the economy entered a recession in February 2020, transportation employment began to decline year-over-year in April when COVID-19 caused significant declines in freight and passenger movement [USDOT BTS 2020c]. While employment in transportation and warehousing declined in each month from April through June, it declined by less, year-over-year, than total employment declined (figure 5-7).[7] Some transportation and warehousing modes experienced greater year-over-year declines than the sector as a whole (figure 5-7). Employment in transit and

[7] Total employment is non-farm employment. The data exclude proprietors, the unincorporated self-employed, unpaid volunteer or family employees, farm employees, and domestic employees.

FIGURE 5-7 Year-Over-Year Change in Transportation Employment by Month and Mode, 2019 to 2020

NOTE: The data exclude proprietors, the unincorporated self-employed, unpaid volunteer or family employees, farm employees, and domestic employees.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Current Employment Statistics, available at: https://www.bls.gov/ces/data/ as of July 2020.

passenger ground transportation declined the most year-over-year, which follows from many states issuing stay-at-home or shelter-in-place orders that caused significant declines in passenger movement.

The total count of workers in the transportation industry includes all occupations, such as administrative staff employed by the trucking industry. Some workers holding transportation occupations work outside of the transportation and warehousing sector, such as truck drivers employed by retail stores (figure 5-8).

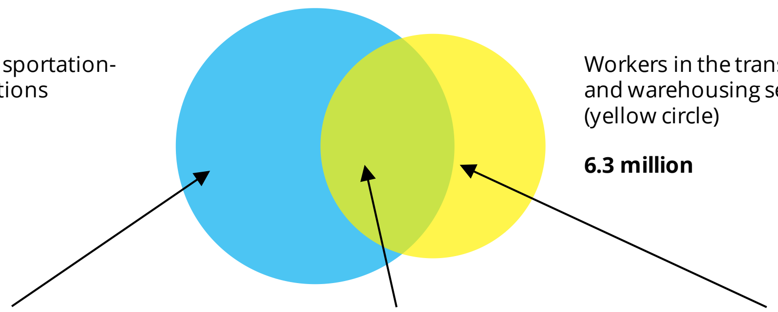
Workers with transportation occupations earned a lower median annual wage ($32,400) than workers in all occupations ($39,800) in 2019 [USDOL BLS 2019]. Figure 5-9 shows annual median wages for the largest, the lowest-paid, and the highest-paid transportation occupations in the United States in 2019. Annual wages vary widely, from a median annual wage of over $140,000 for airline pilots to a median annual wage of roughly $25,000 for parking lot attendants. While the 5 highest-wage occupations employ just over 300,000 workers, the 5 lowest-wage transportation-related occupations collectively employ almost 6 times more workers at 1.1 million. Automation of transportation and technological changes affect which transportation occupations will gain or lose employment. From 2018 to 2028, taxi drivers and chauffeurs, which includes drivers working for ride-hailing services such as Uber and Lyft, are projected to grow the fastest at 19.5 percent—the 39th fastest growing occupation out of the 1,079 occupations identified by the Bureau of Labor Statistics.[8]

[8] See U.S. Department of Labor, Bureau of Labor Statistics, Employment Projections, Occupational Projections and Worker Characteristics, 2018-2028, available at https://www.bls.gov/emp/tables/occupational-projections-and-characteristics.htm as of May 2020.

FIGURE 5-8 Relationship Between the Transportation and Warehousing Sector and Transportation-Related Occupations: May 2019

Workers in transportation-related occupations (blue circle)

9.3 million



Workers in the transportation and warehousing sector (yellow circle)

6.3 million

Workers in transportation-related occupations outside the transportation and warehousing sector
6.1 million

Examples: Truck drivers for grocery stores; school crossing guards

Workers in transportation-related occupations in the transportation and warehousing sector
3.2 million

Examples: Truck drivers for freight companies; postal service mail carriers

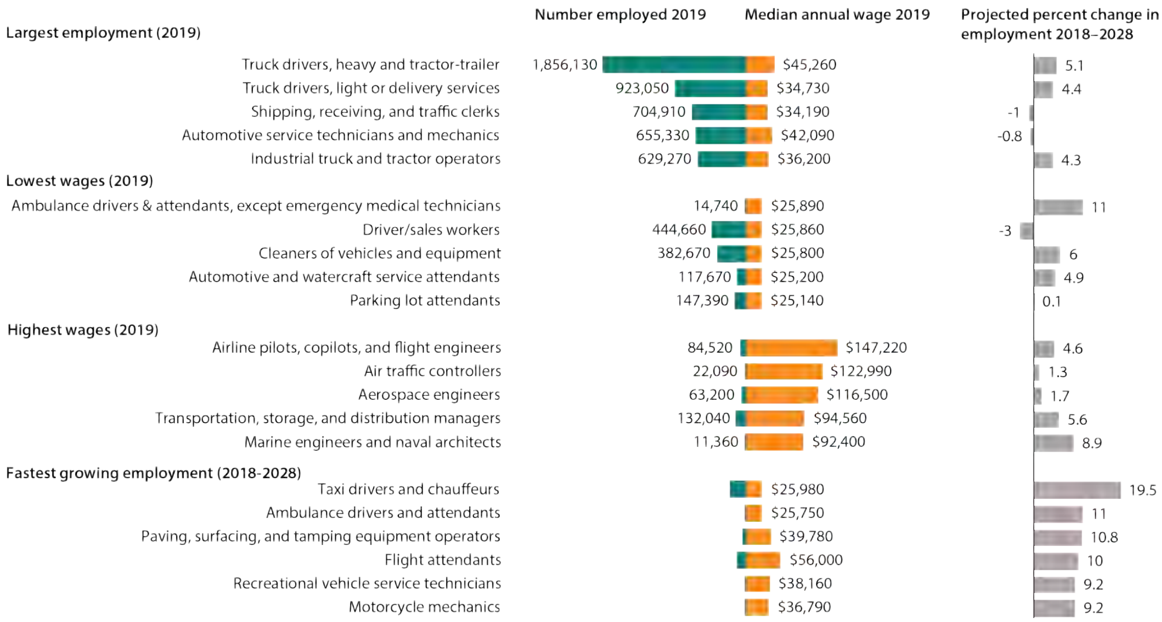
Workers in non-transportation occupations in the transportation and warehousing sector
3.1 million

Examples: Accountants for freight companies; stock clerks for warehouses

NOTES: Values differ from figure 5-7 because they are from a different data survey. "Transportation-related occupations" refers to occupations selected by BTS as listed in BTS' National Transportation Statistics, Employment in Transportation and Transportation-Related Occupations, table 3-24, available at https://www.bts.gov/content/employment-transportation-and-transportation-related-occupations as of April 2019.

SOURCE: Tabulated by U.S. Department of Transportation, Bureau of Transportation Statistics from U.S. Department of Labor, Bureau of Labor Statistics, Occupational Employment Statistics, available at http://bls.gov/oes as of July 2020.

FIGURE 5-9 Employment and Wages in Select Transportation Occupations: 2019



NOTES: Based on analysis of occupation groups classified as detailed and with Standard Occupation Code (SOC) 53-000 (transportation and material moving occupations). Material moving occupations are not included if transportation is not directly involved, such as packers and packagers.
Airline pilots typically fly on scheduled air carrier routes to transport passengers and cargo. Ambulance drivers excludes emergency medical technicians.

SOURCE: 2019 Wages and Employment—U.S. Department of Labor, Bureau of Labor Statistics, Occupational Employment and Wages, available at http://www.bls.gov/oes as of April 2019. 2018-2028 Employment—U.S. Department of Labor, Bureau of Labor Statistics, Employment Projections, Occupational Projections and Worker Characteristics 2018-2028, available at https://www.bls.gov/emp/tables/occupational-projections-and-characteristics.htm as of June 2020.

Transportation Expenditures and Revenues

Public and Private Sector Expenditures and Revenue

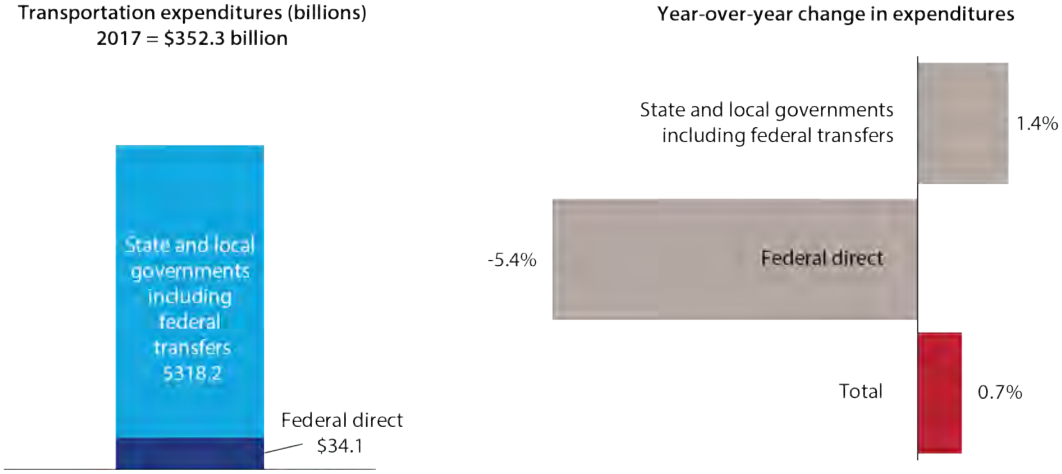
Expenditures

In 2017 federal, state, and local governments spent $352.3 billion on transportation. Most government spending on transportation takes place at the state and local levels, although state and local capital expenditures are often paid for in part with federal funds. The most recent data are for 2017. In 2017 state and local governments spent $318.2 billion, including expenditures paid for with federal transfers, such as the Federal-Aid Highway Program and the Airport and Airway Trust Fund. The Federal Government spent $34.1 billion directly on transportation, excluding federal transfers to states [USDOT BTS 2020a]. As shown in figure 5-10, direct federal expenditures declined 5.4 percent while state and local government expenditures grew 1.4 percent.

Most direct federal spending was for aviation ($17.0 billion, or 50.0 percent) followed by water ($8.5 billion, or 25.0 percent), highway ($4.4 billion, or 12.8 percent), railroads ($3.1 billion, or 9.1 percent), and the remainder on general support, transit, and pipeline ($1.0 billion, or 3.0 percent) (see figure 5-11).

State and local government spending (including expenditures paid for with federal grants) accounted for $318.2 billion of the $352.3 billion spent on transportation in 2017. Most of state and local spending was for highways ($219.1 billion, or 68.8 percent) followed by transit ($66.7 billion, or 21.0 percent), air ($26.0 billion, or 8.2 percent),

FIGURE 5-10 Total and Year-Over-Year Growth in Transportation Expenditures: 2017



NOTE: 2017 data are most recent data available.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Government Transportation Financial Statistics, available at www.bts.gov/gtfs as of May 2020.

water ($6.4 billion, or 2.0 percent), pipeline ($0.05 billion, or 0.02 percent), and general support ($0.02 billion, or 0.01 percent) (figure 5-11).

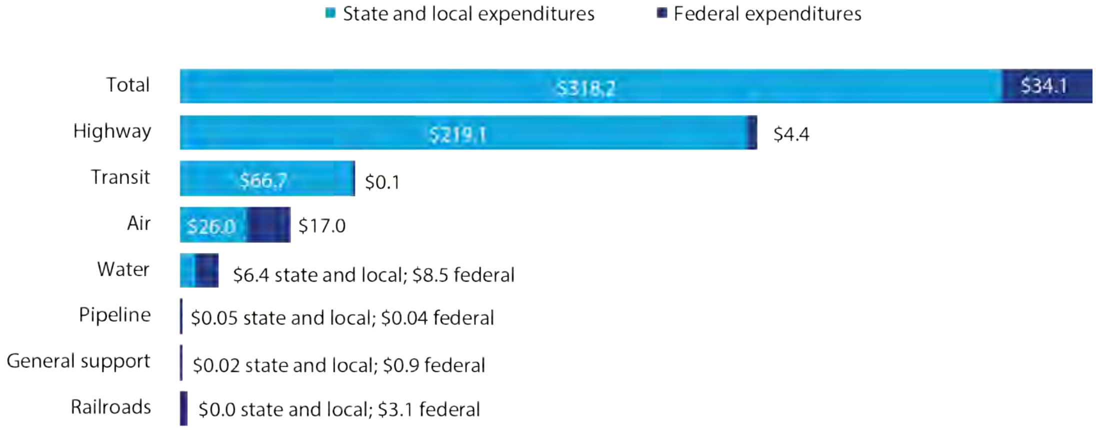
Revenue

Government transportation revenue comes from user taxes and fees, such as gasoline taxes and tolls, air ticket taxes, and general revenues, as well as income from investing transportation funds and receipts from fines and penalties. In 2017 government revenue collected and dedicated to transportation programs totaled $355.4 billion (in 2017 dollars) [USDOT BTS 2020a]. Over half of the revenue ($230.5 billion, or 64.9 percent) came from taxes and charges levied on transportation-related activities (own-source revenue). The remaining $124.9 billion (35.1 percent) came from non-transportation-related activities that support transportation programs, such as state or local sales or property taxes used to finance transportation projects (supporting revenue). Total (own-source and supporting) transportation revenues of $355.4 billion exceeded transportation expenditures of $352.3 billion by 3.1 billion in 2017 [USDOT BTS 2020a].

Of the $355.4 billion collected and dedicated to transportation programs in 2017, the Federal Government collected $91.5 billion (25.7 percent, see figure 5-12) from the following:

- $44.3 billion in highway revenues ($41.0 billion own-source and $3.3 billion supporting revenue),
- $20.6 billion in aviation revenues ($15.4 billion own-source and $5.2 billion supporting revenue),
- $12.3 billion in transit revenues (all supporting revenue),
- $10.2 billion in water transportation revenues ($1.3 billion own-source and $8.9 billion supporting revenue),
- $3.1 billion in rail transportation revenues (all supporting revenue),
- $0.9 billion in general support revenues (all supporting revenue), and
- $0.01 billion in pipeline revenues ($0.02 billion own-source and $0.13 billion supporting revenue).

FIGURE 5-11 Federal, State, and Local Transportation Expenditures by Mode: 2017 (billions of 2017 dollars)

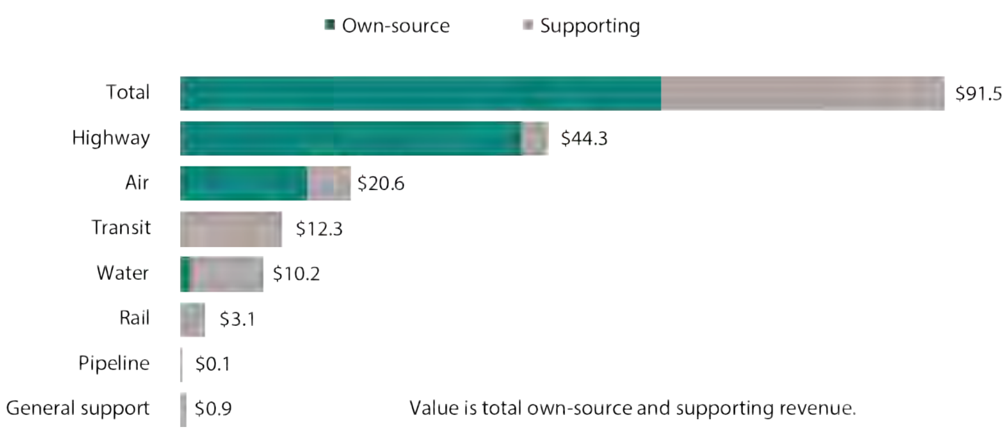


NOTES: 2017 data are latest available. Federal expenditure includes direct federal spending, excluding grants to state and local governments.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Government Transportation Financial Statistics, available at www.bts.gov/gtfs as of May 2020.

FIGURE 5-12 Federal Transportation Revenue by Mode: 2017 (billions of 2017 dollars)

Federal own-source revenue ($57.6) + federal supporting revenue ($33.9) = total federal revenue allocated for transportation ($91.5)



NOTES: 2017 data are latest available. Own-source refers to taxes and charges levied on transportation-related activities and used specifically for transportation purposes. Supporting revenue is from non-transportation-related activities that support transportation programs, such as state or local sales or property taxes used to finance transportation projects.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Government Transportation Financial Statistics, available at www.bts.gov/gtfs as of May 2020.

State and local governments collected $263.9 billion (74.3 percent) of the $355.4 billion of total transportation revenue in 2017. Of this revenue, the state and local governments collected (figure 5-13):

- $181.0 billion in highway revenue sources, such as fuel taxes, motor vehicle taxes, and tolls ($97.8 billion own-source and $83.2 billion supporting revenue);
- $24.5 billion in aviation-related revenue, such as landing fees and terminal area rental ($21.7 billion own-source and $2.8 billion supporting revenue);
- $52.6 billion in transit revenue—almost entirely from fares ($20.6 own-source and $32.0 supporting revenue); and
- $5.8 billion in water revenue (all own-source).

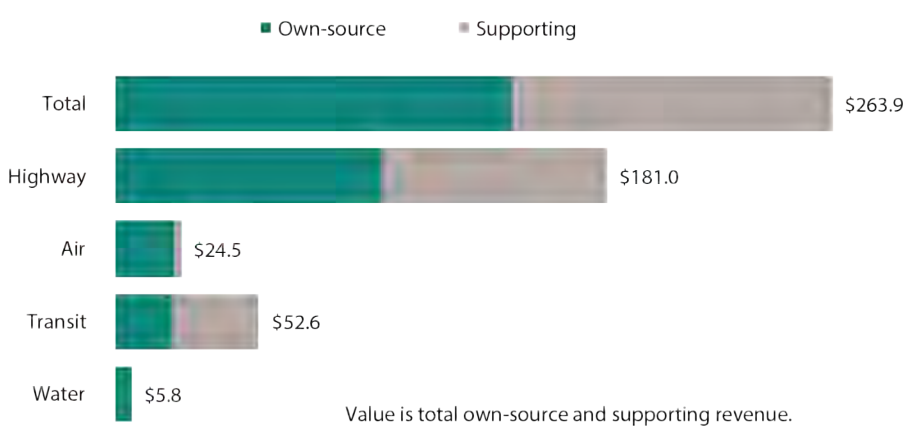
Transportation Investment

Transportation assets (infrastructure and equipment taking more than 1 year to consume) represent a small but important share of total public and private investment in the United States.[9] In 2018 public and private investment in transportation infrastructure and equipment totaled $444.0 billion, or 14.2 percent of the $3,121.1 billion in investment in all infrastructure and equipment (table 5-1). Public and private investment in new transportation infrastructure accounted for $142.2 billion (4.6 percent) and private transportation equipment accounted for $301.8 billion (9.7 percent).

[9] For definitions and additional data, see: https://data.bts.gov/stories/s/9h78-phpi.

FIGURE 5-13 State and Local Transportation Revenue by Mode: 2017 (billions of 2017 dollars)

State and local own-source revenue ($145.9) + state and local supporting revenue ($118.0) = total state and local revenue allocated for transportation ($263.9)



NOTES: 2017 data are latest available. Own-source refers to taxes and charges levied on transportation-related activities and used specifically for transportation purposes. Supporting revenue is from non-transportation-related activities that support transportation programs, such as state or local sales or property taxes used to finance transportation projects.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Government Transportation Financial Statistics, available at www.bts.gov/gtfs as of May 2020.

TABLE 5-1 Total Transportation Investment: 2018

	Total	
	$ Billions	Percent
Total investment	3,121.1	100.0
Transportation	444.0	14.2
Transportation infrastructure	142.2	4.6
Transportation equipment	301.8	9.7
Other (non-transportation)	2,677.2	85.8
Structures	1,590.0	50.9
Equipment	1,087.1	34.8

NOTE: Totals may not sum due to rounding. Investment includes spending on new structures and equipment and exclude maintenance and repair of existing structures and equipment. Intellectual property products, such as software and research and development, not included in public investment total.

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, Private Fixed Investment in Structures by Type (table 5.4.5 millions), available at http://www.bea.gov/iTable/index_nipa.cfm as of September 2019.

Cost of Transportation

The cost to produce transportation services stems from the resources it requires, such as fuel and labor. Firms purchase these resources to produce transportation services. For example, airlines pay for pilots, commercial jets, and jet fuel to provide air transportation services. The cost of the resources used by producers of transportation services influences the prices they charge businesses and households for transportation services.

Fuel Prices

Fuel prices are a cost to industries that produce transportation services. These industries embed the costs in the price they charge businesses and households—for the transportation services they provide for a fee or for the goods they produce with the transportation services. Average annual fuel prices for all classes of transportation fuel declined in 2019 through June 2020, falling below 2016 prices—the most recent low before fuel prices began to climb in 2017 and 2018 (figure 5-14).

Labor Costs

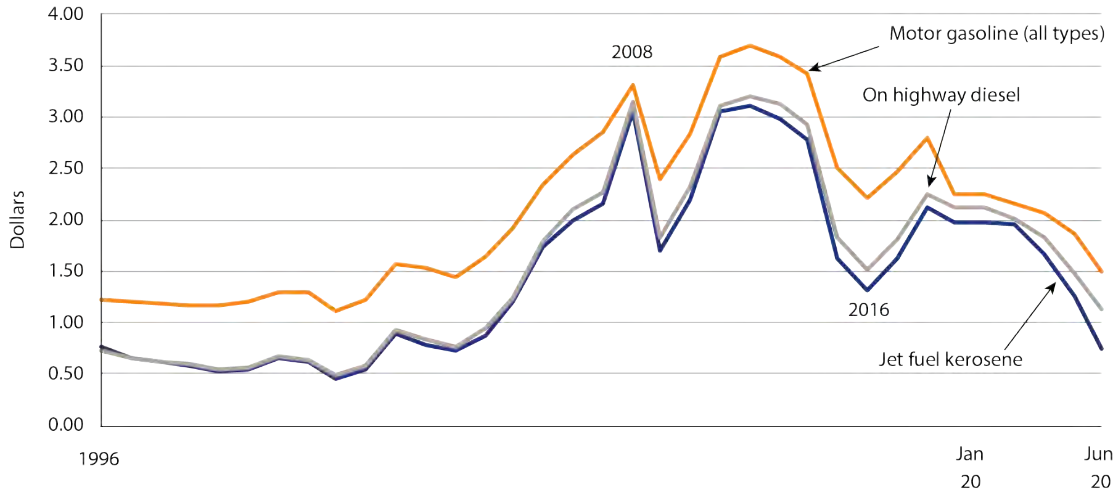
The cost of labor is an additional cost to produce transportation services. Recent data show an increase in the cost of labor for all occupations, as shown in the Employment Cost Index (ECI). The ECI provides insight into the cost of labor used to produce transportation by showing compensation costs (the sum of wages and employee benefits) for transportation and material moving workers.[10] The ECI shows that compensation costs for transportation and material moving occupations grew 3.5 percent from the first quarter of 2019 to the first quarter of 2020, whereas compensation costs for all workers grew 2.7 percent [USDOT BLS 2020]. When faced with higher labor costs, companies often increase the price they charge for goods and services to offset the decline in profit from paying more for labor.

Prices Faced by Businesses Purchasing Transportation Services

Fuel and labor, among other factors, affect the prices for-hire transportation providers charge for their services. The amount received by producers for selling their transportation services (e.g., airfares) are an indicator of the prices faced by

[10] The ECI measures the change in the cost of labor, free from the influence of employment shifts among occupations and industries.

FIGURE 5-14 Sales Price of Transportation Fuel to End-Users (dollars/gallon): 1996 to June 2020



NOTES: Motor gasoline and on-highway diesel fuel prices are retail prices and include taxes paid by the end-user. Gasoline price is the average retail price for regular and premium (leaded and unleaded) gasoline. On-highway diesel does not include bio-diesel or other alternative fuels. Jet fuel prices are based on sales to end-users (sales made directly to the ultimate consumer, including bulk customers in agriculture, industry, and utility) but do not include tax. Railroad diesel fuel prices are the average price paid by freight railroads and include taxes paid. Data for 1996—2019 are a monthly average.

SOURCES: Annual data: Bureau of Transportation Statistics, National Transportation Statistics, Table 4-11: Sales Price of Transportation Fuel to End-Users (current cents / gallon), available at www.bts.gov as of July 2019; Monthly data: U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, table 9.7, available at http://www.eia.doe.gov/emeu/mer/prices.html as of July 2020.

households and businesses purchasing transportation services. The amount received by producers for all transportation services increased modestly from 2019 through June 2020, with the amount received for water transportation services increasing the most at 2.9 percent, followed by rail transportation services at 1.1 percent, air services at 0.7 percent, and truck services at 0.2 percent (figure 5-15). As they do when faced by higher prices for labor, businesses may raise the prices they charge consumers for goods and services when they face higher prices for transportation services.

Prices Faced by Households

Households pay for travel in two ways. First, they pay to own and operate vehicles for their own use. Second, they pay fares to use for-hire passenger transportation services (e.g., air, transit bus, and rail services) for their travel.

The Consumer Price Index (CPI) for all items related to owning and operating a motor vehicle (called private transportation in the CPI) declined modestly (0.3 percent), while the CPI for public transportation increased modestly (0.3 percent) from 2018 to 2019 (table 5-2).[11] Not all public transportation prices increased. Ship fares declined 2.2 percent.

Data Gaps

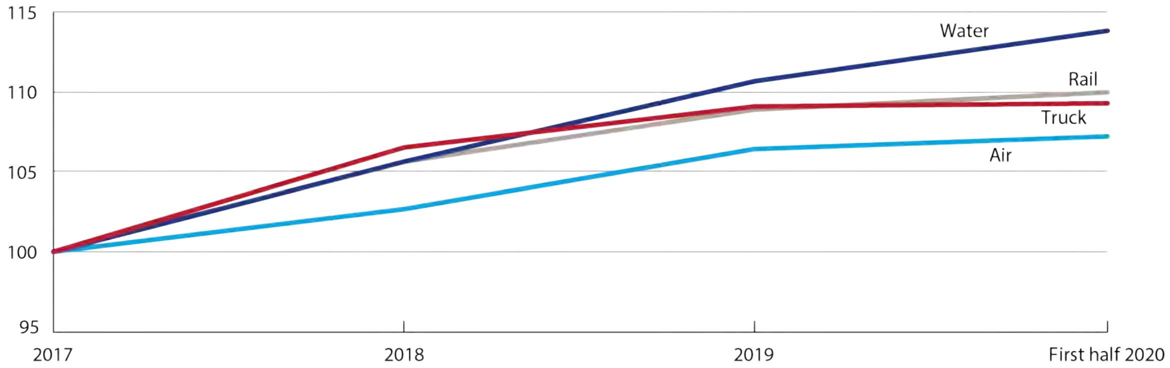
Needs for the Future

The fast-breaking changes during the COVID-19 pandemic underscore the need for the following:

- timely data on the volume of transportation services to better gauge the current supply and demand for freight transportation services, and
- timely data to measure public transportation expenditures and revenue across all levels of government.

[11] The Consumer Price Index for Urban Consumers (CPI-U) measures the change in prices paid by urban consumers for particular goods and services, such as those, related to transportation.

FIGURE 5-15 Business Costs for Purchasing Transportation Services: Producer Price Indexes for Transportation and Warehousing Services: 2017 to June 2020



NOTE: Annual averages. Rebased to 2017.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Producer Price Index Industry Data, available at http://www.bls.gov/ppi as of July 2020.

In addition, decision makers would benefit from:

- expanded financial statistics to measure innovative finance in transportation, such as Public-Private Partnerships, and
- information related to the economic contribution of shared transportation services (e.g., ride-hailing and bikeshare).

BTS has begun to improve and expand its transportation financial data series. In collaboration with the National Academy of Public Administration (NAPA), BTS has obtained input from experts and stakeholders on the limits of current transportation financial data and on suggested improvements. This collaboration resulted in ways to improve transportation financial statistics for the future, which includes:

- increasing geographic granularity,
- developing explanatory materials to increase transparency, and
- accelerating the data release process by enhancing relationships with data source agencies.

TABLE 5-2 Consumer Costs for Transportation-Related Goods and Services: Consumer Price Indexes for All Urban Consumers: 2018 and 2019

Goods and services	2018 average	2019 average	Percent change from 2018 to 2019
Overall transportation	210.7	210.1	-0.3
Private transportation	206.4	205.8	-0.3
New and used motor vehicles	99.1	99.5	0.3
New vehicles	146.3	146.8	0.4
Used cars and trucks	138.4	139.8	1.0
Motor fuel	241.9	233.2	-3.6
Gasoline (all types)	240.6	232.0	-3.6
Other motor fuels	228.8	221.2	-3.3
Motor vehicle parts and equipment	143.7	146.4	1.9
Tires	122.9	125.0	1.7
Motor vehicle maintenance and repair	286.4	296.0	3.4
Motor vehicle insurance	566.0	571.0	0.9
Motor vehicle fees	188.7	192.9	2.2
Parking fees and tolls	232.5	239.0	2.8
Public transportation	258.8	259.5	0.3
Airline fare	264.9	265.4	0.2
Other intercity	160.2	159.1	-0.7
Intercity train fare	NA	NA	NA
Ship fare	66.4	64.9	-2.2
Intracity transportation	319.8	323.3	1.1
Intracity mass transit	128.0	129.8	1.4

KEY: NA = not available.

NOTES: "New and used motor vehicles" includes all purchased consumer vehicles. "Private transportation" includes purchases made by households on new and used motor vehicles, motor fuel, motor vehicle parts and equipment, motor vehicle insurance, and motor vehicle fees. "Public transportation" includes fares for mass transit, buses, trains, airlines, taxis, school buses for which a fee is charged, and boats. Taxis are included in "intracity transportation." Change in airline fare may differ from the value reported by the Bureau of Transportation Statistics (BTS) due to differences in methodology. For information on the CPI airline fare calculation, see https://www.bls.gov/cpi/factsheets/airline-fares.htm. For airline fare information from BTS, see https://www.bts.gov/air-fares.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index (CPI-U) data, available at http://www.bls.gov/cpi as of July 2020.

References

U.S. Department of Labor (USDOL), Bureau of Labor Statistics (BLS):

—2020. Employment Cost Index: Total compensation: All Civilian [ECIALLCIV], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/ECIALLCIV, May 2020.

—2019. Employment by Occupation. Available at http://www.bls.gov/oes/ as of June 2018.

U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS):

—2020a. *Government Transportation Financial Statistics.* Available at http://www.bts.gov as of December 2019.

—2020b. *National Transportation Statistics*, table 3-23, available at www.bts.gov as of July 2020.

—2020c. *Monthly Transportation Statistics*, available at https://data.bts.gov/stories/s/m9eb-yevh as of July 2020.

—2014. *Transportation Services Index and the Economy Revisited*, December 2014. Available at http://www.bts.gov as of December 2019.

CHAPTER 6

Transportation Safety

Introduction

Transportation is notably safer today than it was 50, 30, or even 20 years ago. In general, fatalities and injured people, as well as fatality and injury rates, have all declined. However, transportation's toll in deaths and injuries remains high. There were 3,163 more fatalities across all transportation modes in 2019 than in 2010—38,203 v. 35,040 (table 6-1). Notably, the low point in fatalities was 34,568 in 2011 (figure 6-1), with transportation fatalities subsequently rising[1] [USDOT BTS NTS]. Highway fatalities account for, by far, the largest share of total transportation deaths (figure 6-2). Transportation deaths accounted for about one-fourth of the total U.S. deaths from unintentional injury in 2017 [USDHHS CDC 2019b]. Transportation also resulted in over 2.73 million injured people in 2018, mostly from the highway mode (table 6-2). This chapter discusses the latest fatality and injury statistics for 2017, 2018 and 2019 (as available) for all transportation modes. It examines potential factors contributing to crashes and accidents.[2] It also examines the progress made to improve safety and the challenges that remain. Statistics that reveal changes in transportation safety brought on by the COVID-19 pandemic will not be available for this chapter but will appear in future editions.

> ***"Safety is always No. 1 at the U.S. Department of Transportation"***
>
> ***-Secretary Elaine Chao***

[1] Total fatalities is calculated by BTS and published in the National Transportation Statistics, based upon modal fatality data provided by the National Transportation Safety Board; U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration; USDOT, Federal Railroad Administration; USDOT, Federal Transit Administration; U.S Department of Homeland Security, U.S. Coast Guard; USDOT, Pipeline and Hazardous Materials Safety Administration.

[2] Fatality and injury data are obtained and published by USDOT operating administrations. Fatality counts come from incident reports (e.g., police accident reports) or from transportation operators, such as railroads, pipeline companies and transit agencies. Most injury estimates are also reported directly from incident reports, except for estimates of highway injuries by the National Highway Traffic Safety Administration (NHTSA), which samples injury incidents from police accident reports.

Highlights

- Transportation-related accidents claimed 38,203 lives in 2019. About 2.73 million people were injured in 2018, the latest year of available data. Of the 6.75 million crashes and other incidents in 2018, 70 percent—4.82 million—involved property damage only, with no injuries or deaths.
- Between 2010 and 2019, transportation deaths rose to a high of 39,751 in 2016 and then fell for 3 consecutive years to 38,203 in 2019. 2011 had the lowest number of transportation fatalities since 1949 at 34,568. An estimated 2.73 million people were injured from transportation accidents in 2018.
- In 2019 about 95 percent of all transportation deaths and over 99 percent of transportation injuries involved highway motor vehicles.
- Rural areas, with only 19 percent of the U.S. population but about 30 percent of vehicle-miles traveled (VMT), accounted for 42 percent of all traffic fatalities in 2019. The 2018 rural area fatality rate per 100 million VMT is twice as high as the urban area rate—1.68 v. 0.86 fatalities.
- Emergency medical responses to crashes is slower in rural than in urban areas. In rural areas, about 39 percent of fatal crash victims do not arrive at a hospital for 1 to 2 hours from the time of the crash, compared to 9 percent in urban areas.
- About 2.4 males died in highway crashes to every 1 female in 2018—25,841 males vs. 10,676 females.
- Given the fact that only 10 percent of passenger vehicle occupants do not use safety belts, it is notable that 47 percent of those killed in 2018 highway crashes were unrestrained compared to 13 percent among those who used restraints.
- Alcohol-impairment is a top factor contributing to motor vehicle fatalities and recreational boating fatalities. An average of one alcohol-impaired driving fatality occurred every 50 minutes in the United States in 2018, resulting in a total of 10,011 deaths.
- Speeding coupled with drinking is often a common factor in highway crashes. Some 37 percent of speeding drivers in fatal crashes were found to have been drinking compared to 15 percent among non-speeding drivers in fatal crashes.
- Transportation accounts for about 40 to 42 percent of on-the-job fatalities in most years, the largest single cause of death. Of the 2,077 people who died in these transport incidents in 2017, 1,084 were operators of motor vehicles.

TABLE 6-1 Transportation Fatalities by Mode: 2010, 2017, 2018, and 2019

	2010	2017	2018	2019	Change from 2018 to 2019
TOTAL fatalities	35,040	39,368	38,501	38,203	▼
Air	477	347	395	452	▲
Highway	32,999	37,473	36,560	36,096	▼
Railroad[1]	599	678	683	770	▲
Transit rail[2]	122	141	174	176	▲
Water	821	709	682	697	▲
Pipeline	22	20	7	12	▲
Other counts, redundant with above					
U.S. Air carrier[3]	2	0	1	4	▲
On-demand air taxi & Commuter carrier	17	16	16	34	▲
General aviation	458	331	379	414	▲
Railroad, trespasser deaths not at highway-rail crossing	441	505	518	570	▲
Railroad, killed at public crossing with motor vehicle	136	140	132	129	▼
Rail, passenger operations	215	308	275	297	▲
Rail, freight operations	520	510	540	603	▲
Transit, non-rail	100	98	86	92	▲
Recreational boating	672	658	633	613	▼
Commercial waterborne	149	51	49	84	▲

[1]Includes Amtrak. Fatalities include those resulting from train accidents, highway-rail crossing incidents, and other incidents.

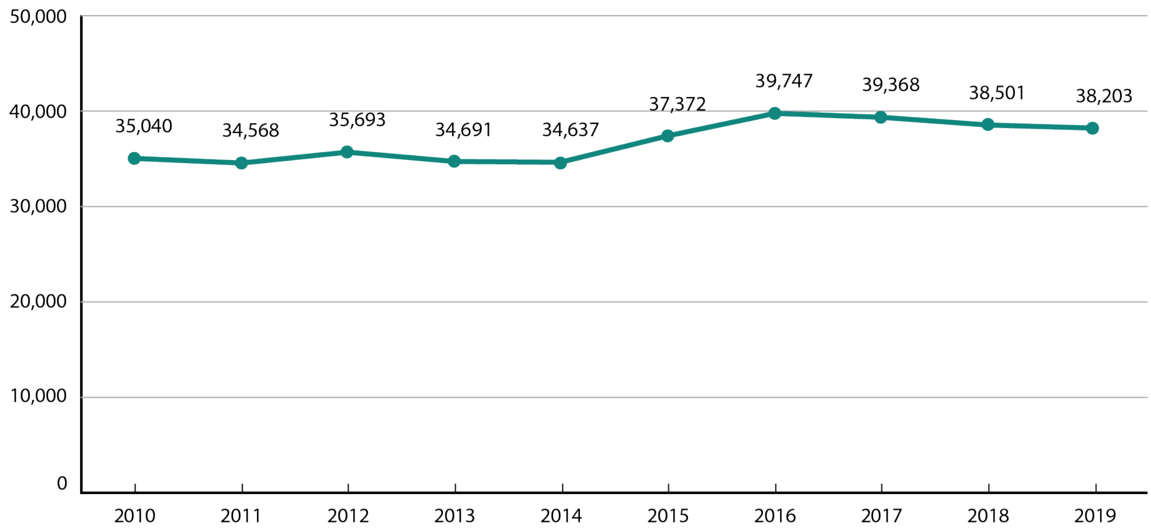
[2]Includes transit employee, contract worker, passenger, revenue facility occupant, and other fatalities for all modes reported in the National Transit Database.

[3]Air carriers operating under 14 CFR 121, scheduled and nonscheduled service.

NOTES: Pipeline fatalities includes those resulting from asphyxiation, fire, and explosions, which include causes such as excavation, natural or out-side forces, and other causes of damage or failure. Other counts, redundant with above help eliminate double counting in the Total fatalities. See NTS table 2-1 in source below for adjustments to avoid double counting, complete source notes and an expanded time-series.

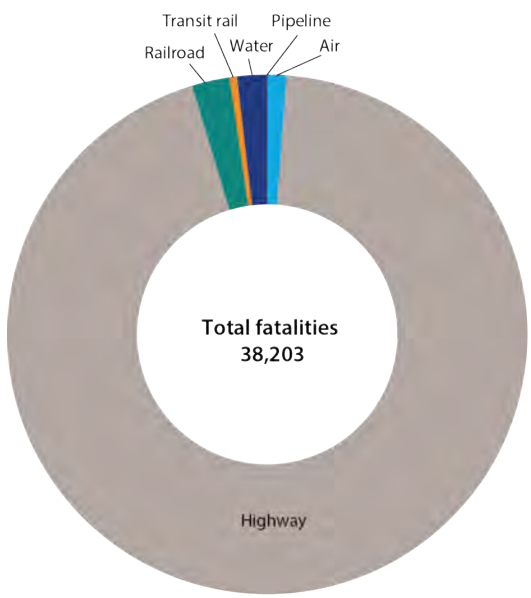
SOURCE: Various sources as cited by U.S. Department of Transportation, Bureau of Transportation, National Transportation Statistics, table 2-1, available at www.bts.gov as of October 2020.

FIGURE 6-1 Total Transportation Fatalities: 2010–2019



SOURCES: Various sources as cited by U.S. Department of Transportation, Bureau of Transportation, National Transportation Statistics, table 2-1, available at http://www.bts.gov/nts as of October 2020.

FIGURE 6-2 Share of Transportation Fatalities by Mode: 2019



NOTES: See NTS table 2-1 in source below for adjustments to avoid double counting, complete source notes and an expanded time-series. Pipeline fatalities (12 in 2019) are too few to be visible in the figure but are included in the total.

SOURCE: Various sources as cited by U.S. Department of Transportation, Bureau of Transportation, National Transportation Statistics, table 2-1, available at http://www.bts.gov/nts as of October 2020.

TABLE 6-2 Transportation Injuries by Mode: 2010, 2017, 2018, and 2019

	2010	2017	2018	2019	Change from 2018 to 2019
TOTAL	2,259,488	2,762,872	2,727,386	U	NA
Air	278	229	270	259	▼
Highway[a]	2,248,000	2,745,000	2,710,000	U	NA
Railroad	7,661	8,203	7,664	7,260	▼
Transit rail	8,671	6,320	6,367	6,645	▲
Water	3,770	3,084	3,004	2,989	▼
Pipeline	108	36	81	36	▼
Other counts, redundant with above					
U.S. Air Carrier[b]	17	19	26	18	▼
On-demand air taxi & Commuter carrier	5	4	17	14	▼
General Aviation	256	206	227	227	—
Railroad, injured at public crossing with motor vehicle	718	679	618	654	▲
Transit non-rail	16,705	16,509	16,464	16,666	▲
Recreational boating	3,153	2,629	2,511	2,559	▲
Commercial waterborne	617	455	493	430	▼

[a] 2018 and 2019 estimates are not comparable to earlier year estimates due to methodology change.

[b] Air carriers operating under 14 CFR 121, scheduled and nonscheduled service.

KEY: NA = Not Applicable.

NOTES: Please see the National Transportation Statistics table 2-2 in source below for complete source notes and an expanded time-series.

SOURCES: Various sources as cited U.S. Department of Transportation, Bureau of Transportation, National Transportation Statistics (NTS), table 2-2. Available at www.bts.gov as of October 2020.

Fatalities and Injured People by Mode

Highway Motor Vehicles

Crashes and other incidents[3] involving highway motor vehicles killed 36,096 people in 2019, according to preliminary data from the USDOT's National Highway Traffic Safety Administration (NHTSA)[4] [USDOT NHTSA 2020]. Some 2.73 million people were injured in 2018 (the latest annual injury data available when this report was finalized). In recent years highway motor vehicles were involved in about 95 percent of all transportation fatalities and 99 percent of transportation injuries in the United States. Both the number and rate of highway fatalities have decreased over the last half century—with deaths falling from a yearly rate of more than 5 per 100 million vehicle-miles of travel in the 1960s to 1.10 per 100 million VMT in 2019 [USDOT NHTSA 2020].[5]

However, since 2010, fatality numbers have fluctuated from year-to-year. In 2011 there were 32,479 highway deaths, the lowest number since 1949 [USDOT NHTSA 2019a]. Over the next 5 years fatalities rose, reaching 37,806 in 2016 and then declined each year in 2017, 2018, and 2019. The 36,096 number for 2019 represents 2 percent fewer deaths then in 2018, but 9 percent more than in 2010.

When analyzing highway safety, it is useful to examine two categories of people: vehicle occupants (counting motorcycle riders and any passengers riding with them as occupants) and non-occupants—those outside or not on the vehicle(s) when the crash or incident occurred. Since 2010, occupant fatalities have risen, from 27,889 in 2010 to 28,758 in 2019. All of the increase is accounted for by motorcyclists and occupants of large trucks.

Motorcyclist fatalities rose from 4,518 in 2010 to more than 5,000 each year from 2015 to 2019, when 5,014 motorcyclists died. This was in part due to increased ridership, the increasing age of riders, and reduced helmet usage.[6] A recent travel survey estimated that the average age of motorcycle riders and passengers riding with them increased from 46 in 2009 to 49 in 2017 [USDOT FHWA 2018]. The average age of motorcycle riders dying in motorcycle crashes increased from 40 in 2008 to 42 in 2017 [USDOT NHTSA 2019c]. The number of motorcyclist fatalities per vehicle-miles traveled was about 27 times greater than that for passenger car occupants in 2018 [USDOT BTS 2019a].

Large-truck occupant fatalities increased each year from 2015 to 2019, as fatalities climbed to 892—up from 530 in 2010. The number of people killed outside the large truck in these crashes rose from 3,146 to 4,113 in the same period—a level not seen since 1988 [USDOT NHTSA 2019a and 2019b].[7]

Non-occupant fatalities—pedestrians, bicyclists and other cyclists[8], and bystanders struck by motor vehicles, increased by more than 2,200 between 2010 and 2019, when 7,338 non-occupants died. Pedestrians and bicyclists/other cyclists struck by motor vehicles accounted for about 20 percent of total transportation-related deaths in 2018, up over

[3] Crashes and other incidents include a motor vehicle traveling on a trafficway customarily open to the public and result in the death of a person (occupant of a vehicle or a non-occupant) within 30 days of the crash. Other incidents also include an event between a vehicle (passenger car, truck, bus, or motorcycle) and a non-occupant such as a pedestrian, pedalcyclist, or other vehicle types.

[4] NHTSA's 2019 data are from a preview report, published in October 2020, may be further refined as new data become available. This number was lower than an early estimate published in May. In issuing its data, NHTSA typically first provides an early estimate of fatalities for the just completed data year. This is followed by preliminary data file, and a final data file with revisions where needed in the preliminary data.

[5] The historic low fatality rate was 1.08 per 100 million VMT in 2014 [USDOT NHTSA 20191 and b].

[6] For additional information on motorcycle safety, please see *NHTSA Traffic Safety Facts: Motorcycles*, which is available at https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812785.

[7] NHTSA cautions that some large-truck body types were misclassified as light trucks in pre-2016 data, resulting in an understatement of large-truck crashes. The problem has been resolved for 2016 and beyond, but NHTSA does not plan to adjust the data for earlier years due to lack of needed source materials [USDOT NHTSA 2019g].

[8] Bicyclists and other cyclists including riders of two wheel, non-motorized vehicles, tricycles, and unicycles powered solely by pedals.

7 percent since 2000. However, pedestrian deaths remained below the highpoint of about 8,000 in 1980 [as cited in USDOT BTS NTS table 2-1].

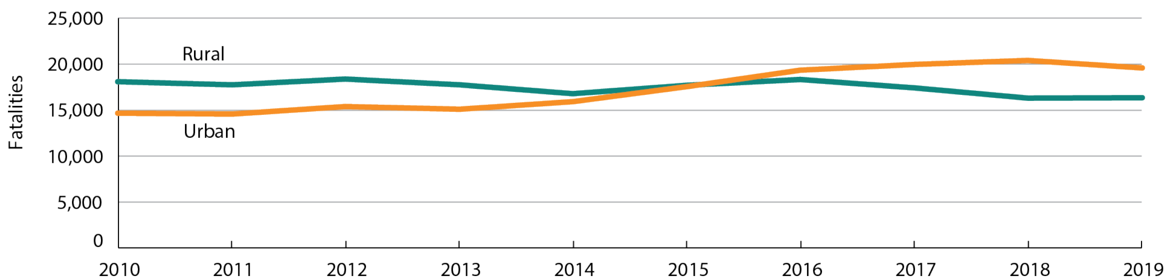
Rural/Urban Highway Fatalities

While rural areas account for only 19 percent of the U.S. population and about 30 percent of VMT, 45 percent of all traffic fatalities occurred in rural areas in 2019 (figure 6-3). The rural area fatality rate per 100 million VMT is twice as high as the urban area rate—1.66 v. 0.86 fatalities, respectively (figure 6-4). NHTSA's analysis of rural fatalities showed that emergency medical response time is slower in rural areas than urban areas. In rural area fatal crashes, about 39 percent of crash victims do not arrive at a hospital for 1 to 2 hours from the time of the crash.

That percent in urban areas is 9 percent [USDOT NHTSA 2019a]. Still, the number of fatalities has been increasing in urban areas while decreasing in rural areas (figure 6-3). Rural fatalities decreased by 13 percent between 2010 and 2019, while urban fatalities increased by 25 percent during this 10-year period [USDOT NHTSA 2019b and 2020].

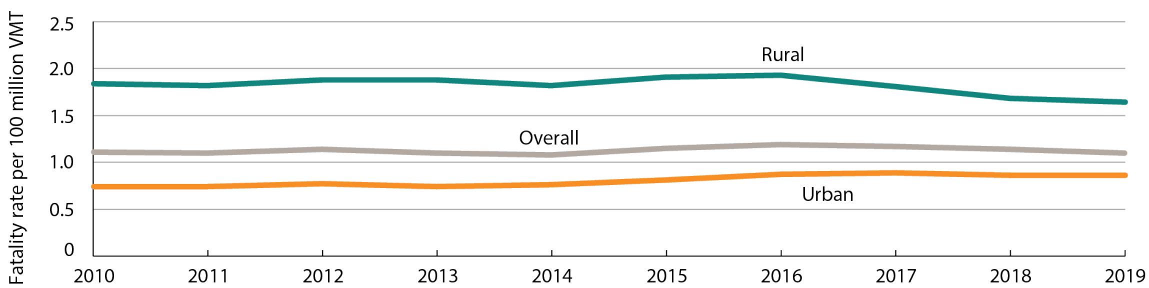
Since 2010, the overall number of rural traffic fatalities declined by nearly 2,500, totaling 16,340 in 2019 (by contrast, urban traffic fatalities increased by nearly 5,000, reaching 19,595 in 2019) [USDOT NHTSA 2019b]. Rural areas are the site for about 57 percent of fatal crashes involving large trucks, including many trucks carrying loads to and from urban areas. This is a decline from 61 percent in 2015 [USDOT FMCSA 2019a].

FIGURE 6-3 Motor Vehicle Traffic Fatalities, by Year and Location: 2010–2019



SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, DOT HS 813 021, available at http://www.nhtsa.dot.gov/ as of October 2020.

FIGURE 6-4 Fatality Rates per 100 Million Vehicle-Miles Traveled (VMT), by Year and Location: 2010–2019



NOTE: *Urban* and *Rural* fatality rates are currently unavailable.

SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, DOT HS 813 021 and DOT HS 813 004, available at http://www.nhtsa.dot.gov/ as of December 2020.

People Injured in Motor Vehicle Accidents

In 2018 motor vehicle occupants were the fourth largest category of people treated in hospital emergency rooms for non-fatal injuries [USDHHS CDC WISQAR]. NHTSA estimates that 2.75 million people were injured in motor vehicle accidents in 2017, of whom 225,000 (or 8 percent) were incapacitated. Estimates for 2018 indicate a 1.3 percent decline to 2.73 million [USDOT NHTSA 2019f]. Due to a change in estimation procedures, it is not appropriate to compare 2016 (3.06 million injured people), 2017, and 2018 numbers with earlier year estimates.[9] Injury estimates for 2019 were not yet available when this report was finalized.

The human and economic costs of injuries from motor vehicle crashes are great—in 2012 there were about 6,900 emergency room visits and 515 hospitalizations per day to treat crash injuries. Summed up over a year, the nearly 188,000 hospitalizations entailed lifetime medical costs of $18.4 billion [USHSS CDC 2014]. Motor vehicle injuries also result in other costs, such as lost workplace and household productivity, and indirect costs arising from traffic stoppage at the crash site. Accounting for all these costs, the total 2010 economic cost from motor vehicle injuries was estimated at $242 billion. An even greater toll is taken when lost quality of life from pain and injury are considered. When all these estimates were summed, the total comprehensive cost[10] was $836 billion in 2010 [USDOT NHTSA 2015]. The costs of motorcycle crashes are especially high, with $12.9 billion in economic costs and $66 billion in comprehensive societal economic costs.[11]

Other Transportation Modes

Other non-highway transportation modes include aviation (including both commercial air carriers and general aviation), railroads, rail transit, water (especially recreational boating), and pipeline—with most showing declining trends over the last decade. Between 2010 and 2019, while air, water, and pipeline declined, rail and transit rail increased somewhat (table 6-1). In 2019 2,107 people died in accidents involving these non-highway modes—compared to 2,041 in 2010. As for injured people, excluding transit rail which is addressed separately below, air, railroad, water, and pipeline injuries fell from 11,817 to 10,544 between 2010 and 2019 (table 6-2). People injured on transit rail fell from 8,671 in 2010 to 6,645 in 2019. Most transit takes place on highways. Bus and other non-rail transit injured people have averaged a little over 16,000 per year between 2010 and 2019 [as cited in USDOT BTS NTS table 2-2].

Aviation

Aviation safety statistics can be separated into commercial (for-hire aviation, including air carriers, commuter air carrying 10 or fewer passengers, and air taxis) and general aviation. After many years with no passenger fatalities, U.S. air carriers recorded one fatality in 2018 and 4 fatalities in 2019. As for air taxis and commuter air, there were 34 fatalities in these services in 2019, up from 12 fatalities from in 2018. This compares with annual averages of 21 between 2010 and 2018, 43 deaths per year between 2000 and 2009, and about 64 deaths annually between 1990 and 1999. [12]

---

[9] NHTSA's injury estimates for 2016 and beyond are obtained from a new sample design and are not comparable to prior years estimated from a different sample. NHTSA's new estimation procedure is called the Crash Report Sampling System; it replaces the General Estimates System, first used in 1988. NHTSA cautions not to compare the 2016–2018 numbers with estimates made in prior years (2015 and before) using the earlier methodology. additional information on the Crash Report Sampling System is available at: https://www.nhtsa.gov/crash-data-systems/crash-report-sampling-system.

[10] These costs include productivity losses, property damage, medical costs, rehabilitation costs, congestion costs, legal and court costs, emergency services such as medical, police, and fire services, insurance administration costs, and the costs to employers.

[11] For more detailed discussion of the cost of motor vehicle crashes, see USDOT NHTSA The Economic and Societal Impact of Motor Vehicle Crashes, 2010 (May 2015, revised edition). DOT HS 812 013. Available at http://www.nhtsa.gov/ as of October 2020.

[12] Although not involving U.S. carriers, two fatal crashes in foreign countries involving Boeing 737 MAX 8 series aircraft in 2018 and 2019 resulted in the FAA grounding of all airplanes of this type indefinitely on March 13, 2019.

General aviation (GA) fatalities fell from 458 in 2010 to 331 in 2017, and then rose in 2018 and 2019, reaching 402 in 2019. There was a mixed record for two other measures of general aviation safety trends. One measure, the number of fatal accidents, continued its steady decline from over 400 per year in the early 1990s to 227 in 2019. The number of fatal crashes differs from the number of fatalities due to year-to-year variation in the number of plane occupants who died. The other measure, the GA fatal accident rate per 100,000 flight hours, rose for fiscal year 2018 (Oct. 1, 2017 through Sept. 30, 2018) according to preliminary data. The rate increased to 1.029, up from 0.935 in 2017 [NTSB 2019]. The 2018 increase ended 6 straight years of improvement.

Unmanned aircraft systems (UAS), or "drones," pose several challenges for aviation safety, but as of this writing no crashes have resulted. While there have been numerous sightings of unauthorized drones from planes in the air and near airports, information is currently too limited to determine the risks of collision with planes piloted by humans or damage on the ground to people or facilities.[13] However, UAS have been involved in six highly probable or confirmed drone strikes investigated by the NTSB in U.S. airspace [AOPA 2020]. While the potential for adverse safety impacts of amateur drone use are much discussed, the transportation sector is adopting many innovative applications for drones that could improve safety, such as surveilling traffic conditions and monitoring the physical condition of bridges.

Railroad[14]

Most deaths associated with railroad train operations occur outside the train, such as people struck by trains while on track rights-of-way or people in cars struck at highway rail-grade crossings. Very few train passengers or crew members have died in train accidents in the last ten years. Between 2010 and 2019, 55 train passengers died in train accidents—less than 6 per year—but a total of 7,621 people died in railroad accidents or incidents outside the train, an average of 762 people per year [as cited in USDOT BTS NTS].[15] Trespasser and grade crossing issues are further discussed under the failure to exercise needed precautions section of the chapter.

Of the 900[16] people who died in railroad-related accidents in 2019 [as cited in USDOT BTS NTS] the Federal Railroad Administration (FRA) attributes about one-third of the deaths to passenger train operations and two-thirds of the deaths to freight train operations, which accounted for far more train-miles than passenger train-miles [USDOT FRA OSA].

Transit[17]

The 268 transit fatalities[18] in 2019 were slightly above the 2018 total of 260 and average of 246 fatalities per year over the past decade. Two-thirds (176) of the 2019 deaths involved transit rail and about one-third (92) involved bus, according to data reported to the Federal Transit Administration (FTA) [USDOT FTA NTD].[19] This compares with 174 transit rail deaths and 86 transit bus fatalities in 2018. Like the railroad mode, most of the fatalities in transit-related accidents are

[13] UAS sightings and near misses are further discussed in USDOT BTS *Transportation Statistics Annual Report 2018*, p. 6-8.

[14] Data in this section are as reported to the Federal Railroad Administration (FRA) as of October 2020. Numbers may change as FRA receives additional or amended reports from railroads.

[15] Not counted here are passengers who died as a result of non-train related events (e.g., health-related deaths).

[16] In table 6-1, the 900 railroad total deaths are the sum of passenger operations and freight operations in the "other counts, redundant with the above."

[17] In table 6-1 and figure 6-4, the number of transit passenger fatalities includes both passengers on the vehicle and those struck while waiting to get on or who have just gotten off the vehicle.

[18] Includes transit rail and non-rail modes (e.g., aerial tramway, motor bus, bus rapid transit, commuter bus, demand response, demand taxi, ferryboat, jitney, publico, trolleybus, and vanpool fatalities).

[19] Rail transit accounts for slightly more than half of the transit fatalities reported to the Federal Transit Administration: however, commuter rail and Port Authority Trans Hudson heavy rail safety data are counted in Federal Railroad Administration data.

not passengers or transit employees/contractors inside the transit vehicle. Onboard fatalities, 14 passengers (9 on transit rail, 5 on bus) and 4 vehicle operators, together accounted for roughly 5 percent of the transit fatalities in 2019 (figure 6-5). In 2019, 73 (or about 27 percent) of the transit fatalities were suicides.

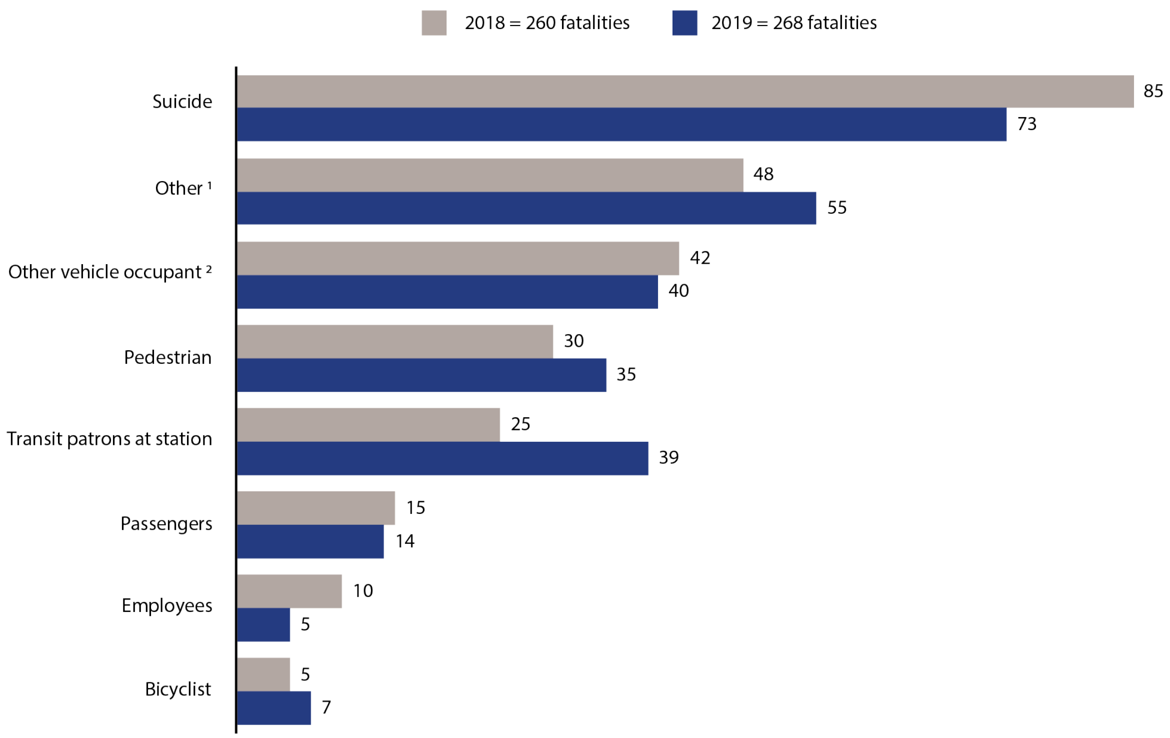
According to data reported to FTA, the number of security or crime events on transit facilities that exceed the reporting thresholds have increased in recent years [USDOT FTA NTD].[20] Assault (1,084 events counted, 83 percent of reported events), robbery (146 events, 11 percent), and suspicious packages/bomb threats (34 events, 3 percent) were the highest reported events in 2017 and 2018.

Water

Water transportation deaths ranked third among all modes in the number of transportation deaths in 2019. Recreational boating accounts for the lion's share of water transportation deaths. The U.S. Coast Guard (USCG) reports that there were 613 fatalities in boating accidents in 2019—20 fewer than in 2018, but well above the low of 560 in 2013 [USDOT BTS NTS]. One reason for the post-2013 increase is that people had more disposable income after the end of the last recession to spend on leisure time activities, such as boating [NMMA]. Nearly all boating fatalities happen

[20] Security events must meet the National Transit Database reporting threshold i.e., injury requiring immediate transport away from the scene, a fatality, an evacuation for life-safety reasons, or estimated property damage equal to or exceeding $25,000.

FIGURE 6-5 Transit Fatalities by Category: 2018 and 2019



¹ Other includes those killed outside of a vehicle that do not fit in any other category.
² Other vehicle occupant includes the number of occupants of other vehicles killed.

SOURCE: U.S. Department of Transportation, Federal Transit Administration, National Transit Database, available at https://www.transit.dot.gov/ntd as of October 2020.

while the vessel is engaged in or transporting people to and from a recreational, fishing, or watersport activity [USDHS USCG 2020].

Out of these 613 recreational boating deaths reported to the USCG in 2019, there were 565 fatal boating accidents or incidents. Another 2,559 injured people in 3,612 reported accidents had property damage amounting to $55 million. The USCG notes that non-fatal accident statistics are "severely" underreported because people may be unaware that they are supposed to report these incidents or are unwilling to report.

Many boating fatalities occur on calm, protected waters; in light winds; or with good visibility. Alcohol use, operator distraction, failure to wear life jackets, and lack of training continue to play key roles in fatal recreational boating accidents. Seventy percent of boating accident deaths in 2019 involved motorized craft; the remaining 30 percent involved kayaks, canoes, rowboats, and other non-motorized boats.

In terms of number of fatalities, recreational boating is becoming safer. In 1980 there were twice as many fatalities as in 2019—1,360 v. 613. Even with the post-2013 increase, boating fatalities are well below the 1990s average of about 800 per year [as cited in USDOT BTS NTS]. In terms of fatality rates by amount of boating activity, however, it is not clear whether recreational boating is safer, due in part to inadequate information on boating accident exposure measures. The USCG currently uses an exposure measure based on the number of fatalities per 100,000 registered boats; but it is not known how many boats in use are unregistered, adding uncertainty to using registered boats for this exposure metric.

As for commercial waterborne transportation, such as excursion boats, freighters, and fishing vessels, there were 84 vessel-related fatalities in 2019, up from 49 in 2018.[21] Cruise ship companies that pick up or drop off passengers in the United States are expected to report suspected on-board criminal activity under a law passed in 2010. In 2018 cruise lines reported 120 alleged crimes to the Federal Bureau of Investigation. Sexual assaults accounted for 82 of the reported incidents, and 22 thefts of more than $10,000 were the second highest category. While no homicides were reported, there were 5 suspicious deaths and 5 missing U.S. nationals in 2018 [USDOT].

Oil/Hazardous Liquid and Gas Pipelines

There were 12 pipeline fatalities in 2019 arising from all oil and gas pipeline incidents—up from 8 in 2018.[22] Gas pipelines (especially gas distribution pipelines) account for most of the fatalities in most years and all the 2019 fatalities [USDOT PHMSA].

Pipeline-related fatalities averaged about 15 deaths per year in the two decades between 2000 and 2019. Injuries averaged 61 per year during this period. Gas pipelines accounted for most of the fatalities—averaging 12 per year for gas distribution pipelines and 2 per year for gas transmission lines. Fatalities for hazardous liquid pipelines averaged 1 per year. The extent of gas pipelines outnumbered hazardous liquid pipelines almost 12 miles to 1. Pipeline incident costs averaged $471.6 million per year over the period, most of which involved oil or other hazardous liquid spills [USDOT PHMSA].

Transportation-Related Fatalities and People Injured on the Job

Transportation accounts for about 40-45 percent of on-the-job fatalities in most years, the largest single cause.[23] Some 2,080 people died in these transport incidents in 2018, or about 40 percent of

[21] This does not include people who died in incidents judged not to involve the vessel, such as slips and falls. Suicides, homicides, and some other causes of death are excluded.

[22] The USDOT Pipeline and Hazardous Materials Administration (PHMSA) groups pipeline incidents under three classifications—serious, significant, and all. The fatality data above are taken from an all incidents data pull in May 2020. Data may change as PHMSA receives additional or amended reports from pipeline entities.

[23] Since 1992, transportation's share of occupational fatalities has varied from 39.4 to 43.7 percent, with an annual average of 41.6 percent [USDOL BLS as cited in USDOT BTS NTS].

5,250 occupational fatalities, according to the latest census by the Bureau of Labor Statistics (BLS) [USDOL BLS 2019].

Roughly half of the on-the-job transportation-related fatalities—1,044—were motor vehicle operators, of whom heavy or tractor trailer truck drivers accounted for 831. Truckers had the sixth highest occupational fatality rate (26.0 deaths per 100,000 workers). There were 70 fatalities among aircraft pilots and flight engineers, giving them the third highest occupational injury fatality rate per 100,000 full time equivalent workers—58.9 (The fatal injury rate for all workers was 3.5 per 100,000 workers). Highway construction workers, railroad maintenance workers, and maritime workers also are at risk in performing their jobs. The special case of safety in highway work zones is discussed in box 6-A. Transportation events accounted for under 6 percent of the non-fatal occupational injuries and illnesses in 2018 [USDOL BLS 2019].[24]

[24] Includes non-fatal occupational injuries/illnesses requiring at least 1 day away from work.

Contributing Factors to Transportation Crashes and Accidents

Numerous human and vehicle factors, as well as circumstances in the surrounding environment, contribute to transportation crashes. The most commonly cited human factors involve driver or operator errors or risky behaviors, such as speeding, and operating vehicles or carrying out transportation operations while under the influence of alcohol or drugs, or while distracted or fatigued. Vehicle factors include equipment- and maintenance-related failures (e.g., tire separations, defective brakes or landing gear, engine failure, and worn out parts) [USGAO 2003]. In 2018 vehicle factors, most commonly tires, were recorded for 5.8 percent of large trucks (up from 3 percent in 2016) and 2.7 percent of passenger vehicles (down from 3 percent in 2016) involved in fatal crashes [USDOT FMCSA 2019a]. Factors in the surrounding environment include roadway or bridge condition, infrastructure design (e.g., short runway, no road shoulders), hazards (e.g., utility poles at the side of the road, hidden rocks under water), and operating conditions (e.g., fog,

Box 6-A Work Zone Safety

Construction and maintenance of the Nation's highways often take place while traffic is flowing in close proximity, creating dangerous conditions for highway workers and for people in passing vehicles. Short of stopping traffic altogether, all measures used to separate work zones from traffic present risks to both workers and those in vehicles, whether they are concrete barriers separating traffic lanes, barrels filled with sand or water, or workers holding hand held flags to route traffic on two-lane highways.

In 2018, 754 people died in work zone crashes—slightly down from the average for the three prior years of 767. Of the 2018 total, 124 were work zone workers.[1] An estimated 37,000 people injured from crashes took place in work zones in 2017, the last year for which data are available, including roughly 1,000 pedestrians in work zones of which nearly all are likely workers [NWZSIC]. These data suggest that most of those injured or killed in work zone crashes are people in passing vehicles, not workers in the work zone.

[1] Includes both traffic and non-traffic related causes of crashes. The total for work zone workers is from the Bureau of Labor Statistics Census of Fatal Occupational Injuries.

turbulence, choppy waters, wildfire, wet roads). About 10 percent of fatal highway vehicle crashes take place in adverse weather.

In some cases, a single factor is the clear cause of the accident (e.g., cars falling into a river due to a sudden bridge collapse or a tree falling on a passing car). But often it is hard to delineate among the various factors. In the case of general aviation, many accidents occur in bad weather when the consequences of human error are magnified by outside conditions.

Human factors often contribute to fatal crashes involving passenger vehicles (cars, vans, pickup trucks, and sport utility vehicles) and, to a somewhat lesser extent, large trucks. Driver-related factors in fatal crashes declined somewhat over the 2016–2018 period. For drivers of large trucks, the percentage of fatal crashes with one or more driver-related factors declined slightly from 32.6 to 32.3 percent, while for drivers of passenger cars, the decline was from 55.0 to 53.2 percent. There's been a decrease for large truck drivers in driver-related factors such as speeding and distraction [USDOT FMCSA 2020].

Differences by Sex and Age

The number of highway fatalities varies greatly by sex and age. Although males comprise about half of the U.S. population (estimated at 49 percent according to the U.S. Census), they accounted for 70 percent of highway fatalities in 2018. About 2.4 males died in highway crashes to every 1 female in 2018—25,841 males vs. 10,676 females [USDOT NHTSA 2019a].

Males, on average, drive about 6 more miles per day than females—about 22.2 versus 16.1 miles [USDOT FHWA 2018]. Also, males account for large majorities of the three categories of road users for whom fatality numbers have risen between 2011 and 2017; males accounted for about 70 percent of pedestrian fatalities, 88 percent of bicycle deaths, and 91 percent of motorcycle deaths occurred in 2017 [USDOT NHTSA 2019a].

Males are the drivers in 72 percent of fatal crashes and have a higher risk than females of being the driver in fatal crashes as measured by 100 million miles of vehicle travel. They are also more likely than females to be speeding (27 vs. 17 percent) and

TABLE 6-3 Age and Gender in Fatal Passenger Vehicle Crash Involvements: 2017

	Male			Female			Total[1]		
	Involved in crashes	Miles driven	Involvement rate	Involved in crashes	Miles driven	Involvement rate	Involved in crashes	Miles driven	Involvement rate
16-19	1,975	31,733	6.2	951	30,678	3.1	2,928	62,410	4.7
20-24	3,656	89,913	4.1	1,645	82,245	2	5,304	172,159	3.1
25-29	3,372	97,584	3.5	1,553	115,903	1.3	4,925	213,487	2.3
30-59	12,822	785,270	1.6	6,103	558,225	1.1	18,934	1,343,495	1.4
60-69	2,912	207,919	1.4	1,344	136,712	1.0	4,256	344,631	1.2
70-79	1,810	85,010	2.1	918	54,431	1.7	2,728	139,441	2.0
80+	1,187	19,674	6.0	555	12,309	4.5	1,742	31,983	5.4

[1]Total includes other and/or unknowns

NOTE: Involvement rate is the Number of Fatal Passenger Vehicle Crashes per 100 million miles of travel by the identified group.

SOURCE: Insurance Institute for Highway Safety, *Fatality Facts 2018 - Teenagers*, available at https://www.iihs.org/topics/fatality-statistics/detail/teenagers as of February 2020.

with blood alcohol concentrations (BACs) at or above 0.08 percent (32 vs. 21 percent) when they are in fatal crashes [IIHS 2019a].

In every age group in 2017, male drivers have higher rates of involvement in fatal crashes than females as shown in table 6-3. Teenage involvement rates are the highest, with the rate for teenage males twice that of their female cohort. Thereafter, involvement rates decline for both sexes in all age groups until age 70 and above, when they again rise.

Despite the continued high involvement rate for teenage drivers in fatal crashes, that rate is appreciably lower than in earlier decades. Many factors contributed to this decline, including greater adoption of graduated licensing systems, restrictions on nighttime driving, and prohibiting teenage drivers from having teenage passengers in their car [IIHS 2019b].

Speeding

Speeding topped the law enforcement notation list for drivers of both passenger vehicles and large trucks in fatal crashes. Impairment (fatigue, alcohol, illness, etc.) closely followed speeding as the second most cited factor for passenger vehicle drivers, while distracted/inattentive driving was second on the list for large-truck drivers [USDOT FMCSA 2019a]. In 2019, 9,478 traffic fatalities involved crashes in which one or more drivers were speeding [USDOT NHTSA 2020]. The number of speeding-related deaths fluctuate from year to year, but in the 2010 to 2019 period, speeding fatalities fell by nearly 1,030 and dropped as a portion of highway fatalities, from 32 to 26 percent. About 31 percent of motorcyclists in fatal crashes in 2018 were speeding, the highest share among vehicle driver types, as were 18 percent of passenger car drivers, 14 percent of light-truck drivers, and 7 percent of large-truck drivers in fatal crashes.

Males, especially young males, account for a high proportion of speeding drivers in fatal crashes. In 2018, 30 percent of male drivers involved in fatal crashes in the 15- to 20-year-old age groups were speeding at the time of the crashes, compared to 18 percent of the female drivers in the same age group. This difference among the sexes was evident in all age groups, even for those 75 and older, albeit the difference narrows with age.

Speeding coupled with drinking is common in highway crashes. Specifically, 37 percent of speeding drivers in fatal crashes were found to have BAC of .08 or above compared to 16 percent among non-speeding drivers in fatal crashes. About half (48 percent) of the drivers in fatal speeding-related crashes in 2018 were not wearing seat belts at the time of the crash, versus 21 percent of those involved in non-speeding fatal crashes [USDOT NHTSA 2019d].

Alcohol Abuse

All 50 States and the District of Columbia limit blood alcohol concentration (BAC) to 0.08 grams per deciliter (g/dL) while operating a highway vehicle [USDHHS NIH NIAAA]. In 2018 an average of one alcohol-impaired driving fatality occurred every 50 minutes in the United States [USDOT NHTSA 2019i]. Table 6-4 shows that 10,511 people were killed in motor vehicle crashes in 2018 in which a driver (one or more drivers in a crash could be alcohol-impaired) had a BAC of 0.08 g/dL or higher; this was a slight decline from 2017, but still 231 more deaths than in 2015. Fatalities in alcohol-impaired-driving crashes remain below the 2000 level, which was above 13,000.[25]

Figure 6-6 displays who died in fatal crashes when the driver had a BAC of 0.08 g/dL or higher in 2018. Drivers accounted for over 6,300 (61 percent) of the fatalities; about 3,000 (28 percent) were either passengers in the vehicle with an impaired driver or occupants of other vehicles, and more than 1,100 were pedestrians or other non-occupants (11 percent). Some 25 percent of

[25] According to the USDOT National Highway Traffic Safety Administration, an alcohol-impaired crash involves at least one driver or motorcycle operator with a Blood Alcohol Concentration (BAC) of at least 0.08 grams per deciliter. Crashes where the BAC of the driver or operator measures over 0.01 are considered alcohol-related or alcohol-involved crashes.

TABLE 6-4 Fatalities by Highest Blood Alcohol Concentration (BAC) in Highway Crashes: 2010, 2017, and 2018

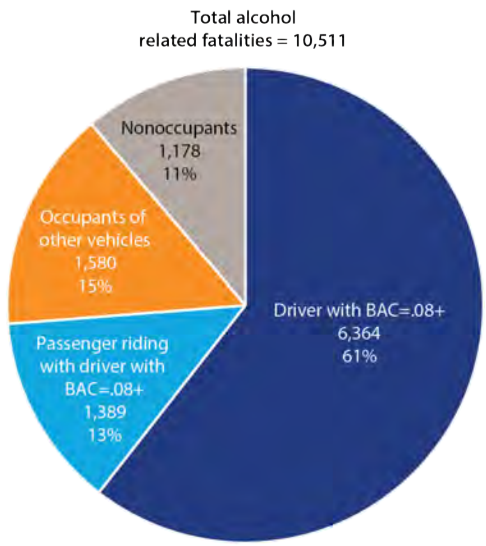
	2010	2017	2018
Total fatalities	32,999	37,473	36,560
Fatalities in alcohol-related crashes (BAC = .01+)	11,906	12,785	12,389
Percent	36.1	34.1	33.9
BAC = 0.00			
Number	21,005	24,580	24,075
Percent	63.7	65.6	65.9
BAC = 0.01–0.07			
Number	1,771	1,876	1,878
Percent	5.4	5.0	5.1
BAC = 0.08+			
Number	10,136	10,908	10,511
Percent	30.7	29.1	28.8

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 = 0.01+) may not add to totals due to rounding.

SOURCE: U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration, Traffic Safety Facts: Alcohol-Impaired Driving (Annual Issues). Special tabulation as of November, 2019.

FIGURE 6-6 Highway Fatalities in Crashes Involving at Least One Driver with a BAC of .08 g/dL or Higher by Role: 2018



KEY: BAC = blood alcohol concentration.

NOTE: Non-occupants includes pedestrians, bicyclists / other cyclist[1], and others not listed above.

SOURCE: U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration, Traffic Safety Facts: Alcohol-Impaired Driving (annual issues), available at https://www.nhtsa.gov/research as of November 2019.

[1] Bicyclists and other cyclists, including riders of two wheel, non-motorized vehicles, tricycles, and unicycles powered solely by pedals.

motorcycle operators in fatal crashes were alcohol-impaired, the highest share among highway motor vehicle driver types.

The tangible economic costs of alcohol-related crashes in 2010 were estimated to be $44 billion, and $201.1 billion when quality of life considerations were included [USDOT NHTSA 2018c]. This is nearly one-fourth of the $836 billion estimated total societal cost of motor vehicle accidents in 2010 [USDOT NHTSA 2018c].

As for people using recreational boats, alcohol use is perennially listed by the U.S. Coast Guard (USCG) as the leading contributing factor in fatal boating accidents. The USCG found alcohol use to be the primary contributing cause in 23 percent of fatal boating accidents in 2019, resulting in 113 deaths; drug use was the primary contributing factor in 4 fatal accidents, resulting in 2 deaths [USDHS USCG 2020]. As of January 1, 2019, 47 States and the District of Columbia limit BAC to 0.08 g/dL for operators of recreational boats. The remaining three States—North Dakota, South Carolina, and Wyoming—have a 0.10 g/dL standard [USDHHS NIH NIAAA].

Driving Under the Influence / While Impaired

Many states test drivers for presence of alcohol and drugs after fatal crashes.[26] A study by the Governors Highway Safety Association analyzed the results of these tests in 2016, finding that among drivers in fatal crashes that were tested

[26] Driving while under the influence may include by any legal or illegal substance such as alcohol, marijuana, opioids, methamphetamines, or any potentially impairing prescribed or over the counter drugs.

for drugs and/or alcohol, about 44 percent tested positive for drugs and just under 38 percent tested positive for alcohol. More than half of those testing positive for drugs were positive for two or more drugs, and over 40 percent were also positive for alcohol. The tests were for any presence of alcohol or drugs in the driver's system. The study noted that presence of drugs does not imply impairment [GHSA]. Since 1991[27] Federal transportation agencies have required testing on the job for safety-sensitive transportation operators and workers in many industries.[28]

[27] The testing is required by the Omnibus Transportation Employee Testing Act of 1991, Public law 102-143.

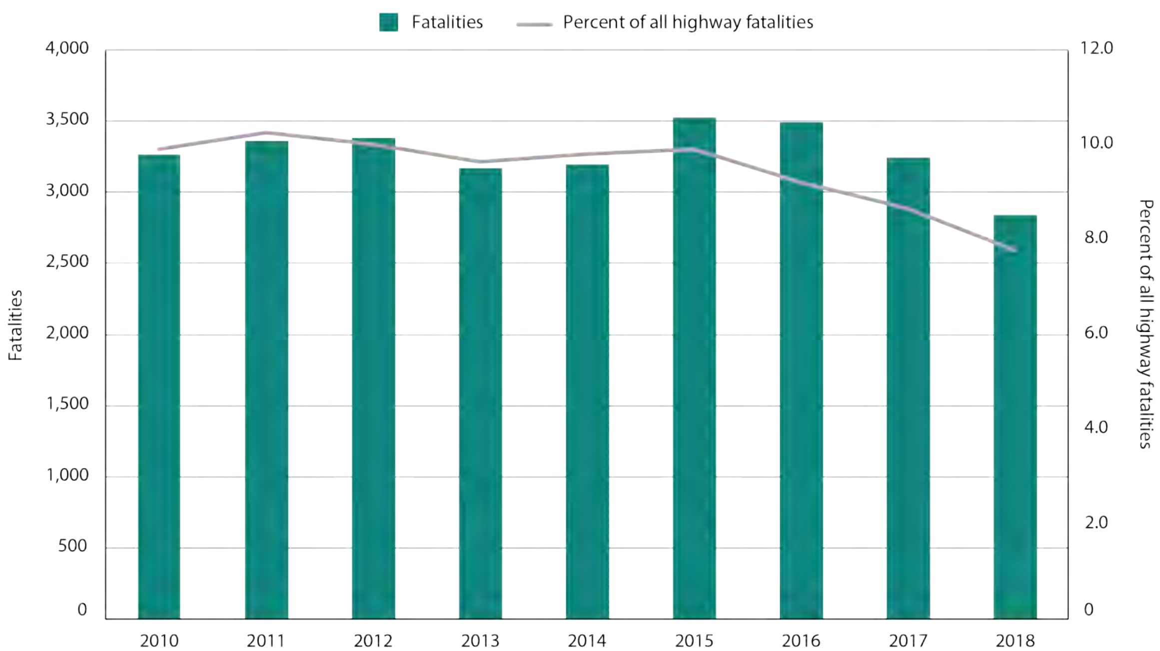
[28] For citations to Federal regulations and minimum standards for required random testing rates under regulations issued by the USDOT operating administrations and the U.S. Coast Guard, see Bureau of Transportation Statistics, Transportation Statistics Annual Report 2018, box 6-C, page 6-17.

Distraction and Fatigue

Distracted and fatigued vehicle operators are found in all modes of transportation, including airline pilots, bus drivers, train engineers, and tugboat operators [NTSB 2016]. In the case of recreational boating, operator inattention was cited as the top contributing factor in all boating accidents (nonfatal as well as fatal) in 2018, according to the U.S. Coast Guard—about 21 percent of boating accidents [USDHS USCG].

As for motor vehicles, the number of fatalities in distraction-affected highway crashes declined appreciably from 2015–2018, from 3,526 in 2015 to 2,841 or 8 percent of total fatalities in 2018 (figure 6-7). Drivers under the age of 30 are disproportionately represented in distraction-affected fatal crashes, especially drivers aged 15 to 19 years [USDOT NHTSA 2019e].

FIGURE 6-7 Distracted Driving Fatalities: 2010–2018



NOTES: Distracted driving involves any activity that could divert a person's attention away from the primary task of driving, such as texting, using a cell phone, eating and drinking, grooming, using a navigation system, adjusting a radio, etc. Distracted driving fatality data for 2010 and later years are not comparable with previous years due to changes in methodology.

SOURCES: U.S. Department of Transportation, National Highway Traffic Safety Administration, Traffic Safety Facts, Query Tool, available at http://www.nhtsa.gov as of November 2019.

Vehicle occupants comprised 82 percent of deaths in distraction-related crashes in 2018. In addition, there were 506 non-occupants who died, mostly pedestrians, in these crashes. It is not known how many non-occupants were also distracted when struck (e.g., walkers using a cell phone while crossing a street).

Although many other activities (e.g., eating, sipping coffee, smoking, grooming, tending to a child, adjusting a radio) are distracting to drivers and other vehicle operators, bicyclists / other cyclist, and pedestrians, cell phone use and texting have received the most attention as these devices have attained nearly universal usage in the last few years. Eight percent of all fatal crashes in 2018 involved distractions such as cell phones and other electronic devices. Figures 6-8a and 6-8b show that 26 States, the District of Columbia, and Puerto Rico prohibit drivers' use of handheld cell phones, and 48 states plus the District of Columbia and Puerto Rico ban texting while driving.

Drowsy driving was found to be a factor in 693 fatal crashes (about 2 percent) resulting in 775 fatalities in 2018 [USDOT NHTSA query tool]. However, it is likely that the role of fatigue in crashes has been underestimated [AAA 2018]. New research, facilitated by use of dash-cam video, may make more accurate estimation possible. In 2018 the AAA Foundation for Traffic Safety examined dash-cam footage of drivers in the moments before 589 crashes and found drowsiness in about 11 percent of crashes[29] [AAA 2018].

Distracted or inattentive driving by commercial motor vehicle drivers was a contributing factor in approximately 6 percent of fatal crashes involving large trucks in 2017. In addition, truck driver impairment (e.g., fatigue, drugs/alcohol, illness, etc.) was a factor in 4.0 percent of these fatal crashes [USDOT FMCSA 2019a].

Human Factors

Ignoring warnings is a problem common across all transportation modes, whether a changing traffic light, a railroad crossing signal, or instructions to wear life jackets on boats. The same is true in failure to anticipate changes in weather conditions in trip planning or in adjusting travel when difficult weather arises that makes continuing the course unwise.

In the case of railroads, several hundred people die every year when struck by trains while on railroad property or rights-of-way, many of which have signage warning against entry. If unauthorized, they are termed trespassers. Trespassers accounted for about 61percent of the total railroad fatalities between 2010 and 2019, or 468 deaths per year on average. After reaching a low of 399 in 2011, trespasser deaths have since risen, reaching 591 in 2019—75 more than the 1990s average of 516 fatalities per year.

Figure 6-9 shows location by county of all trespasser fatalities in the decade 2010–2019:

- 28 counties had 25 or more fatalities,
- 82 counties had between 10 and 24 fatalities, and
- 933 counties had 1 to 9 fatalities.

At the direction of Congress, the Federal Railroad Administration (FRA) recently issued a national strategy for reducing trespasser fatalities. The report found that about three-fourths of the deaths in the 10 counties with the highest trespasser fatalities occurred within 1,000 feet of a highway rail-grade crossing [USDOT FRA 2018].

Suicide is the cause of many trespassing and grade crossing fatalities. According to FRA, there were 192 suicides in 2019—about 21 percent of all railroad fatalities. Another 26 people were injured in suicide attempts.[30] Highway rail-grade crossing fatalities averaged about 255 per year in the 2010–2019 period, or roughly one-third of all railroad-related fatalities. In 2019 there were 293 deaths at grade crossings, more than half the average of 550

[29] With an injury, air bag deployment, or significant property damage.

[30] After a death is determined to be a suicide, the death is counted separately, and no longer included in other casualty counts; hence, the numbers for trespasser deaths do not include suicides.

FIGURE 6-8a State Laws on Distracted Driving—Handheld Ban: July 2020

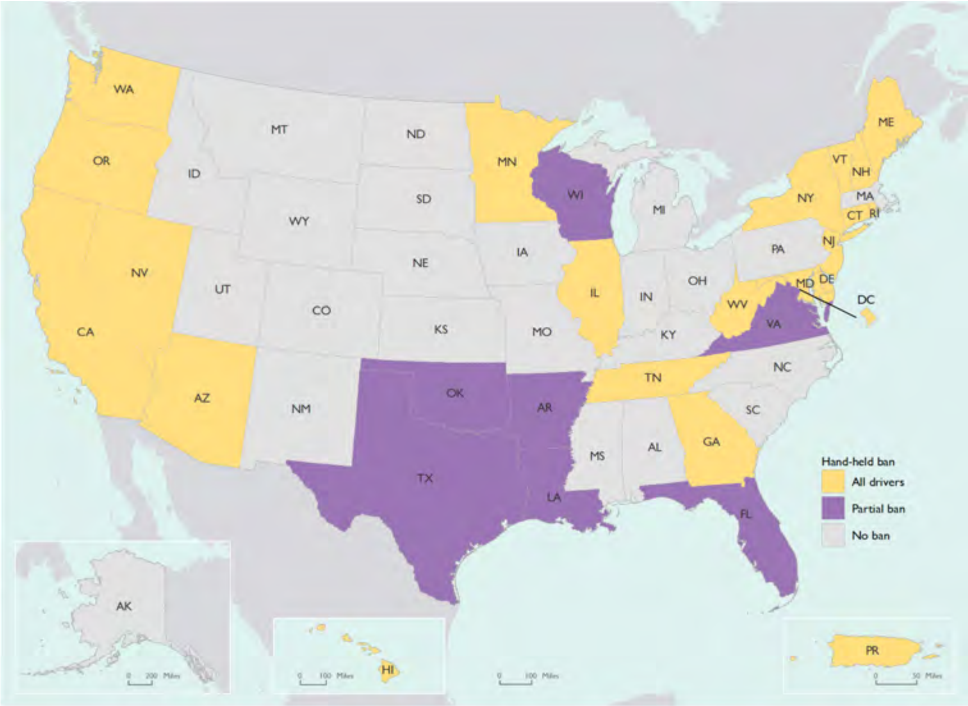
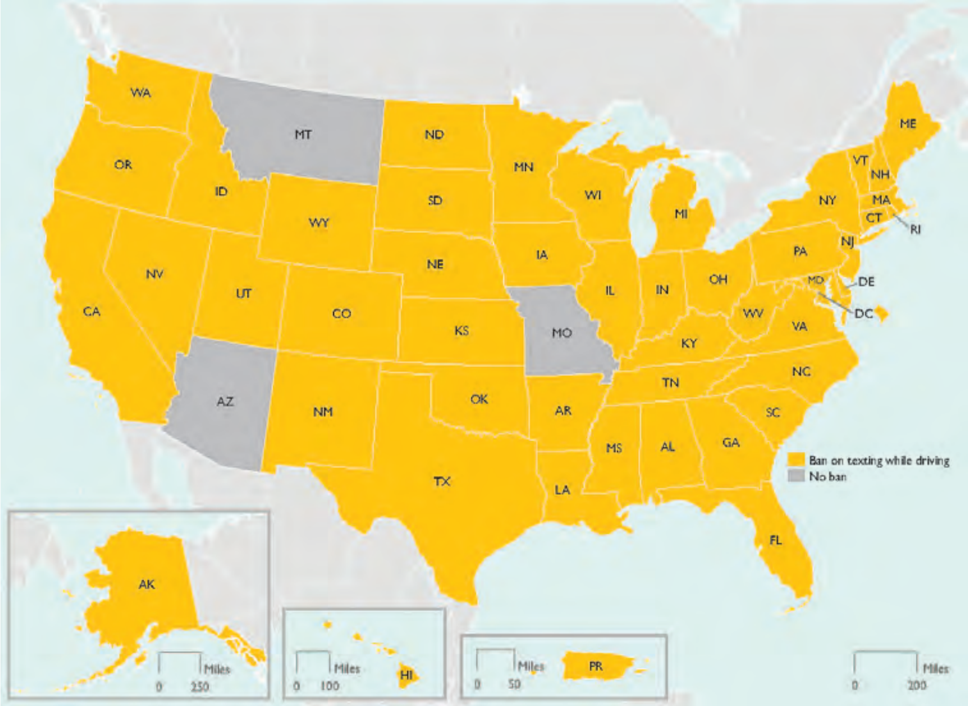


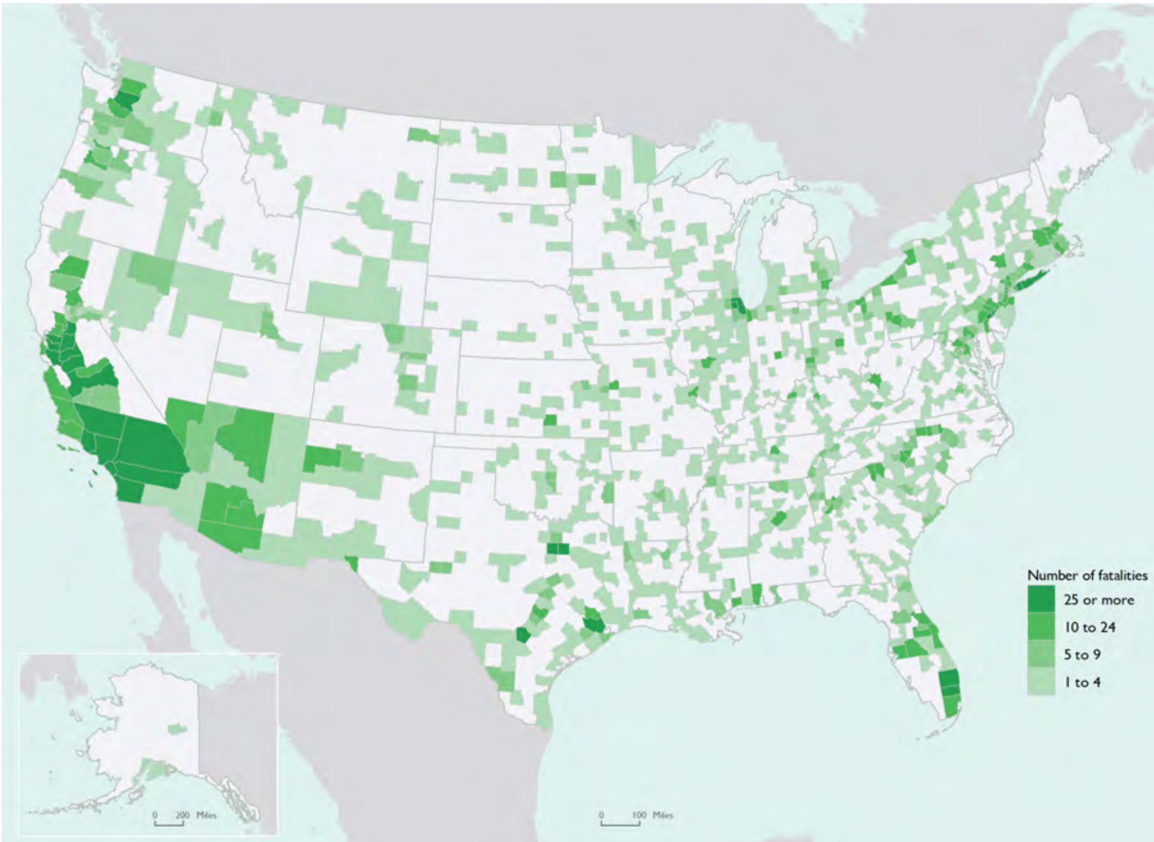
FIGURE 6-8b State Laws on Distracted Driving—Texting Ban: July 2020



NOTE: Partial ban includes select drivers (e.g., under the age of 18, those with a learner's permits or intermediate license).

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, based on the Insurance Institute for Highway Safety, Overview of Distracted Driving, Cellphones, and Texting, available at www.iihs.org as of November 2019.

FIGURE 6-9 Rail Trespassing Fatalities by County: 2010–2019



SOURCE: U.S. Department of Transportation, Federal Railroad Administration, Office of Safety Analysis, accident data database, available at http://safetydata.fra.dot.gov/ as of December 2019.

deaths per year in the 1990s [as cited in USDOT BTS NTS].[31]

In the case of general aviation, loss of control of the aircraft while maneuvering is the single biggest cause of fatal general aviation crashes, and pilot error is a major reason. This often happens due to poor judgment, failure to maintain appropriate air speed, failure to recognize circumstances leading to aerodynamic stall or spin while maneuvering the plane, and pilot inexperience or proficiency, among other factors [USDOT FAA].

Many general aviation crashes occur each year when pilots who are not instrument rated (licensed to fly using instruments in the plane when visibility is limited) or who are deficient in their instrument flying skills unexpectedly encounter adverse weather conditions that they are ill-prepared to handle [SKYBRARY]. Technology now available can allow general aviation aircraft to get up-to-date weather information along the flight path, which could make it easier for pilots to avoid bad weather.[32]

[31] Counts of highway grade-crossing fatalities are reported to both rail and highway agencies. In table 6-1, to avoid double-counting, these fatalities are included in the overall count for highways, but not for rail.

[32] As of Jan. 1, 2020, most aircraft that fly above 10,000 feet or in certain airspaces are required to have installed an ADS-B Out transmitter that transmits information to satellites about plane location. Even for aircraft where it is not required, this technology can provide general aviation pilots with up to date weather and air traffic information.

Countermeasures To Reduce Safety Risks

Over time, occupant protection devices, advances in vehicle design, improved road and infrastructure design, graduated driver licensing for teenagers, safety campaigns, enforcement of drunk-driving laws, and many other preventative measures contributed to declines in highway vehicle and other transportation deaths and injuries [KAHANE, MASTEN]. Advancements in emergency medical response capabilities and treatment also played important roles. Installation of crash avoidance technologies in new vehicles and conveyances are also working to ensure vehicles are becoming safer than ever before.

Seat Belt Use

About 90 percent of occupants of car, vans, and sport utility vehicles (SUVs) used safety belts in 2017 and 2018, up from 71 percent in 2000 and 85 percent in 2010 [USDOT NHTSA 2019a]. Pickup truck occupants had the lowest usage at 83 percent in 2017 (table 6-5). Because only 10 percent of highway vehicle occupants do not use safety belts according to the latest survey, it is notable that 47 percent of passenger vehicle occupants killed in 2018 were unrestrained. As for fatal crash survivors, 87 percent used restraints, while 13 percent did not [USDOT NHTSA 2019a].

Among states and territories, seat belt use ranged from a low of 76 percent in New Hampshire, the only state that does not require seat belt use, to a high of 98 percent in Hawaii. States with primary enforcement laws, allowing police to ticket vehicle occupants solely for not wearing seat belts, have higher belt usage (91 percent in 2018) than states with weaker or no enforcement (86 percent) [USDOT NHTSA 2019k].

Seat belt use is most effective in conjunction with air bags, which deploy automatically in crashes. Many older vehicles (as many as 4 in 10) might not have passenger side air bags. Recalls to replace defective airbags and other occupant protection equipment sometimes are undertaken, most visibly in the ongoing case of airbags manufactured by Takata Corp. As of December 2019, recalls of about 56 million airbags involving 19 automakers and 41 million vehicles had been announced [USDOT NHTSA 2019].

TABLE 6-5 Safety Belt and Motorcycle Helmet Use: 2010, 2018, and 2019
(percent)

	2010	2018	2019
Overall safety belt use[a]	85	90	91
Drivers	86	90	91
Right-front passengers	83	89	90
Passenger cars	86	90	91
Vans and sport utility vehicles	88	92	93
Pickup trucks	75	84	86
Motorcycle helmet use[a,b]	54	71	71
Operators	55	71	75
Passengers	51	69	48

[a] Seat belt use is as of the Fall of each year. Motorcycle helmet use is as of the Fall of each year.

[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 (USDOT), 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 2020 as cited in USDOT, Bureau of Transportation Statistics, National Transportation Statistics, table 2-30, available at http://www.bts.gov as of June 2020.

Helmet Use

Good helmets can be effective in protecting people from head injuries when riding motorcycles, bicycles, and the increasing number of human powered or motorized personal transportation devices, such as two-wheel scooters, skateboards, and e-scooters [MINETA]. Helmets not only protect riders in collisions, but from falls, which are common.

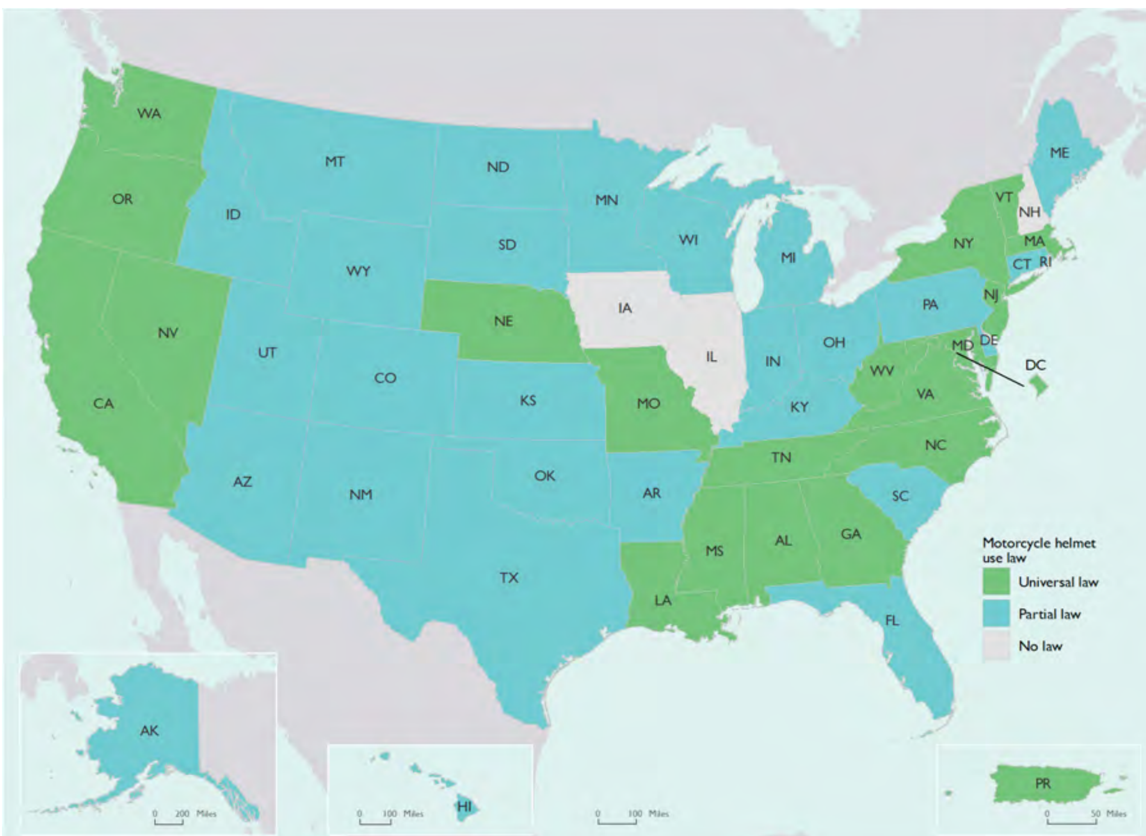
NHTSA estimates that DOT-compliant helmets[33] are 37 percent effective in preventing fatal injuries to motorcycle riders and 41 percent for motorcycle passengers [USDOT NHTSA 2019i]. Overall usage of DOT-compliant helmets has fluctuated in recent years (table 6-5), from 54 percent in 2010 to 71 percent in 2018.

In 1975, 47 states and the District of Columbia had adopted universal helmet use laws that required motorcycle helmets for all riders, but many states have subsequently made their helmet laws less restrictive [COSGROVE]. In 2019 only 21 states, districts, and territories, including the District of Columbia and Puerto Rico, continued to have universal helmet use laws (figure 6-10).

An average of 749 bicyclists each year were killed in incidents with motor vehicles between 2009 and 2018, with the 2015–2018 annual average rising

[33] DOT-compliant helmets provide a standard of protection specified in Federal Motor Vehicle Safety Standards No. 218, which includes standards for energy attenuation, penetration resistance, chin strap structural integrity, and labeling requirements

FIGURE 6-10 State Laws on Motorcycle Helmet Use: 2019



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, based on Insurance Institute for Highway Safety, Highway Loss Data Institute, Motorcycle Helmet Laws, available at www.iihs.org as of March 2020.

to 819. Tens of thousands more bicyclists end up in hospital emergency rooms with serious injuries. Not all bicyclist fatalities or injuries involve motor vehicles or occur on public roadways, and these are less likely to be reported by police. Many of these injuries do not involve motor vehicles (e.g., rider falls off bike on bike path). Helmet use has long been advocated for bicycle riders, and many states have laws requiring children riding bicycles to wear helmets but no similar requirement for adults, who account for the most deaths and injuries. A study of 76,000 bicyclists treated in hospitals and intensive care units for head and neck injuries between 2002 and 2012 found only 22 percent of the adult bicyclists wore helmets, and only 12 percent of injured children under 17 wore helmets [SCOTT ET AL].

Helmet use (or lack thereof) is also a prominent issue in many cities where battery powered e-bikes and e-scooters are available for rent. These rental locations are basically wherever the last rider left them, and helmet use by new riders is not monitored. Box 6-B describes the safety issues associated with the emergence of e-scooters in many of the Nation's cities.

Box 6-B E-Scooter Safety

Rental e-scooters started to show up in U.S. cities in 2017. The number of bikeshare and e-scooter systems has reached almost 300 serving more than 200 cities [USDOT BTS 2019b]. With the swipe of the app on a smart phone, riders can get on and ride these stand-up, battery-powered scooters from wherever the last renter left them. Convenient and cheap to rent for short periods of time—metered by the minute—these devices are seen by some transportation planners as a solution to the "last mile problem," making it easier for people to get to and from their homes to transit stations and to their ultimate destinations. E-scooters are now widely available in numerous cities, although New York and some other cities continue to ban them from city streets and sidewalks.

Rider safety, and to some extent pedestrian safety, are a concern as rental opportunities for these devices have proliferated. Few users wear helmets and training even for first time users is often limited to tutorials presented on the app. Sidewalk and road maintenance is also an issue, as scooter riders can be bumped off by cracks and other imperfections in the sidewalk or potholes. Scooters left on sidewalks can also be a tripping hazard for pedestrians, especially the elderly and vision impaired.

No nationwide estimates of injuries are yet available. E-scooter mishaps often go unreported to police unless a motor vehicle is involved. Riders often go to hospital emergency rooms for treatment of their injuries if they fall or run into something, but many hospitals do not separately keep data on scooter injuries. Some cities with widespread scooter use, such as Austin, TX, are beginning to collect data, but coverage is spotty. Austin's public health agency, in cooperation with the Federal Centers for Disease Control, interviewed 190 injured scooter riders, found that 80 percent had a fracture or other serious injury, and 15 percent had evidence of traumatic brain injury (less than 1 percent of the injured were wearing a helmet). Some 55 percent of the injured scooter riders were injured on the street, 33 percent on the sidewalk, and 16 percent of the mishaps involved a motor vehicle [APH].

As more e-scooters and other kinds of personal or micromobility devices appear on sidewalks, streets, and other public ways, complete data about safety risks will be crucial to developing strategies to reduce injuries.

Occupant Protection

Many studies over the years have concluded that safety devices, such as flotation devices for boaters, seat belts, frontal air bags, child restraints, and motorcycle helmets, help save lives and reduce injuries in crashes and other transportation incidents. About 79 percent of people who died in boating accidents in 2019 drowned, and 86 percent of those who drowned were not wearing a life jacket.

Training and Refresher Training

For all transportation modes, operator training can enhance safety. Driver education courses for high school students are a prerequisite for a driver's license in all states, and a certain degree of proficiency is expected. Commercial driving licenses require training on the type of highway equipment the driver seeks to operate.

The Federal Aviation Administration requires pilots to have not only pilot licenses but also currency (i.e., recent flying experience), even in general aviation. However, many general aviation pilots fly sporadically, and their skills may be deficient. While pilot licenses do not expire, conditions are attached. For example, private pilots only authorized to fly under visual flight rules (good visibility and in daylight) need to take additional measures to be authorized to fly under instrument flight rules when visibility or conditions are poor, and their airplanes may not be equipped with up-to-date instrumentation. This can be a major concern for pilots when weather conditions change from visual flight rules to instrument flights rules.

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 43 percent of U.S. boat owners have taken a boating safety course. Most boating fatalities occur on vessels in which the operator had no formal instruction in boating safety. Only 20 percent of deaths in fatal boating accidents in 2019 occurred in boats operated by a person known to have received a certificate for boating safety from a nationally approved provider [USDHS USCG 2019].

Monitoring and Enforcement of Safety Standards

Traffic safety enforcement promotes good driving habits (e.g., wearing a safety belt) and discourages unsafe behaviors (e.g., speeding, impaired driving). According to the Bureau of Justice Statistics, about 8.6 percent of the Nation's 223 million drivers in 2015 were stopped by police. Speeding was the leading reason, accounting for about 41 percent of stops, followed by vehicle defects (e.g., broken tail light) at around 12 percent. Among many other reasons given for stops were seatbelt violations (about 3 percent), cell phone violations (about 2 percent), and sobriety checks (about 1 percent). About 15 percent of drivers between 18 and 24 years of age were stopped—the highest percentage among all age groups [USDOJ BJS].

In 2017, according to the Federal Bureau of Investigation, law enforcement agencies across the country made just under 1 million arrests for driving under the influence (DUI). Males accounted for three out of four DUI arrests [USDOJ FBI]. Studies have shown sobriety checkpoints are an effective countermeasure to reduce alcohol-impaired driving. Such checkpoints reduce alcohol-related crashes by roughly 20 percent [USDHHS CDC 2015]. Not all states authorize these checkpoints, however.

The Federal Motor Carrier Safety Administration (FMCSA) is responsible for reducing crashes, injuries, and fatalities involving the Nation's approximately 512,000 interstate freight carriers (including a large number of self-employed truckers), 13,000 interstate passenger carriers, and 19,000 interstate hazardous material carriers [USDOT FMCSA 2018a]. In fiscal year 2019, about 3.5 million roadside inspections of trucks and buses were conducted by state and federal inspectors. About 26,000 warnings letters were issued to 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 2020c]. Inspections may reveal violations that must be corrected before the driver or vehicle can return to service. In 2019 vehicle violations, such as defective lights, worn tires, or brake defects, put about 21 percent of inspected trucks out-of-service until corrected. Truck driver violations put about 5 percent of drivers out-of-service, often due to non-compliance with hours-of-service regulations. As discussed earlier, fatigue is a factor in many crashes. Comparable numbers for motor coaches were about 6.5 percent for vehicle violations and 4.8 percent for driver violations. FMCSA estimated that carrier interventions saved 212 lives and prevented 7,136 crashes and 3,965 injuries in fiscal year 2014, the last year of published data [USDOT FMCSA 2018].

U.S. railroads, most of which are privately owned and operated, are responsible for maintaining their own track and rolling stock in a state of good repair adequate to meet public safety requirements. Railroad operators must comply with detailed track inspection standards promulgated by the Federal Railroad Administration. As discussed in box 6-C, some railroads are exploring additional ways to partially automate the inspection process.

Hazardous Materials Transportation

Transporting hazardous materials requires special precautions, handling, and packaging. There are specialized safety regulations, standards, and reporting systems in place for pipelines, rail, highway, air, and marine 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 6-6 shows that, in 2019, over 22,000 hazardous materials incidents (excluding pipeline incidents) were reported to the USDOT Pipeline and Hazardous Materials Administration (PHMSA)—up from about 19,900 in 2018 [USDOT PHMSA 2020]. In 2018, the Nation had 215,993 miles of oil pipeline and 2,542,504 miles of gas pipeline.

Most hazardous materials incidents occur during the storage or handling of the materials, such as manipulating containers or loading and unloading them for transport. Of the total incidents shown in table 6-6, about 5,700 occurred during loading and roughly 10,700 occurred during unloading. Spillage during transport accounted for additional incidents. Only about 25 percent (about 5,700) of hazardous materials incidents in 2019 resulted from an accident during transportation (e.g., vehicular crash or train derailment). About 79 percent of these accidents happened on highways or in truck terminals.

The above incidents do not include pipelines, which are reported separately to PHMSA. Table 6-7 shows the severity of pipeline incidents from 2010 through 2019 in terms of deaths, injured people, property damage, and liquid spilled. Figure 6-11 summarizes hazardous liquid-related and gas-related pipeline incidents reported from 2010, 2018, and 2019. Year-to-year variation in the number of hazardous liquid incidents is evident, with no consistent trend apparent. The number of barrels of oil moved by pipeline increased from 594 million barrels in 2010 to 1,484 million in 2019 [USDOT BTS NTS].

The pipeline industry is adopting many technical innovations that have the potential to make pipeline operations safer and/or less likely to spill gas or hazardous liquids into the environment. Several involve easier and less intrusive means for detecting existing pipelines, a key concern in areas where new construction might result in damage to gas distribution pipelines. Other innovations focus on leak detection (including aerial identification of leak plumes), detecting corrosion or other pipeline defects, and advanced welding techniques for repair of in-service pipelines [USDOT PHMSA].

Rail Tank Car Safety

There has been a large increase in the total crude oil moved by rail, up from 23.7 million barrels in 2010 to 250.2 million in 2019, but down from a peak of 382.0 million in 2014 [USDOE EIA]. Several derailments resulting in explosions and fireballs have occurred in this country, resulting in community evacuations. In Canada, a 2013 rail catastrophe in Lac-Mégantic, Quebec, involving

Box 6-C Innovation's Role in Railroad Track Inspection

U.S. railroad companies inspect and maintain their own tracks, and the USDOT Federal Railroad Administration (FRA) conducts inspections to assess the effectiveness of railroads' maintenance process and compliance with track safety standards. This keeps the Nation's nearly 93 thousand miles of Class 1 railroad trackage operating safely [USDOT BTS NTS]. As an aid in that process, as mentioned in chapter 2, FRA operates a small fleet of instrumented inspection cars that monitor rail conditions on high-priority or high-density rail routes. The cars measure items such as track alignment, elevation differences between the rails, and whether elevation is appropriate for operating speed into a curve. In 2018 the FRA inspection cars identified five exceptions to design standards per 100 miles of inspected track over the 83,000 miles examined [USDOT FRA 2018].

FRA has also worked with railroads to adapt autonomous track inspection technologies for use on a variety of standard railroad cars, including boxcars and passenger cars. Autonomous track inspection is done by unattended instruments mounted on or in trains with little need for human operators [AREMA 2014]. While visual track inspection, the oldest and most common way to identify track problems, continues to be required in most circumstances, proponents of greater automation in the inspection process maintain that it offers the benefits of speedier and safer inspection, less disruption of operations, and often greater inspection frequency than manual inspection. It also may help identify problems before a potentially dangerous circumstance is evident from human inspection alone [BLET].

Beginning with Amtrak's high-speed Acela service in the late 1990s, unattended inspection instruments on-board trains operating their normal routes have been deployed to collect data on train/track interactions that are transmitted to servers at maintenance centers [AREMA 2009]. This data can be used to identify priorities for preventative maintenance. Increasingly, freight railroads, which account for most track, are also adopting automated inspection equipment.

One example is Canadian National (CN) railroad's use of sensors, artificial intelligence (AI), and wireless communication technologies on specially equipped boxcars to test and monitor real-time geometric track parameters. The cars move with a train at operating track speeds, and thus do not interrupt normal railroad operations, on several CN routes in both Canada and the United States. In 2019 and 2020, CN deployed eight boxcars that inspect tracks on train routes between Chicago and Prince Rupert, British Columbia, and from New Orleans to Halifax, Nova Scotia. The CN sensing technology provides location specific data about track geometry to maintenance employees who can repair or correct track conditions as needed [CN].

Burlington Northern Santa Fe (BNSF), another freight railroad, is currently conducting a testing project to compare autonomous inspection approaches with manual/visual inspection on about 1,350 miles of track in Nebraska and Wyoming used primarily to haul coal. The FRA has temporarily exempted BNSF from meeting some of its manual track inspection frequency standards on the test track mileage during the one-year test period [FR]. The test could shed light and provide specific data on the comparative performance of autonomous vs. manual/visual inspection. All these efforts help keep the Nation's 26,086 Class I locomotives and 293,742 Class I freight railcars moving safely [USDOT BTS NTS].

TABLE 6-6 Hazardous Materials Transportation Incidents: 2010, 2018, and 2019

	2010	2018	2019
Total incidents	14,805	19,875	22,746
Total vehicular accident / derailment incidents	358	324	262
Vehicular accident-related percent of total incidents	2.4%	1.6%	1.2%
Air	1,295	1,433	1,668
Vehicular accident-related	2	5	10
Highway	12,658	17,928	20,651
Vehicular accident-related	320	292	226
Rail	747	505	421
Vehicular accident-related / derailment incidents	35	27	26
Water[1]	105	9	6
Vehicular accident-related	1	0	0

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

NOTES: Incidents are defined in the Code of Federal Regulations (CFR): 49 CFR 171.15 and 171.16 (Form F 5800.1). Accident-related are the result of 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, HAZMAT Intelligence Portal, available at https://hip.phmsa.dot.gov/ as reported in National Transportation Statistics, Table 2-6, as of September 2020.

TABLE 6-7 All Reported Hazardous Liquid and Gas Incidents: 2010–2019

	Number	Fatalities	Injuries	Property damage as reported	Barrels spilled (Haz. Liq.)	Net barrels lost (Haz. Liq.)
2010	577	22	108	$1,690,381,009	100,558	49,452
2011	578	13	55	$424,343,339	89,110	57,375
2012	558	12	57	$226,894,843	45,884	29,247
2013	610	9	44	$367,013,939	117,464	85,595
2014	694	19	94	$269,474,404	48,383	22,155
2015	705	11	48	$348,267,614	102,226	81,100
2016	629	16	87	$376,484,495	86,135	46,840
2017	626	20	36	$334,915,233	89,700	45,008
2018	626	7	81	$2,162,897,225	108,300	70,600
2019	643	12	35	$323,658,562	58,668	26,136

KEY: Haz Liq = Hazardous Liquid, LNG = Liquefied Natural Gas.

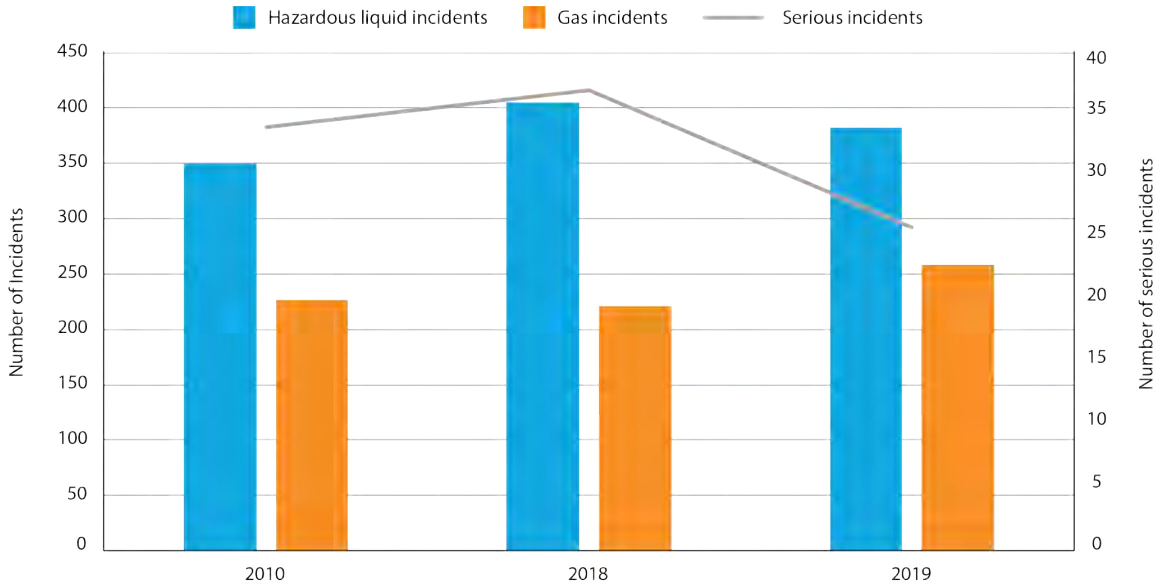
NOTES: Hazardous Liquid includes crude oil; refined petroleum products (e.g., gasoline, diesel, kerosene); highly volatile, flammable, and toxic liquids (e.g., propane); liquid carbon dioxide; and biodiesel. Gross Barrels Spilled is the amount before clean-up, whereas Net Barrels Lost is the amount after clean-up is attempted.

Incident means any of the following events: 1) An event that involves a release of gas from a pipeline, or of liquefied natural gas, liquefied petroleum gas, refrigerant gas, or gas from an LNG facility, and that results in one or more of the following consequences: i) A death, or personal injury necessitating in-patient hospitalization; ii) Estimated property damage of $50,000 or more. Accident is a failure in a pipeline system in which there is a release of the hazardous liquid or carbon dioxide transported resulting in any of the following: a) Explosion or fire not intentionally set by the operator. b) Release of 5 gallons (19 liters) or more of hazardous liquid or carbon dioxide.

Please see the Pipeline and Hazardous Materials Safety Administration's Incident Report Criteria History for a complete definition of past and present reporting requirements, which is available at https://hip.phmsa.dot.gov/Hip_Help/pdmpublic_incident_page_allrpt.pdf as of November 2019.

SOURCE: U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, Pipeline Incident 20 Year Trends. Available at https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-20-year-trends as of October 2020.

FIGURE 6-11 Number of Hazardous Liquid-Related or Gas–Related Pipeline Incidents: 2010, 2018, and 2019



NOTE: Serious incidents include a fatality or injury requiring overnight, in-patient hospitalization, but does not include gas distribution incidents in which the gas release was a result of the fire, not the cause of the fire.

SOURCE: U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, HAZMAT Intelligence Portal as reported in National Transportation Statistics, table 2-50, as of August 2020.

crude oil being transported into Maine, resulted in 47 deaths and substantial property destruction in the town.

Under a law passed at the end of 2015,[34] the Bureau of Transportation Statistics (BTS) assembles and collects data on rail tank cars transporting Class 3 flammable liquids[35] in order to track the progress of upgrades to the rail tank car fleet to meet new safety requirements. By the end of 2029, rail tank cars carrying class 3 flammable liquids must meet the DOT-117 or DOT-117R (retrofitted) specification or equivalent.[36]

In 2018 new and retrofitted DOT-117 rail tank cars grew to 34 percent of the entire fleet used to carry Class 3 flammable liquids, compared to 2 percent in 2015. Of these, 52 percent (14,184 tank cars) are new and 48 percent (13,357 tank cars)

[34] Section 7308 of the *Fixing America's Surface Transportation Act* (FAST Act; P. L. 114-94; Dec. 4, 2015).

[35] A flammable liquid (Class 3) is a liquid with a flash point of not more than 60 °C (140 °F) or any material in a liquid phase with a flash point at or above 37.8 °C (100 °F) that is intentionally heated and offered for transportation or transported at or above its flash point in a bulk packaging. This includes liquids such as refined petroleum products, crude oil, and ethanol.

[36] DOT-117 (TC-117 in Canada): A non-pressurized tank car with a shell thickness of 9/16 of an inch and insulating material that provides thermal protection. Additionally, DOT-117s have a skin that holds the insulation and thermal protection in place and doubles as additional protection from punctures. The tank cars have protected top fittings, a fully protected head shield, and a bottom outlet valve with an enhanced handle designed to prevent the tank car from emptying its contents in an incident. All the enhancements are designed to protect the tank from being punctured and to prevent the valves from being disrupted. DOT-117R tank cars are cars that have been retrofitted to meet the 117 specifications.

are retrofitted. The DOT-117 and DOT-117R tank cars carry a variety of flammable liquids, including ethanol, crude oil, or a combination of fluids including ethanol or crude oil.

The law requires BTS to prepare an annual report detailing progress. It also requires BTS to estimate the anticipated number of DOT-117 and DOT-117R tank cars for each year through 2029 by collecting data from tank car shops that build or retrofit tank cars. The 102 tank car facilities that responded to the 2019 BTS survey said they plan to build or modify 15,110 tank cars during 2019 to meet the new safety requirements. It is expected that by the end of the transition period in 2029, all Class 3 flammable liquids will be carried in rail tank cars that meet or exceed the new standards [USDOT BTS 2019b].

Transportation Safety Data Needs

The principal data gaps related to transportation safety include the following:

- While the number of transportation fatalities is known with high precision, injury data is less precise, especially for incidents involving highways and highway motor vehicles.
- Better incident, injury, and fatality estimates for vehicle non-occupants or those that occur outside of a vehicle in areas such as pedestrians, bicyclists / other cyclists, rail, transit, and other "micromobility" modes.
- As e-scooter and other "micromobility" devices emerge, better data on the extent of their use and their interactions with walkers and traffic will be an important data need, as will their travel behaviors (such as helmet and other protective gear usage).
- Better precursor data about what took place before transportation incidents occurred—whether, for example, distraction or substance abuse by involved parties contributed—are crucial to prevent incidents from happening.
- Better ways to visualize safety problems and the impact of potential solutions will help decision makers deploy effective solutions.

A departmental initiative to address the last point above is described in the last chapter of this report.

References

Aircraft Owners and Pilots Association (AOPA). *NTSB Determines Helicopter Likely Struck Drone* (July 6, 2020). Available at https://www.aopa.org/ as of July 2020.

American Automobile Association Foundation for Traffic Safety (AAA): *Prevalence of Drowsy Driving Crashes: Estimates from a Large Scale Naturalistic Study* (February 2018). Research Brief. Available at www.aaafoundation.org/ as of November 2019.

American Railway Engineering and Maintenance-of-Way Association (AREMA):

—2009: Autonomous Track Inspection Systems – Today and Tomorrow. Available at http://www.arema.org as of March 30, 2020.

—2014: Development and Use of FRA Autonomous Track Geometry Measurement System Technology. Available at http://www.arema.org as of March 30, 2020.

Austin (TX) Public Health (APH), *Dockless Electric Scooter-Related Injuries Study — Austin, Texas, September–November 2018.* Available at https://www.austintexas.gov/ as of April 2020.

Brotherhood of Locomotive Engineers and Trainmen [BLET]. Federal appeals court rules against BMWED in automated track inspection case. October 18, 2019. Available at www.ble-t.org/pr/ as of March 30, 2020.

Canadian National (CN), CN's Autonomous Track Inspection Program. Available at www.cn.ca/en/stories/20191001-atip/ as of March 30, 2020.

Cosgrove, Linda. *Historical Perspective of Motorcycle Helmet Laws* (May 2007). National Highway Traffic Safety Administration. Available at http://www.nhtsa.gov/ as of November 2019.

Federal Register (FR). *Federal Railroad Administration Approval of BNSF Railway Company Test Program to Evaluate Automated Track Inspection Technologies*. Federal Register. p. 55449. November 5, 2018. Available at http://www.federalregister.gov as of March 2020.

Governors Highway Safety Association (GHSA). *Drug-Impaired Driving: Marijuana and Opioids Raise Critical Issues for States* (May 2018). Available at www.GHSA.org as of November 2019.

Insurance Institute for Highway Safety (IIHS):

—*Gender (2019a).* Available at http://www.iihs.org as of July 2020.

—*Teenagers (2019b)*. Available at http://www.iihs.org as of February 2020.

Kahane, C. J. *Lives saved by vehicle safety technologies and associated Federal Motor Vehicle Safety Standards, 1960 to 2012* (January 2015). Report No. DOT HS 812 069. Washington, DC: National Highway Traffic Safety Administration. Available at http://www.nhtsa.gov/ as of November 2019.

Masten, S. V., Thomas, F. D., Korbelak, K. T., Peck, R. C., & Blomberg, R. D. (Masten et al). *Meta-analysis of graduated driver licensing laws* (November 2015), Report No. DOT HS 812 211. Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/ as of October 2020.

Mineta Transportation Institute [Mineta]. How and Where Should I Ride This Thing? "Rules of The Road" for Personal Transportation Devices. May 2019. Available at https://transweb.sjsu.edu/ as of May 2020.

National Transportation Safety Board (NTSB):

—2019. U.S. Aviation Fatalities Increased in 2018. NTSB News Release 11/14/2019. Available at www.NTSB.gov/ as of November 2019.

—2016. Disconnect from Deadly Distractions. Available at www.NTSB.gov/ as of June 2018.

—2010. Motorcycle Deaths Remain High. Available at www.NTSB.gov/ as of October 2020.

National Work Zone Safety Information Clearinghouse (NWZSIC), National Estimates of Total and Injury Work Zone Crashes. Available at www.workzonesafety.org as of March 2020.

Scott, Lagina R.; Bazargan-Hejazi, Shahrzad; Shirazi, Anaheed; Pan, Deyu; Lee, Steven; Teruya, Stacey A.; & Shaheen, Magda. (Scott, et al). Posted on-line September 2019. Helmet use and bicycle-related trauma injury outcomes, Brain Injury, Available at https://doi.org/10.1080/02699052.2019.1650201 as of May 2020.

Skybrary. Inadvertent VFR flight into IMC. Available at http://skybrary.org/ as of February 2020.

U.S. Department of Energy (USDOE), Energy Information Administration (EIA), *Crude Oil Movements by Rail*. Available https://www.eia.gov/ as of November 2019.

U.S. Department of Health and Human Services (USDHHS), Centers for Disease Control and Prevention (CDC):

—2019 Deaths: Final Data for 2015. June 2017. Available at www.cdc.gov/ as of May 2020.

—2017, Web-based Injury Statistics Query and Reporting System [WISQAR]. 10 Leading Causes of Nonfatal Emergency Visits, United States, 2017. Available at www.cdc.gov/ as of May 2020.

—2015. Sobriety Checkpoints: Intervention Fact Sheet (2015). Available at https://www.cdc.gov/ as of November 2019.

—2014. Vital Signs: Health Burden and Medical Costs of Nonfatal Injuries to Motor Vehicle Occupants — United States, 2012. Morbidity and Mortality Weekly Report. October 10, 2014. Available at www.cdc.gov/ as of May 2020.

U.S. Department of Health and Human Services (USDHHS), National Institutes of Health (NIH). National Institute on Alcohol Abuse and Alcoholism (NIAAA). *Alcohol Policy Information System* (as of January 1, 2019). Available at alcoholpolicy.niaaa.nih.gov/ as of May 2020.

U.S. Department of Homeland Security (USDHS), United States Coast Guard (USCG), *Recreational Boating Statistics 2019* (2020). Available at www.uscgboating.org/ as of March 2020.

U.S. Department of Justice (USDOJ). Bureau of Justice Statistics (BJS). *Contacts Between Police and the Public, 2015*. October 2018. Special Report NCJ 251145. Available at http://www.bjs.gov/ as of November 2019.

U.S. Department of Justice (USDOJ). Federal Bureau of Investigation (FBI). *Uniform Crime Report: 2018*. Available at http://www.fbi.gov/ as of July 2020.

U.S. Department of Labor (USDOL). Bureau of Labor Statistics:

—2019: Survey of Occupational Injury and Illness – 2018. Available at https://www.bls.gov/ as of October 2020.

—2018: Census of 2017 Fatal Occupational Injuries (CFOI) - Current and Revised Data. Available at https://www.bls.gov/ as of November 2019.

U.S. Department of Transportation (USDOT). *Cruise Line Incident Reports*. Available at https://www.transportation.gov/ as of February 2020.

U.S. Department of Transportation (USDOT). Bureau of Transportation Statistics (BTS):

—2020: *National Transportation Statistics* (NTS). Available at http://www.bts.gov/nts as of October 2020.

—2019: *Fleet Composition of Rail Tank Cars That Transport Flammable Liquids: 2019 Report*. Available at www.bts.gov as of November 2019.

U.S. Department of Transportation (USDOT). Federal Aviation Administration (FAA). Fly Safe: Prevent Loss of Control Accidents. Available at www.faa.gov as of February 2020.

U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA):

—2018. The *2017 National Household Travel Survey: Summary of Travel Trends*. Available at nhts.ornl.gov as of November 2020.

U.S. Department of Transportation (USDOT), Federal Motor Carrier Safety Administration (FMCSA):

—2020a. *Large Truck and Bus Crash Facts 2018* (September 2020). Available at www.fmcsa.dot.gov/ as of October 2020.

—2020b. *2020 Pocket Guide to Large Truck and Bus Statistics* (October 2020). Available at www.fmcsa.dot.gov/ as of October 2020.

—2020c. Motor Carrier Safety Progress Report Federal Motor Carrier Safety Administration (as of March 31, 2020). All data from Motor Carrier Management Information System, as of January 28, 2018. Available at www.fmcsa.dot.gov/ as of October 2020.

—2018. *FMCSA Safety Program Effectiveness Measurement: Carrier Intervention Effectiveness Model (CIEM), Version 1.1 Report for Fiscal Year 2014 Interventions.* April 2018. Available at ai.fmcsa.dot.gov/ as of November 2018.

U.S. Department of Transportation (USDOT), Federal Railroad Administration (FRA):

—Office of Safety Analysis Web Site and AIP Statistics. Available at safetydata.fra.dot.gov as of October 2020.

—2018: National Strategy to Prevent Trespassing on Railroad Property. Report to Congress. October 2018. Available at safetydata.fra.dot.gov as of September 2019.

U.S. Department of Transportation (USDOT), Federal Transit Administration (FTA): National Transit Database (2019 data viewed in October 2020) Available at http://www.fta.dot.gov as of October 2020.

U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration (NHTSA):

—2020a: Preview of Motor Vehicle Traffic Fatalities for 2019. October 2020. DOT HS 813 021. Available at www.nhtsa.gov/ as of October 2020.

—2020b: Takata Air Bags. Recalls. Viewable at www.nhtsa.gov/ as of October 2020.

—2019a: *Traffic Safety Facts 2017: A Compilation of Motor Vehicle Crash Data.* DOT HS 812 806. September 2019. DOT HS 812 806. Available at www.nhtsa.gov/ as of October 2020.

—2019b: 2018 Fatal Motor Vehicle Crashes: Overview. October 2019. DOT HS 812 826. Available at www.nhtsa.gov/ as of November 2019.

—2019c: Motorcycles: 2017 Data. Updated August 2019. DOT HS 812 785. Available at www.nhtsa.gov/ as of November 2019.

—2019d: Speeding: 2018 Data. April 2020. DOT HS 812 932. Available at www.nhtsa.gov/ as of November 2019.

—2019e: Distracted driving in fatal crashes, 2018. April 2020. DOT HS 812 926). Available at www.nhtsa.gov/ as of November 2019.

—2019f: Police-reported motor vehicle traffic crashes in 2018. November 2019. DOT HS 812 860. www.nhtsa.gov/ as of November 2019.

—2019g: Fatality Analysis Reporting System (FARS) Analytical User's Manual, 1975-2018. September 2019. HS 812 827. Available at www.nhtsa.gov/ as of December 2019.

—2019h: Alcohol-Impaired Driving: 2018 Data. December 2019. DOT HS 812 864. Available at www.nhtsa.gov/as of April 2020.

—2019i: Seat Belt Use in 2018—Overall Results. January 2019. DOT HS 812 662. Available at www.nhtsa.dot.gov/ as of August 2018.

—2015: *The Economic and Societal Impact of Motor Vehicle Crashes, 2010* (May 2015, revised edition). DOT HS 812 013. Available at www.nhtsa.gov/ as of December 2018.

U.S. Department of Transportation (USDOT), Pipeline and Hazardous Materials Administration (PHMSA):

—2020: PHMSA PIPELINE DATA PORTAL: All Significant Incidents. Available at www.phmsa.dot.gov/ as of October 2020.

—2019:Technology Research and Development: Success Stories. April 25, 2019. Available at www.phmsa.dot.gov/ as of February 2020.

U.S. General Accountability Office (GAO). HIGHWAY SAFETY Factors Contributing to Traffic Crashes and NHTSA's Efforts to Address Them. Testimony Before the Subcommittee on Competition, Foreign Commerce, and Infrastructure, Committee on Commerce, Science, and Transportation, U.S. Senate. May 22, 2003. Available at www.gao.gov/ as of November 2019.

CHAPTER 7

Energy Use and Environmental Effects

Introduction

Each year the U.S. transportation system makes possible over 6 trillion passenger-miles of travel and moves more than 5 trillion ton-miles of freight [DOT BTS]. In 2019 petroleum remained the predominant source of transportation energy, supplying over 91 percent of transportation's energy requirements. Highway vehicles accounted for about 83 percent of transportation energy use in 2018 and consumed, by far, the largest quantities of petroleum fuels. Despite transportation's increase in energy use through 2019 (up nearly 5 percent from 2010), U.S. dependence on imported petroleum is now at its lowest level in more than 50 years, falling from nearly half of total demand in 2010 to about 3 percent in 2019.

By adopting advanced technologies and operational improvements, most transportation modes have made large efficiency improvements over the past several decades as they continued to reduce energy use per passenger- and ton-mile. Domestic commercial air travel, for example, reduced its energy use per passenger-mile by 18 percent between 2000 and 2018.

Biofuel, in the form of ethanol blended at 10 percent with gasoline, continues to be the largest alternative source of transportation energy. Natural gas and electricity use by motor vehicles increased in 2019 but still comprise a fraction of total energy use. Together natural gas and electricity use across all modes of transportation accounts for less than 4 percent of energy consumption. Over 1 million plug-in electric vehicles are now on U.S. roads due to rapidly increasing availability of vehicles and growing sales over the past decade.

Emissions from transportation vehicles continued to decrease in 2018, improving air quality in U.S. cities. Millions of tons of solid waste are produced when motor vehicles are scrapped, roads are repaved, and infrastructure is replaced or renovated—much of which are now recycled. Transportation also affects water quality through fuel spills and road salt dissolved in snow and water run-off. Road and aircraft noise can be a nuisance, and at high noise levels contribute to health problems if not appropriately mitigated with technologies, such as sound absorbing barriers.

Innovations to transportation vehicles and operations have the potential to make significant changes in the types and quantities of energy used by transportation. Information technology has facilitated new modes of passenger travel, from internet-based ride-hailing to shared automobiles and other forms of micromobility.[1] Connected, automated, and shared mobility could change the size, ownership, and use of vehicles, affecting their energy use. Today these innovations in transportation are in the early stages of market penetration and may change rapidly to meet changing demand.

[1] Micromobility is a category of modes of transportation that includes light, low-occupancy vehicles, such as electric scooters (e-scooters), electric skateboards, shared bicycles, and electric pedal assisted bicycles (e-bikes).

The rise of the COVID-19 pandemic in 2020 diminished transportation activity, which reduced energy use and the environmental consequences of transportation. Future editions of this report will reveal the magnitude and nature of these changes as data for 2020 and beyond are collected and analyzed.

Energy Use and Trends

Transportation energy use increased for the sixth consecutive year in 2018 before declining slightly in 2019. The 28.2 quadrillion Btu used by transportation vehicles in 2019 was 28.2 percent of total U.S. primary energy use, which made transportation the second largest energy-using

Highlights

- Transportation was the second largest energy-using sector of the economy in 2019 after electricity generation.
- Transportation energy use increased for the sixth consecutive year in 2018 before declining slightly in 2019.
- Transportation continued to rely on petroleum fuels for about 91 percent of its energy in 2019, about 4 percent below the 2000–2010 average due to increased use of biofuels, natural gas, and electricity.
- Transportation has been the largest source of CO_2 emissions in the United States since 2016 and became the largest source of all greenhouse gas emissions in 2017 and 2018 as electric power generation plants, which used to be the largest CO_2 source switched to using more natural gas and less coal.
- Air quality in U.S. cities continues to improve, in part due to reductions in emissions rates—from a 43 percent reduction for heavy trucks, a 56 percent reduction for light trucks, and a 44 percent reduction for passenger cars over 2010 levels.
- Today petroleum is a relatively secure source of energy for the United States. In 2019 U.S. petroleum imports decreased to their lowest level in over half a century—about 3 percent of U.S. petroleum consumption.
- No other major passenger mode can match the reduction in energy use per passenger-mile that air travel has achieved over the past half century.

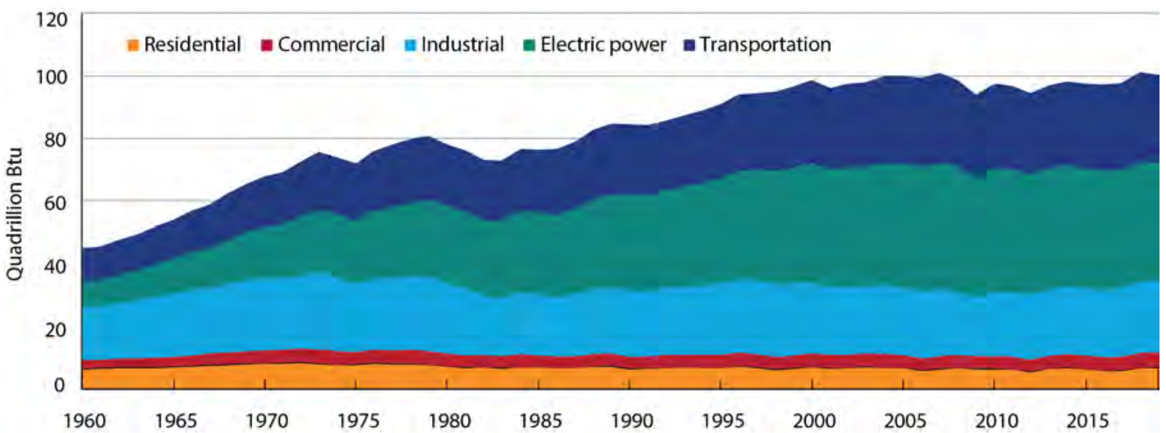
sector of the economy after electricity generation [DOT BTS]. From 2000 to 2019, total U.S. energy use increased by about 2 percent; over the same period, transportation energy use increased about 7 percent while vehicle-miles traveled (VMT) increased by about 18 percent (figure 7-1).

Petroleum supplies about 37 percent of U.S. primary energy use, but transportation relies on petroleum for about 91 percent of its energy, more than any other sector of the economy (figure 7-2). Transportation consumed around 26 quadrillion Btu of petroleum in 2019, about 70 percent of total U.S. petroleum consumption [DOE EIA 2019a].

U.S. petroleum use has generally increased over time, dipping slightly during economic recessions, and is affected by various factors such as increased energy efficiency and increased use of biofuel. Transportation's demand for petroleum has been steady while the number of licensed drivers, vehicle registrations, and the size of the U.S. population have increased and, more significantly, VMT (see figure 1-3).

Today petroleum is a relatively secure source of energy for the United States. In 2019 U.S. petroleum imports decreased to their lowest level in over half a century—about 3 percent of U.S. petroleum consumption [DOT BTS and figure 7-3]. The sudden decline in U.S. import dependence is due primarily to increased domestic production of crude oil and natural gas liquids due to advances in the technology of production from previously unusable "tight" or very low permeability, hard rock geological formations [DOE EIA 2017b]. From a low of 5.0 million barrels per day (mmbd) in 2008, domestic crude oil production increased about 145 percent to about 12 mmbd in 2019. Over the same period, domestic production of natural gas liquids increased by approximately 170 percent, from 2 to 5 mmbd [DOE EIA 2020a]. Tight oil resources expanded U.S. petroleum reserves, known resources that can be produced economically, by 20 percent from 2017 to 2018 [DOE EIA 2020a]. Worldwide, the ratio of petroleum reserves to annual production declined by about 2 percent from 2017 to 2018 but remained above 50, as it has since 2008 [BP].

FIGURE 7-1 U.S. Energy Consumption from Primary Sources by Sector: 1960–2019

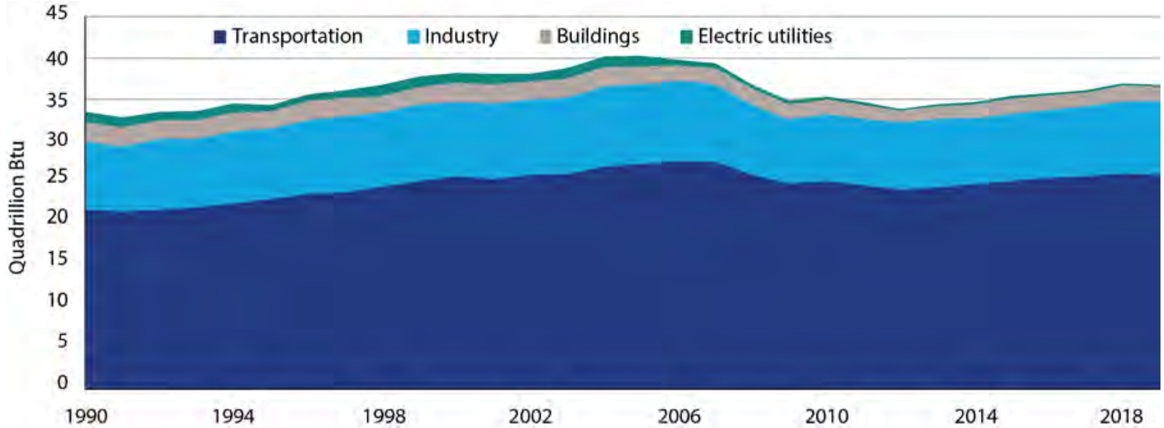


KEY: Btu = British thermal unit.

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 Transportation, Bureau of Transportation Statistics, National Transportation Statistics, table 4-2, available at http://www.bts.gov/nts as of May 2020.

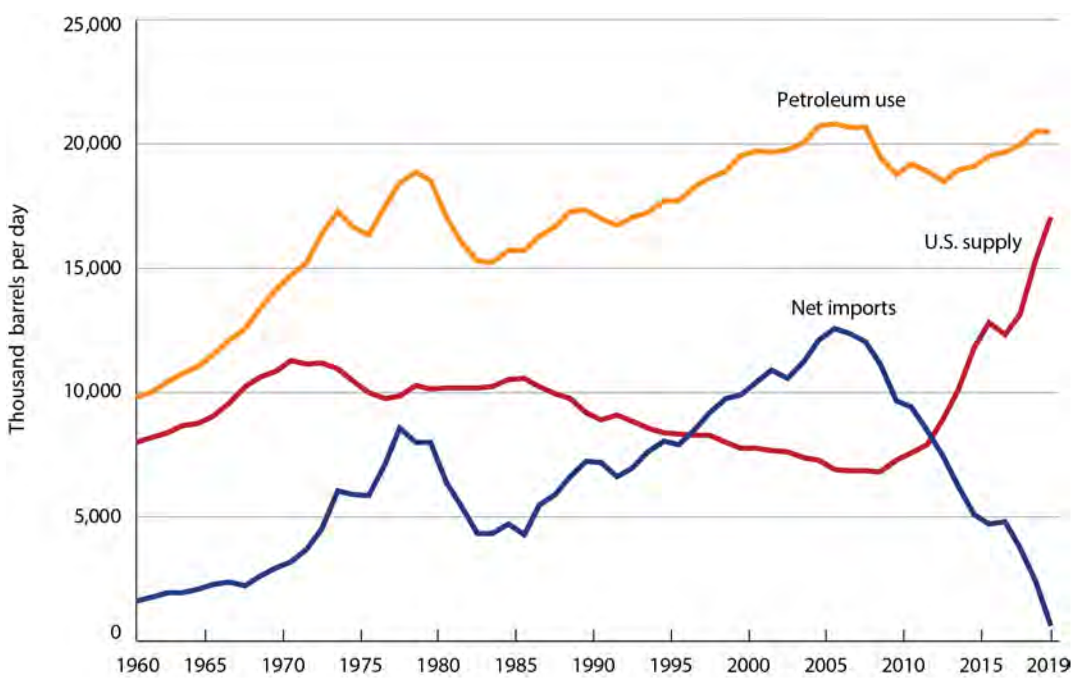
FIGURE 7-2 Petroleum Use by Sector of the U.S. Economy: 2000–2019



KEY: Btu = British thermal unit.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, table 4-3, available at http://www.bts.gov/nts as of May 2020.

FIGURE 7-3 U.S. Petroleum Use, Domestic Supply, and Net Imports: 1960–2019



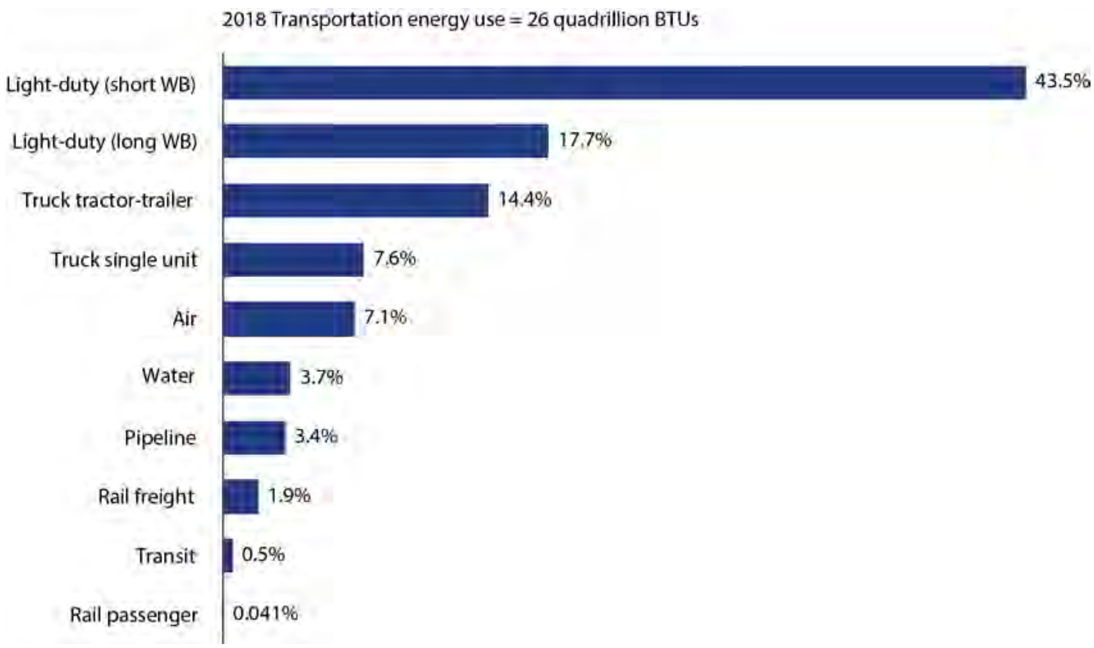
SOURCE: U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, table 3.1, available at www.eia.gov/ as of May 2020.

Energy Use by Mode

The transportation sector consumed 26.2 quadrillion Btu in 2018. Highway vehicles account for the majority of transportation energy use—84 percent in 2018, the latest year when data are available [DOT BTS]. Light-duty vehicles alone (long and short wheelbase) are responsible for about 61 percent of transportation energy use (figure 7-4). Single unit trucks with six or more tires are responsible for about 8 percent, and combination tractor-trailer trucks make up about 14 percent. Since 2005 energy use by single-unit commercial trucks has grown at an average annual rate of 5 percent while VMT has grown at an average annual rate of 3 percent, reflecting the fuel efficiency improvements, increasing importance of local/short-haul truck freight, last-mile deliveries, and work trucks/vocational vehicles.

The domestic operations of air carriers and all general aviation flights use 7 percent of transportation energy, followed by domestic waterborne commerce at about 4 percent, and natural gas pipelines at about 3 percent. Rail freight movements account for 1.9 percent of energy use and transit operations and Amtrak's passenger rail services add less than 1 percent.

FIGURE 7-4 Transportation Energy Use by Mode: 2018



KEY: Btu = British thermal unit; kWh = kilowatt hour; WB = wheelbase

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. Percents may not sum to 100 due to rounding.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, table 4-6, available at http://www.bts.gov as of May 2020

Energy Use by Fuel Type

Petroleum has supplied over 90 percent of the energy for transportation since the mid-1950s when coal-fired steam engines in ships and trains became obsolete [DOT BTS]. Although petroleum supplies over nine-tenths of transportation energy, biofuel, natural gas, and electricity have provided an increasing share in recent years (figure 7-5). Bioethanol, blended at up to 10 percent with nearly all gasoline sold in the United States, accounts for the greatest percent of non-petroleum energy at 5.0 percent. Use of natural gas in medium and heavy-duty vehicles gradually increased from 2.7 percent in 2010 to 3.5 percent in 2019. Electricity continued to provide a small fraction, 0.3 percent of transportation's total energy use. However, as discussed below, sales of plug-in electric vehicles have been growing rapidly both in the United States and worldwide. If the trend continues, electricity could become an important new source of energy for highway vehicles.

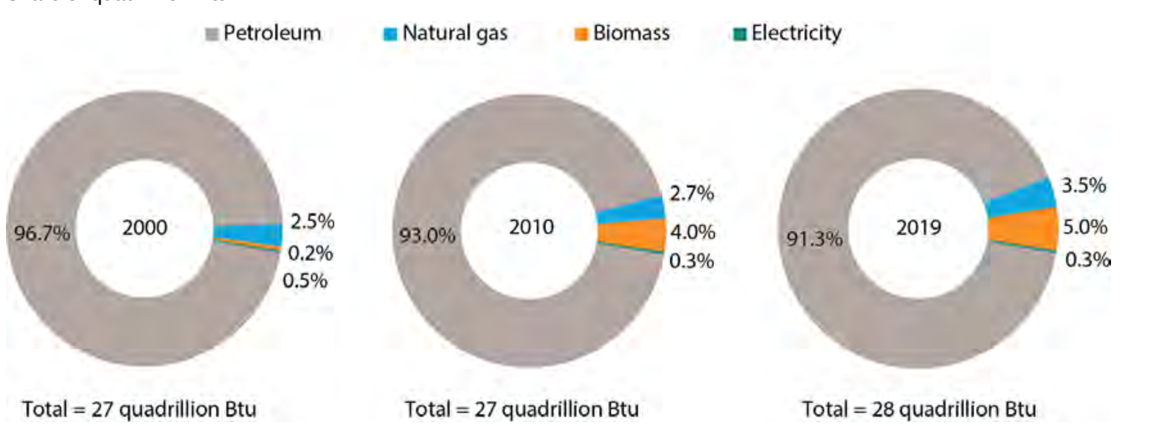
Energy Efficiency

The amount of energy used by transportation is directly proportional to the passenger-miles and ton-miles of goods transported and inversely proportional to the energy efficiency of the transportation system. In other words, an increase in transportation passenger or freight activity, as measured in passenger-miles or ton-miles, increases or decreases overall energy use. Increases in energy efficiency, such as technological advancements to internal combustion engines that improve fuel use per mile traveled or increases in load factors in airplanes or freight rail cars, decreases or improves the amount of energy used.

In terms of energy use per passenger mile, the most energy intensive passenger modes are the larger light-duty vehicles, predominantly full size SUVs, pickup trucks and vans, and transit buses, followed by the smaller, light-duty vehicles—including passenger cars and light trucks (table 7-1). International and domestic airline flights, and motorcycles consume somewhat less energy per passenger-mile. Amtrak and intercity bus use the least energy per passenger-mile. Over the most recent 9-year interval for which data are available (2010–2018), the energy intensity (Btu/passenger-mile) of passenger travel improved for all modes. Domestic and international air travel achieved the greatest reductions in energy use per passenger-mile, improving their energy efficiencies at 18 and 12.8 percent, respectively. Light-duty vehicles, the largest energy users, improved at an average rate of less than 1 percent per year.

FIGURE 7-5 Transportation Energy Use by Fuel Type: 2000, 2010, and 2019

Share of quadrillion Btu



KEY: Btu = British thermal unit.

SOURCE: U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, table 2.5, available at www.eia.gov/ as of May 2020.

TABLE 7-1 Energy Intensities of Passenger Modes: 2010, 2017, and 2018

Btu per passenger-mile

Mode	2018[1]	Percent change 2010–2018	Percent change 2017–2018
Light-duty vehicle long WB	4,152	-6.4	-1.9
Transit motor bus	3,319	-4.2	4.4
Light-duty vehicle short WB	3,070	-2.3	-0.7
Air international	2,840	-12.8	-2.5
Motorcycles	2,450	-1.3	0.0
Air domestic	2,189	-18.0	-0.8
Amtrak	1,688	-3.6	5.0
Intercity bus	803	-2.2	-0.1

[1] 4,152 BTUs equates to about 0.03 of a gallon of gasoline.

KEY: Btu = British thermal unit; WB = Wheelbase.

NOTE: A decrease in energy intensity means improved energy efficiency and an increase in energy intensity means energy efficiency is getting worse.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, Table 4-20, available at www.bts.gov as of May 2020.

The energy efficiency of international air travel has improved as the Btu per passenger mile decreased by 2.5 percent in 2018, continuing a trend that began in 1972. Since 1971 the energy required to move one airline passenger one mile has decreased from 10,102 Btu to 2,488 Btu, a reduction of over 75 percent. No other major passenger mode can match what air travel has achieved over the past half century. Increased load factors (passengers per plane) and aircraft efficiency improvements (energy use per aircraft-mile) are approximately equally responsible for the reduction in energy use per passenger-mile [DAVIS AND BOUNDY].

Information about the energy intensities of freight modes is limited by the lack of data on truck freight movements and waterborne shipments, and the fact that much air freight is carried aboard passenger aircraft in the cargo hold. In addition, most freight shipments involve two or more modes (chapter 4), and system-wide energy efficiencies may show different trends. In table 7-2, rail energy intensities are reported in Btu per ton-mile,

TABLE 7-2 Energy Intensities of Freight Modes: 2010, 2017, and 2018

Btu per vehicle-mile for trucks & Btu per ton-mile for rail

Mode	2018	Percent change 2010–2018	Percent change 2017–2018
Combination trucks	20,583	-3.3	-1.6
Single-unit trucks	16,653	-2.3	-0.8
Rail class I	14,481	6.2	1.8

KEY: Btu = British thermal unit.

NOTE: A decrease in energy intensity means improved energy efficiency and an increase in energy intensity means energy efficiency is getting worse.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, tables 4-20 and 4-25, available at www.bts.gov as of May 2020.

while single-unit and combination truck energy intensities are in Btu use per vehicle-mile. The energy intensities of single-unit and combination trucks improved between 2010 to 2018 as Btu per passenger mile decreased by 2.3 and 3.3 percent, respectively. The energy intensity (Btu per ton-mile) of rail freight declined (or used about 6 percent more energy). The limited freight data suggests that the energy intensity of freight modes may be improving at a slower rate than passenger modes. However, additional data and further study are needed to confirm this observation.

Alternative Fuels and Vehicles

Developing abundant, economical, and clean alternatives to petroleum helps to ensure sustainable energy for transportation. Since 2000 the share of transportation energy supplied by domestically produced biofuels[2], natural gas, and electricity has gradually increased, with biofuels now supplying the greatest amount of non-petroleum energy.

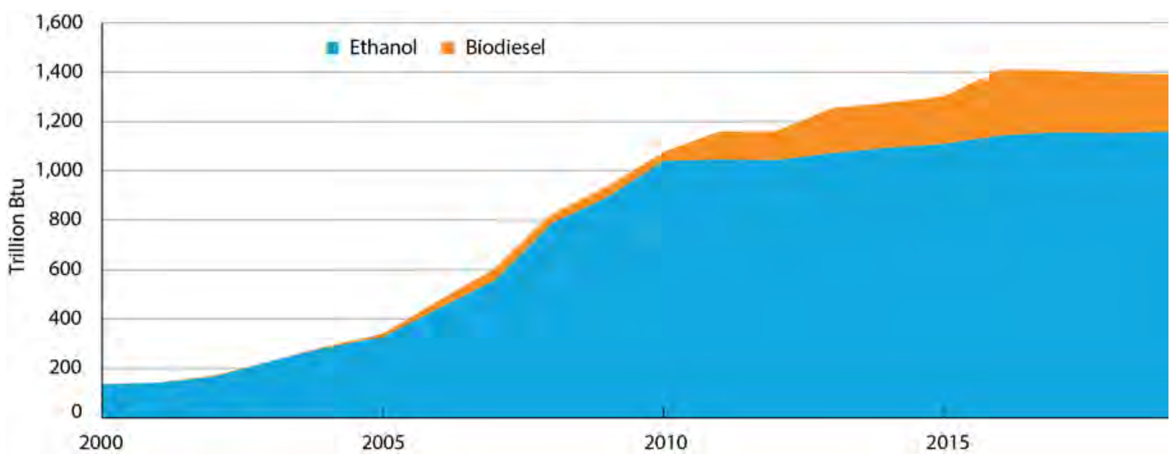
[2] Biofuels are fuels produced from organic matter, such as biomass, corn, sugars, vegetable oils, or other recycled waste.

Biofuels

The most common biofuels contain low-level blends of ethanol and biodiesel with gasoline and diesel fuel largely due to their compatibility with existing highway vehicles and refueling infrastructure. Almost all gasoline sold in the United States in 2019 contained approximately 10 percent ethanol (known as E10 or gasohol), providing more than a quadrillion Btu of energy for highway vehicles (figure 7-6). The use of biodiesel, a renewable fuel suitable for use in medium and heavy-duty trucks and buses, increased from 33.2 trillion Btu in 2010 to 231.0 trillion in 2019. Ethanol is blended with gasoline at up to 10 percent by volume and with diesel up to 5 percent to ensure compatibility with all conventional vehicles and refueling infrastructure. Up to 15 percent ethanol (E15) is approved for use in model year 2001 or newer vehicles [DOE AFDC 2019a], and up to 85 percent ethanol can be safely used in flex-fueled vehicles (FFV).[3] Biodiesel blends of up to 20 percent (B20) are considered safe for current

[3] Flex fuel vehicles (FFVs) are designed to run on gasoline or gasoline-ethanol blends of up to 85 percent ethanol (E85).

FIGURE 7-6 Transportation Use of Biofuels in the United States: 2000–2019



KEY: Btu = British thermal unit.

NOTE: Ethanol (minus denaturant) is the portion of motor fuels blended with gasoline, such as E10 and E85, consumed by the transportation sector.

SOURCE: U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, Table 10.2b, available at www.eia.gov/ as of May 2020.

diesel engines, but not all manufacturers have approved the use of B20. In 2018, U.S. highway vehicles consumed approximately 43 billion gallons of diesel fuel and 1.9 billion gallons of biodiesel [DOT FHWA; DOE EIA 2020b].

Natural Gas

The use of domestically produced natural gas to move passengers and freight increased approximately 44 percent from 2000 to 2019, and 3.0 percent from 2018 to 2019 alone [DOE EIA 2020b]. In 2019 natural gas provided about 4 percent of total transportation energy use—about 95 percent of that was used to transport natural gas in pipelines [DOE EIA 2020d]. Highway vehicles powered by natural gas account for less than 1 percent of transportation's total energy use. Over 175,000 vehicles are now powered by natural gas on U.S. roads including more than 11,000 transit buses, 17,000 garbage trucks, and 5,500 school buses [DOE AFDC 2019c; NGVA]. Good data on the types of natural gas vehicles and their fuel use exists for only about 10 percent of non-pipeline natural gas use and is collected by fleets subject to alternative fuel vehicle regulations [DOE EIA 2020b]. For vehicles in these fleets, natural gas use by highway vehicles increased even as the number of these vehicles declined due to the increase in the number of buses and large trucks using natural gas. Transit buses now comprise the majority (66 percent) of natural gas vehicles in regulated fleets and account for 96 percent of natural gas use by such fleet vehicles [DOE AFDC 2019c]. Many natural gas vehicles are powered by renewable natural gas derived from decaying organic matter in landfills, dairy farms, wastewater treatment plants, and other sources.

Electricity

Electricity can be produced from a wide variety of energy sources and can power transportation vehicles efficiently without pollutant emissions from the vehicle. If recent advances in electric vehicle technology continue, electricity could become a major source of energy for transportation. The small amount of transportation electricity use shown in figure 7-5 consists only of electricity use by rail and pipelines. Electricity use by battery electric vehicles is not shown on the graph due to insufficient data. In 2017 electric vehicles on U.S. highways used an estimated 6.8 trillion Btu of electricity or 0.03 percent of total transportation energy use [DAVIS AND BOUNDY].

Electricity use by highway vehicles has been increasing rapidly since the first commercial EVs were introduced in 2010, but the amount of energy use is small. Box 7-A provides a summary of technology and definitions related to electric vehicles and charging stations.

In 1999 Hybrid Electric Vehicles (HEVs) began to emerge on market with only 17 sold, but HEVs have gained market share with more than 400,000 sold in 2019. In 2010, 19 battery electric vehicles (BEV) were sold in the United States along with 326 plug-in hybrid electric vehicles (PHEV). In 2019, 242,000 BEVs and 83,800 PHEVs were sold in the United States (figure 7-7). In 2019 worldwide sales of new electric vehicles exceeded 2.2 million units [Insideevs]. The total number of BEVs and PHEVs on U.S. highways now exceeds 1 million vehicles.[4] Even with such rapid growth, BEVs and PHEVs comprise less than half of one percent of motor vehicles on U.S. highways, about 0.35 percent of travel by passenger cars and light trucks and, because of their greater energy efficiency (100 mpg equivalent in 2017) and less intensive use, about 0.04 percent of total transportation energy use and about 0.05 percent of energy use on U.S. highways.[5] Through 2015 there were approximately equal numbers of BEVs and PHEVs on the road. Since then BEV sales have grown more rapidly, reaching 74 percent of

[4] An estimated 750,000 plug-in vehicles (PEV) had been sold through 2017 [Gohlke and Zhou]. Adding the 361,315 sold in 2018 brings the total to over one million, allowing for a reasonable amount of scrappage.

[5] These rough estimates are not accurate to more than one significant digit. They are based on Gohlke and Zhou (2018) estimates for 2017, increased by the ratio of 2019 BEV plus PHEV sales in 2018 to the 750,000 estimated plug-in vehicles in operation in 2017: (750,000 + 361,315)/750,000 = 1.5. This results in about 10 billion miles of travel and 10 trillion Btu of energy use in 2019.

Box 7-A Electric Vehicles and Charging Stations

Electric vehicles (EV) are typically grouped into four categories:

1. Hybrid Electric Vehicles (HEV),
2. Plug-in Hybrid Electric Vehicles (PHEV),
3. Battery or All Electric Vehicles (BEV), and
4. Fuel Cell Electric Vehicles (FCEV).

HEVs obtain all their energy from conventional gasoline but are powered by both an internal combustion engine (ICE) and an electric motor. Electricity for the motor is generated partly by the internal combustion engine and partly by converting the kinetic energy of the vehicle into electricity by using a generator to assist with braking the vehicle.

PHEVs have larger on-board storage batteries and larger electric motors than HEVs and can take electricity from the electricity grid (they can be plugged in). PHEVs are usually described by the number of miles they can travel using the energy stored in their batteries (their “electric” or “charge-depleting range”). For example, a PHEV40 is can travel 40 miles on the electricity stored in its battery. If not plugged in, a PHEV operates much like an HEV.

BEVs are powered only by electricity from the utility grid and are usually described by the miles they can travel on a single charge (E.g., BEV100, BEV300, etc.).

FCEVs obtain energy from fuel cells that convert hydrogen stored on board the vehicles into electricity.

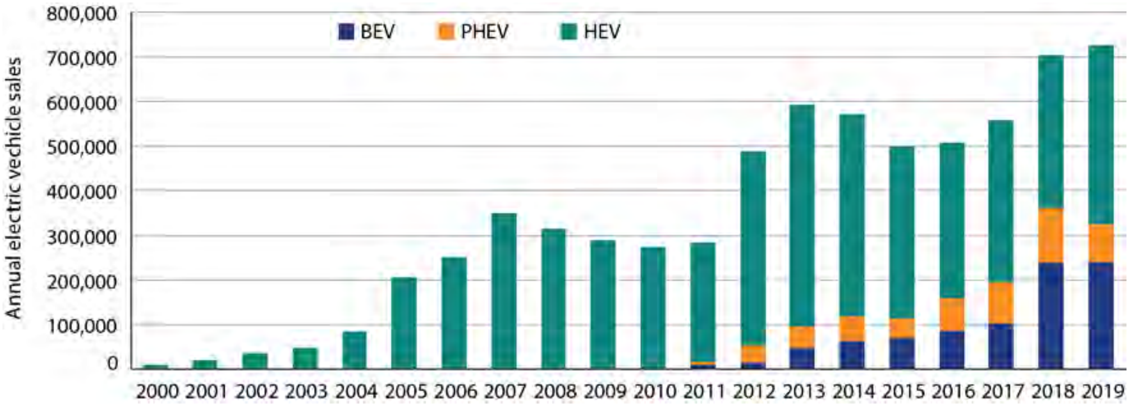
EV Charging Stations are usually divided into three categories:

- **Level 1** provides charging through a standard 120-volt AC outlet and can deliver only 2 to 5 miles of range per hour of charging time.
- **Level 2** requires special equipment and provides charging via a 240-volt AC outlet at the rate of 10 to 20 miles of range per hour.

DC Fast Charger (DCFC) provides direct current charging at power levels from 50 kW to 320 kW and can provide from 4 up to 19 miles per minute, depending on the power level. To avoid shortening battery life, DCFC is typically used up to only 80% of an EV battery’s capacity.

SOURCE: U.S. Department of Energy, Alternative Fuels Data Center, 2019e, “Electricity”, available at https://afdc.energy.gov/fuels/electricity.html as of December, 2019.

FIGURE 7-7 Sales of Hybrid, Plug-in Hybrid, and Battery Electric Vehicles: 2000–2019



KEY: BEV = battery electric vehicle; HEV = hybrid electric vehicle; PHEV = plug-in hybrid electric vehicles.

SOURCES: Argonne National Laboratory, Light-Duty Electric Drive Vehicle Monthly Sales Updates, updates available at http://www.anl.gov/es/light-duty-electric-drive-vehicles-monthly-sales-updates as of May 2020.

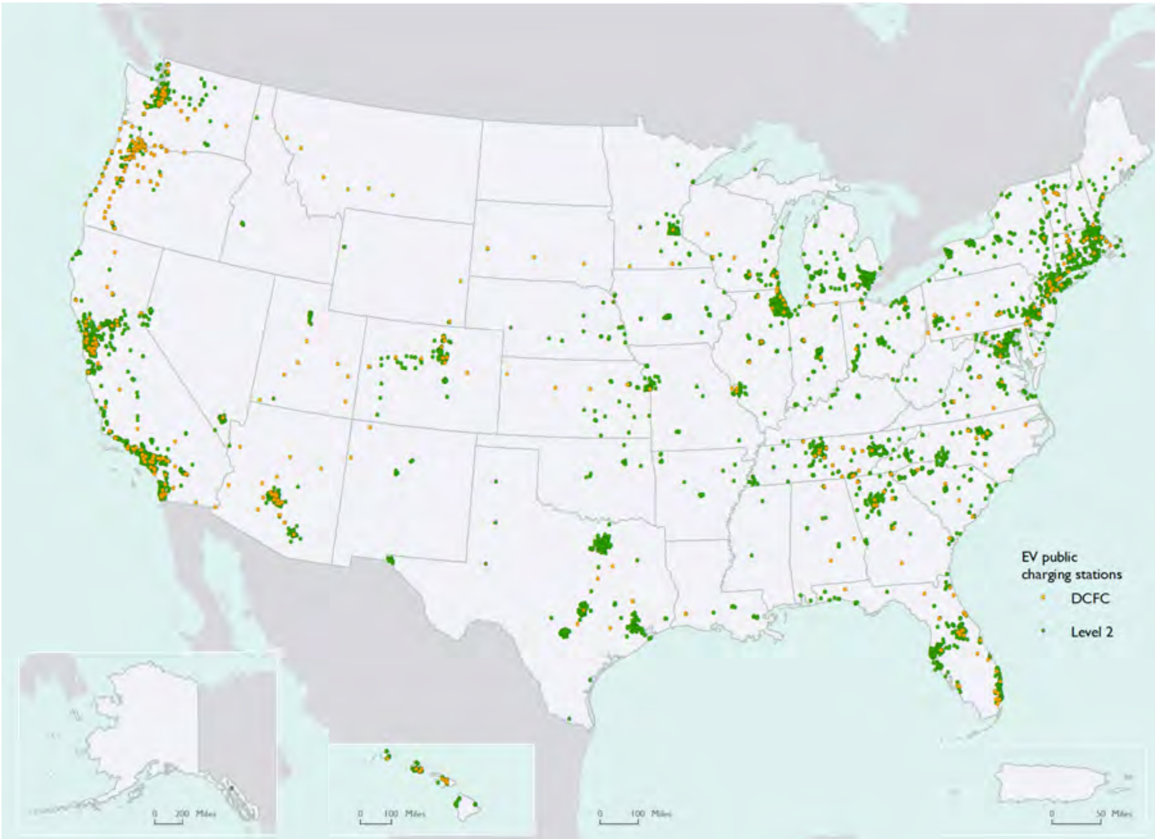
the plug-in market in 2019 [ANL]. Several factors, such as lower operating cost battery packs, cost per kWh, and more vehicle choices, are helping to fuel consumer demand.

The rapid growth of BEV and PHEV sales has been encouraged by a variety of federal, state, local, and private sector strategies, including tax credits and rebates, zero emission vehicle requirements, free workplace charging, subsidies for home charging equipment by electric utilities, and preferred access to parking or high occupancy vehicle (HOV) lanes. At the same time, the cost of storage batteries, the single most expensive component of BEVs, has come down by almost an order of magnitude. In 2010 battery packs for BEVs cost an estimated $1,160 per kWh of storage capacity; in 2018 the cost per kWh was approximately $175 per kWh [BLOOMBERG NEF]. Even at current prices batteries are expensive: a 64-kWh battery pack for a compact size BEV with a driving range of 250 miles would cost approximately $9,600. As battery costs have decreased, the driving range of BEVs has increased. The first mass-market BEV had an estimated driving range of 73 miles. By mid-2017 new BEV models averaged over 200 miles of driving range [Gohlke and Zhou]. The number of mass-market BEV makes and models also increased from 1 in 2010 to 17 in the 2019 model year, creating a greater range of choices for potential buyers (www.fueleconomy.gov).

Most electric vehicle charging (75–80 percent) is done at home, followed by workplace and public charging (figure 7-8a and 7-8b). Nonetheless, public charging is important to the development of the plug-in electric vehicle market. Especially for battery electric vehicles, fast public charging can enable longer trips and more miles traveled per day. Widespread availability of public direct current fast chargers (DCFC) can enable BEVs to travel thousands of additional electric miles per year, greatly increasing the value of a BEV to current and potential owners [Greene et al 2019b]. Unlike other alternative fuels, electricity use by BEVs is not subject to state or federal motor fuel taxes. By one estimate, electric vehicles displaced 210 million gallons of gasoline consumption nationwide in 2017 [GOHLKE AND ZHOU].

The longer time required to recharge electric vehicles, compared to refueling conventional gasoline or diesel vehicles, and their more limited driving range makes the availability of recharging stations especially important to the utility of BEVs. Public charging stations in the United States have grown from fewer than 550 in 2010 to over 27,000

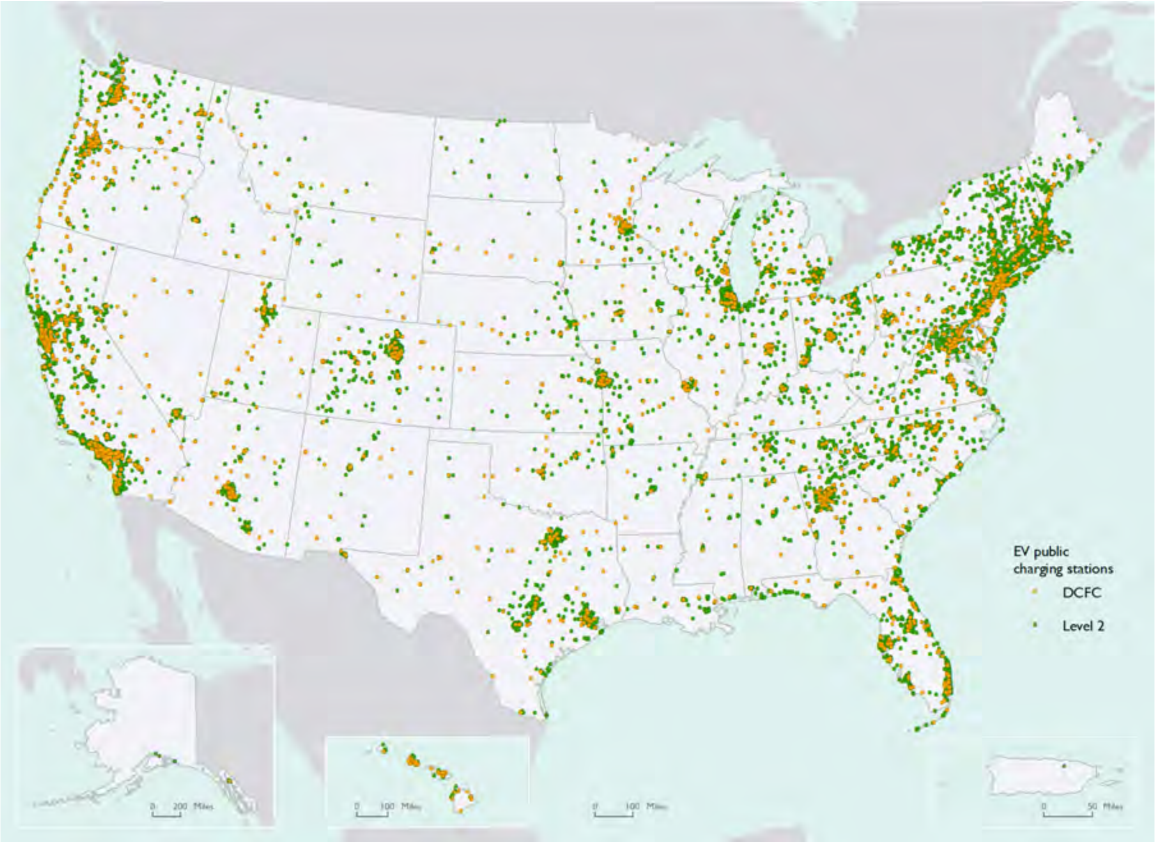
FIGURE 7-8a Electric Vehicle Public Charging Stations in the United States: 2014



NOTES: DCFC—Direct current fast chargers refers to the voltage that the electric vehicle charger uses (3-phase 480-volt AC electric circuit but delivers direct current (DC) to the vehicle volts). Generally, runs 60-80 miles of driving range per hour of charge. Level 2—Level 2 charging refers to the voltage that the electric vehicle charger uses (240 volts). Generally, runs 10-20 miles of driving range per hour of charge.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Atlas Database (NTAD), Alternative Fueling Stations dataset based on Alternative Fuels Data Center, available at https://data-usdot.opendata.arcgis.com/datasets/alternative-fueling-stations as of January 2020.

FIGURE 7-8b Electric Vehicle Public Charging Stations in the United States: 2019



NOTES: DCFC—Direct current fast chargers refers to the voltage that the electric vehicle charger uses (3-phase 480-volt AC electric circuit but delivers direct current (DC) to the vehicle volts). Generally, runs 60-80 miles of driving range per hour of charge. Level 2—Level 2 charging refers to the voltage that the electric vehicle charger uses (240 volts). Generally, runs 10-20 miles of driving range per hour of charge.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Atlas Database (NTAD), Alternative Fueling Stations dataset based on Alternative Fuels Data Center, available at https://data-usdot.opendata.arcgis.com/datasets/alternative-fueling-stations as of January 2020.

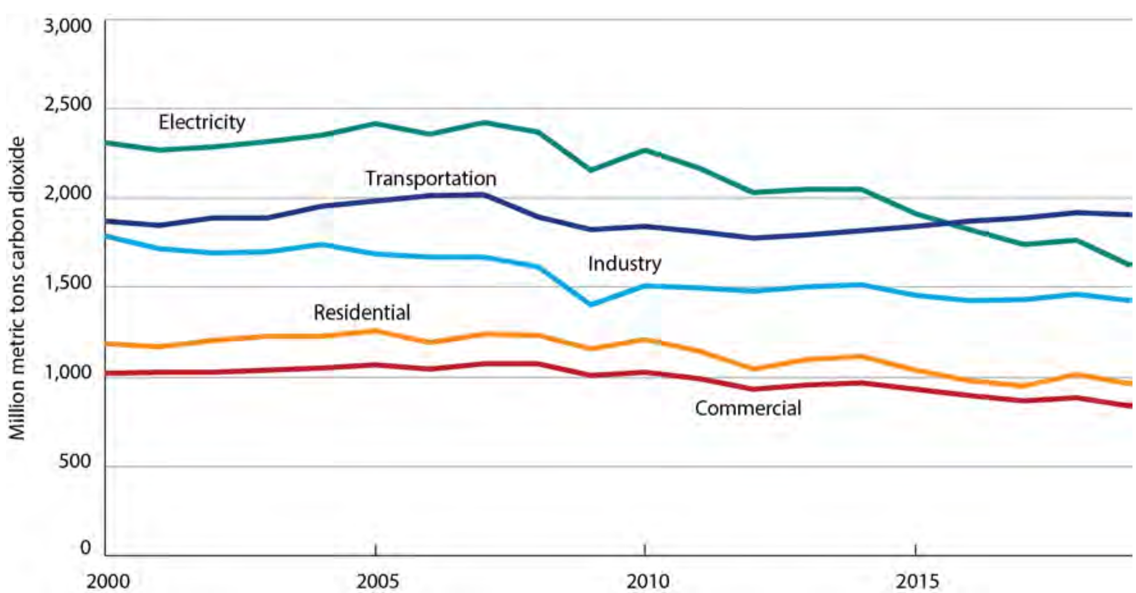
in 2019 with more than 85,000 plugs [DOE AFDC 2019d] of which over 12,500 are fast chargers. Fast chargers are especially important for intercity travel in BEVs because they can supply 4 or more miles of travel per minute of charge. Even faster chargers are being deployed along some U.S. highways that can provide 9 to 19 miles of driving range per minute of charge, enabling EVs with 250 miles of range to charge up to 80 percent of battery capacity in as little as 10-11 minutes [VWGA]. Based on 15,000 miles driven annually, average annual cost of vehicle ownership of a new hybrid is $7,736 and an electric vehicle is $8,320, which is less than the average annual cost of vehicle ownership across all vehicles categories of $9,282 [AAA]. The increase in public charging infrastructure over the past 5 years can be seen by comparing figures 7-8a and 7-8b. In 2019 over 300 stations were in operation with about 1,200 plugs [Electrify America]. As many as 450 DCFCs are expected to be in operation across the United States in 2020.

Transportation's Effects on the Human and Natural Environment

Greenhouse Gas Emissions

Emissions of greenhouse gases by U.S. transportation increased from 1,852.3 million metric tons of carbon dioxide (CO_2) equivalent in 2017 to 1,882.6 in 2018, an increase of 1.6 percent [EPA 2020a]. Transportation continued to be the largest, emitter of carbon dioxide (CO_2) emissions from U.S. energy use in 2019, accounting for about 22 percent of total U.S. CO_2 emissions (figure 7-9). Transportation's CO_2 emissions first surpassed emissions from electricity generation in 2016. In 2017 transportation also became the largest source of all types of greenhouse gases, including methane, nitrous oxide, and other gases [DOE EIA 2019a]. Emissions from electricity or power plants decreased by 30 percent from 2000 to 2019, while emissions from transportation activities increased by almost 2 percent during this time.

FIGURE 7-9 U.S. Carbon Dioxide Emissions from Energy Consumption: 2000–2019



SOURCE: U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, table 11.2-11.6, available at http://www.eia.gov/ as of May 2020.

Electric power generation is converting from coal to more use of natural gas. Coal emits more than 200 pounds[6] of CO_2 per million Btu of energy for various fuels compared to 117 pounds for natural gas, resulting in a decrease in CO_2 emissions [USDOE EIA 2020].

CO_2 from fossil fuel combustion remains the predominant greenhouse gas for transportation, comprising 97 percent of the sector's total greenhouse gas emissions in tons of CO_2 equivalent (figure 7-10). Other gases include methane (CH_4), a trace product of incomplete combustion of hydrocarbon fuels; nitrous oxide (N_2O), mainly produced in the catalytic converters of vehicle emissions control systems; and hydrofluorocarbons (HFCs), predominantly due to leakage from vehicle air conditioning systems. Also shown in figure 7-9 is the share of CO_2 emissions from electric power plants that can be attributed to electricity produced for use in transportation (eCO_2). Overall, transportation's greenhouse gas emissions are almost entirely the result of combustion of petroleum fuels. The modal distribution of emissions largely reflects the energy use by each mode of transportation.

Vehicle Emissions and Air Quality

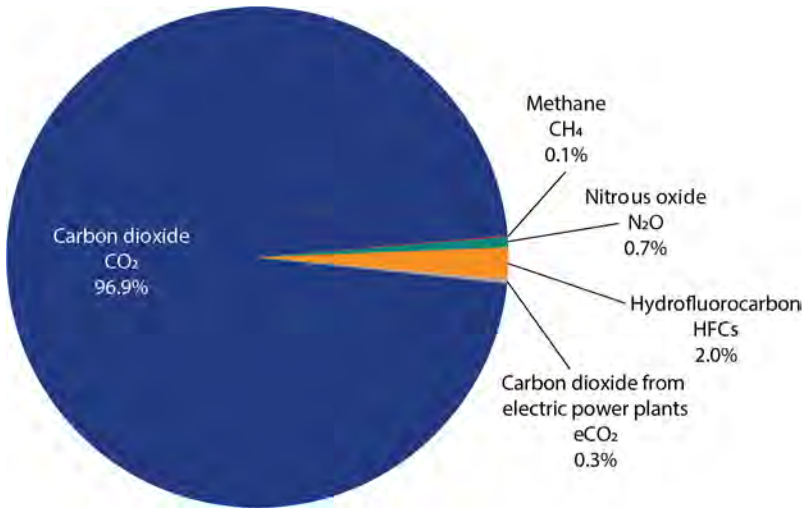
The rates at which pollutants are emitted from transportation vehicles have decreased by 40 percent for heavy trucks, 57 percent for light trucks, and 56 percent for passenger cars since year 2010, with the greatest reductions achieved by passenger cars. Figure 7-11 shows emission rates in grams per mile indexed to 2010 for four basic pollutants: hydrocarbons (HC)[7], carbon monoxide (CO), oxides of nitrogen (NOx)[8] and small

[6] Pounds of CO_2 per million Btu of energy for various types of coal: Coal (anthracite) 228.6; Coal (bituminous); 205.7 Coal (lignite) 215.4; Coal (subbituminous) 214.3.

[7] Hydrocarbons and carbon monoxide are products of the incomplete combustion of gasoline and diesel fuel.

[8] Oxides of nitrogen are formed when the nitrogen and oxygen in air chemically combine when fuel is burned in an internal combustion engine.

FIGURE 7-10 Transportation's Greenhouse Gas Emissions by Gas: 2018

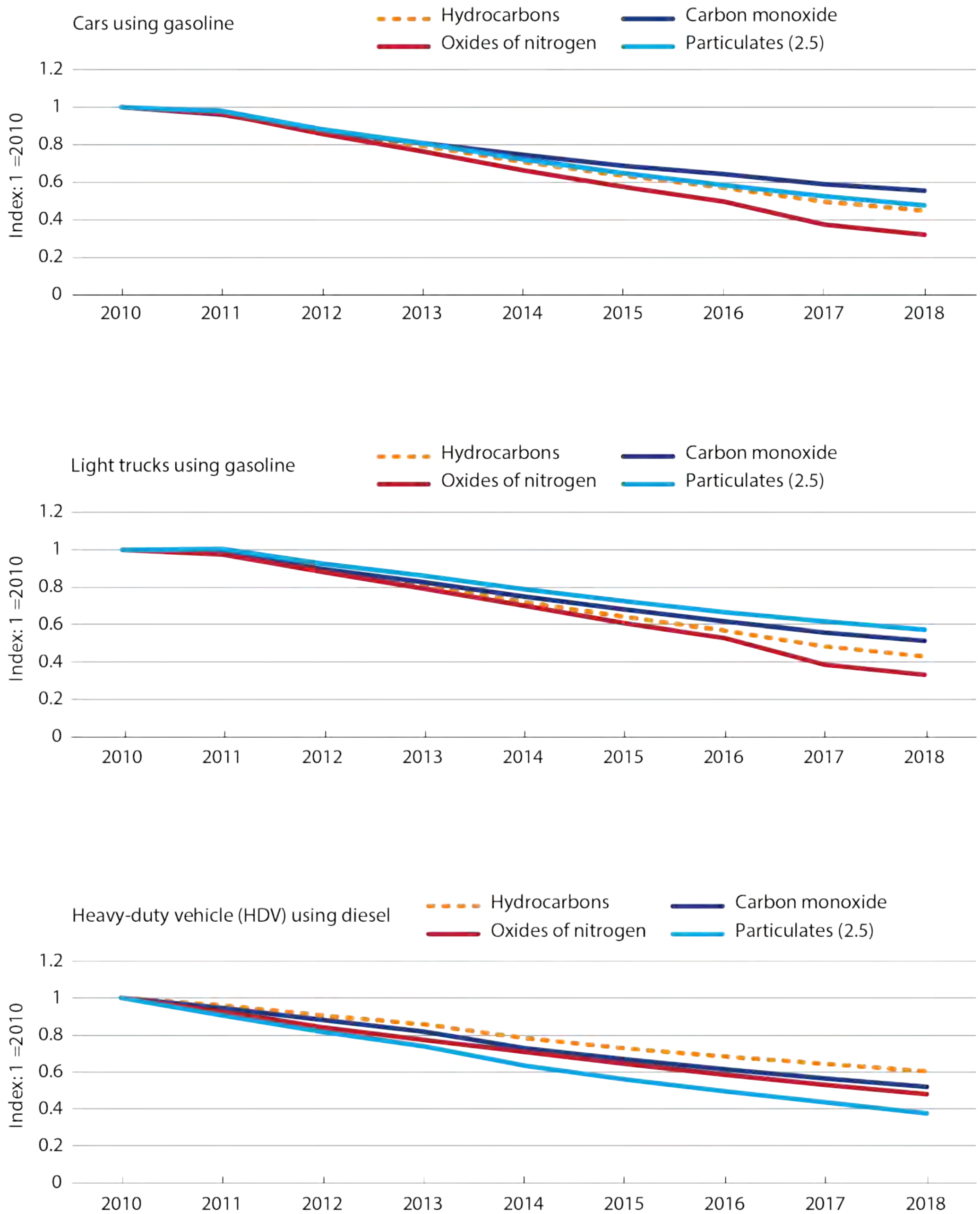


KEY: CH_4 = methane; CO_2 = carbon dioxide; eCO_2 = carbon dioxide from electric power plants; HFC = hydrofluorocarbon; N_20 = nitrous oxide.

SOURCE: U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017, table 2-12 and table ES-6, available at http://www.epa.gov/ghgemissions/ as of May 2020.

FIGURE 7-11 Estimated National Average Emissions Rates by Vehicle Type and Pollutant: 2010–2018

Indexed to 2010



KEY: CO = carbon monoxide; HC = hydrocarbons; NOx = nitrogen oxides; PM2.5 = particulate matter with diameter <= 2.5 micrometers.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, table 4-43, available at http://www.bts.gov/nts as of November 2019.

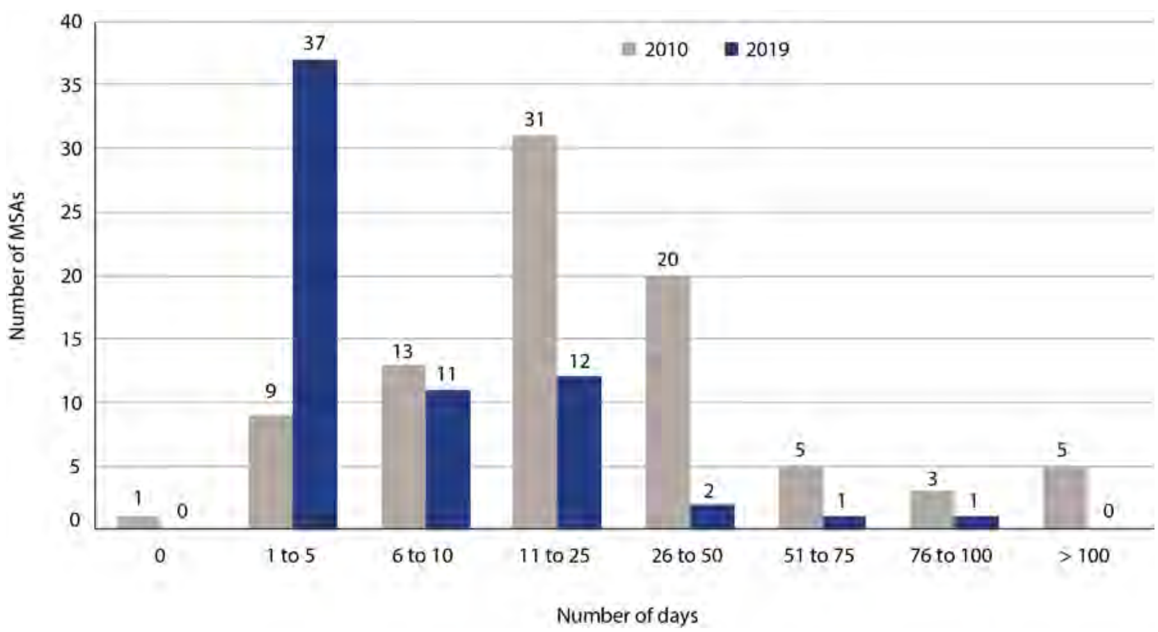
particulate matter (PM 2.5)[9] in engine exhaust.[10] The reductions in emissions by highway vehicles were driven by tighter vehicle emissions standards, which have gradually changed over time. Aircraft, locomotives, and ships have also been required to meet increasingly strict emissions standards. The result has been a gradual reduction in air pollution from transportation despite increased transportation activity or vehicle-miles traveled.

Reduced pollutant emissions from transportation and other sectors have contributed to better air quality in U.S. metropolitan areas. The number of days that metropolitan areas experienced unhealthy air has been trending downward over the past quarter century. Figure 7-12 shows the frequency with which the number of days the 87 continuously monitored Metropolitan Statistical Areas (MSA) experienced unhealthy air quality (Air Quality Index > 100). Compared to 2010, there were about 12 percent in 2019 and about 49 percent in 2018 as many MSAs with more than 25 days of poor air quality (4 in 2019, 16 in 2018, and 33 in 2010). Overall, the number of MSAs reporting 1 to 5 unhealthy days category increased in 2019 as the number of MSAs decreased from 2010 in the 11 to 25 and 26 to 50 days categories. It should be noted that year-to-year fluctuations can be caused by weather conditions and pollutant transport from other regions as well as variations in emissions. Not all MSAs saw improvement and improving air quality remains a challenge.

[9] PM 2.5 is comprised of solid particles of less than 2.5 microns in diameter that result from incomplete combustion of fuel, additives, or lubricants.

[10] PM 2.5 emissions are also produced by brake and tire wear. Brake and tire PM 2.5 emissions are not shown in figure 7-16 but are typically less than 10 percent of exhaust emissions.

FIGURE 7-12 Number of Days with Unhealthy Air Quality Index (AQI > 100) by MSA: 2010 vs. 2019



KEY: MSA= Metropolitan Statistical Area.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, table 4-51, available at http://www.bts.gov as of October 2019.

Water Quality

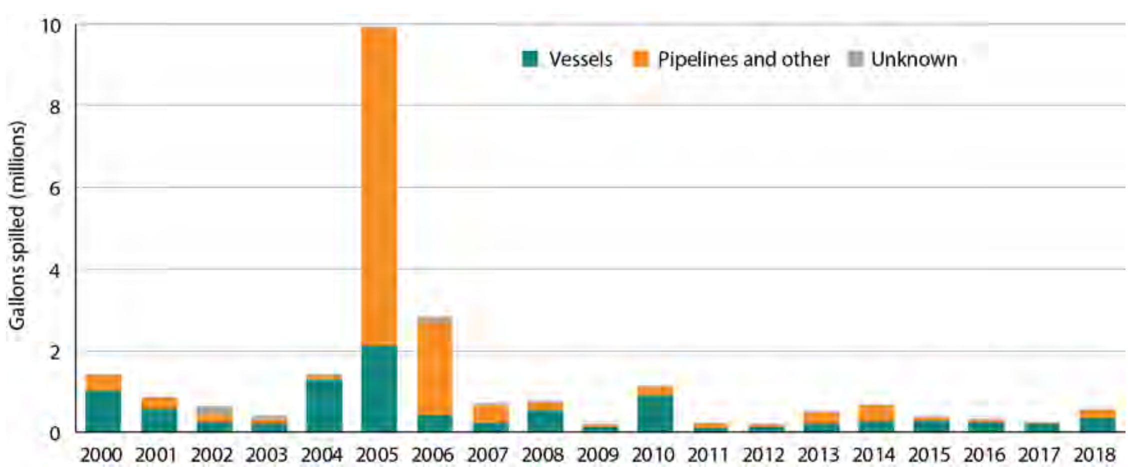
The transportation system affects water quality via spills of harmful substances from ships, barges, railroads, trucks, and pipelines, and run-off from roadways and other transportation infrastructure. Although there are tens of thousands of incidents involving hazardous materials transported each year, about 97 percent are small events with minor consequences [TRB]. Spills and leaks of petroleum, petroleum products, and other flammable liquids are by far the most common type of incident. The quantity of petroleum spills is highly variable from year to year but seemed to be generally improving since 2010. In 2018 the gallons of petroleum spilled into navigable waterways increased from 241,000 to 550,000 (figure 7-13).

Runoff from roads and other transportation infrastructure is a source of surface and ground water pollution. Among the pollutants in runoff from transportation facilities, the EPA lists heavy metals, oils, toxic chemicals, and road salt [EPA 2019c]. De-icing snowy or icy roads is considered essential to highway safety. Salt (sodium chloride) is an effective, economical, and the most widely used de-icing agent [DOT FHWA]. The use of salt to de-ice U.S. roads has doubled since 1975. In 2018 approximately 24.5 million metric tons of salt were applied to U.S. roadways to melt snow and ice, an increase of about 3 million tons over 2017 [USGS]. Salt usage fluctuates from year to year depending on winter weather.

Solid Waste and Recycling

Approximately 12 million motor vehicles were scrapped in the United States in 2018 [DOT BTS], about 95 percent of which will be recycled. Eighty-six percent of the weight of a scrapped vehicle is recycled [Auto Alliance]. The rest, known as auto shredder residue, comprised of plastics, cloth, glass, and other materials, is sent to landfills. Automotive lead acid batteries are the most recycled commodity in the U.S. economy, with a recycling rate of about 99 percent [EPA 2019b]. As electric vehicles age and are eventually scrapped, methods for recycling their lithium-ion batteries will need to be implemented.

FIGURE 7-13 Petroleum Spills into Navigable Waterways: 2000–2018



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 Apr. 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 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/nts as of October 2019.

Recycled asphalt pavement comprised 21 percent of all asphalt pavement installed in 2018. Of 101 million tons of asphalt reclaimed from road repaving projects, 91 million tons were reprocessed and reused as pavement and nearly all the rest was stockpiled for future use. About 0.01 percent, 12 thousand tons, went to landfills [Williams et al]. About 165 million tons of concrete waste were generated by demolition of roads and bridges in 2017 [EPA 2019b]. Of that, approximately 140 million tons are recycled as aggregate for pavements, riprap or loose stone to reduce shoreline erosion, and other uses [CMRA].

Each year, billions of tons of sediment are dredged from shipping channels to create or maintain access to ports, harbors, marinas, and naval facilities [EPA 2020]. Dredging activities in U.S. waters and disposal of dredge material are regulated by the EPA and Army Corps of Engineers (USACE). The USACE estimates that 200 to 300 million cubic yards of sediment are dredged annually. Approximately 20 to 30 percent is used for beneficial purposes, such as flood control, improvement of aquatic habitats, the maintenance of beaches and storm damage reduction [EPA; USACE 2015].

Collisions with Wildlife

Collisions between vehicles and wildlife on highways and roads not only cause injury and death, but also destroy, disrupt, and fragment wildlife habitats and ecosystems. Comprehensive statistics on roadkill do not exist, but in 2017, 305,000 collisions between motor vehicles and animals caused property damage, injuries, or fatalities to vehicle occupants [DOT NHTSA 2018]. By one estimate, there were 1.33 million vehicle collisions with deer alone in 2018, slightly fewer than the 1.34 million in 2017 [State Farm].[11] Collisions with smaller animals generally go unreported but are undoubtedly far more numerous. Many states collect some data on roadkill but do not attempt to make comprehensive estimates for all types of animals.

[11] State Farm's annual estimates are for the period from July 1 to June 30 of the following year.

For example, maintenance personnel of the Colorado Department of Transportation collect roadkill statistics by month, highway, region, and type of animal. The statistics are neither a complete count nor a scientifically valid sample but may be indicative of trends and species, especially for larger animals [CDOT]. From 2015 to 2018, the reports include 6,000 to 7,000 animals per year. In all years, deer are the most frequent victims comprising 67 percent of reported roadkill in 2018. Other large animals include elk (about 6 percent); bighorn or pronghorn sheep (0.7 percent); and bear and moose, both at 0.2 percent. Collisions between vehicles and animals also kill people. In 2017, 211 people lost their lives in collisions with animals, an increase of 22 persons over 2016 [IIHS].

Transportation infrastructure, such as highways and roads, affects wildlife through habitat disruptions and fragmentation. In recent years, innovative data collection, research methods, and technologies are helping improve infrastructure design by connecting wildlife migration corridors, enhancing ecosystems, and creating safer roads. Wildlife tagging, global positioning systems (GPS), cameras, geographic information systems (GIS) and geodatabases are used to track wildlife migratory paths and related data – all of which help to identify the locations and types of transportation infrastructure needed along segments of highways. For example, Interstate 80 in Wyoming installed highway underpasses, overpasses, and fencing on segments of the superhighway where wildlife corridors were identified for mule deer, elk, and pronghorn, resulting in a decrease in collisions between vehicles and wildlife [GUARINO]. Another study developed a data-driven tool to measure state highway attributes and how that affects butterfly ecosystems and populations. Pollinators, such as butterflies, are critical to our food supply as well as to the health of ecosystems. This tool measured factors such as traffic volume, traffic speed, and right-of-way width to provide guidance for highway operation and maintenance decisions, including milkweed location; pesticide, road salt, heavy metals, and insecticide use; mowing; and other vegetation management techniques to strengthen the butterfly's ecosystem [CARIVEAU et. al.].

Statistics can be used in other ways to enhance ecosystems and wildlife corridors. For example, highway attributes, such as drainage structures, roadway barriers, number of lanes, and adjacent natural plants; and habitat size, quality, and connectivity can be used to quantify a mitigation valuation program called connectivity mitigation credits[12] [SAMANNS et. al.]. This new type of environmental mitigation program restores and enhances wildlife corridors to offset disturbances caused by highway transportation projects.

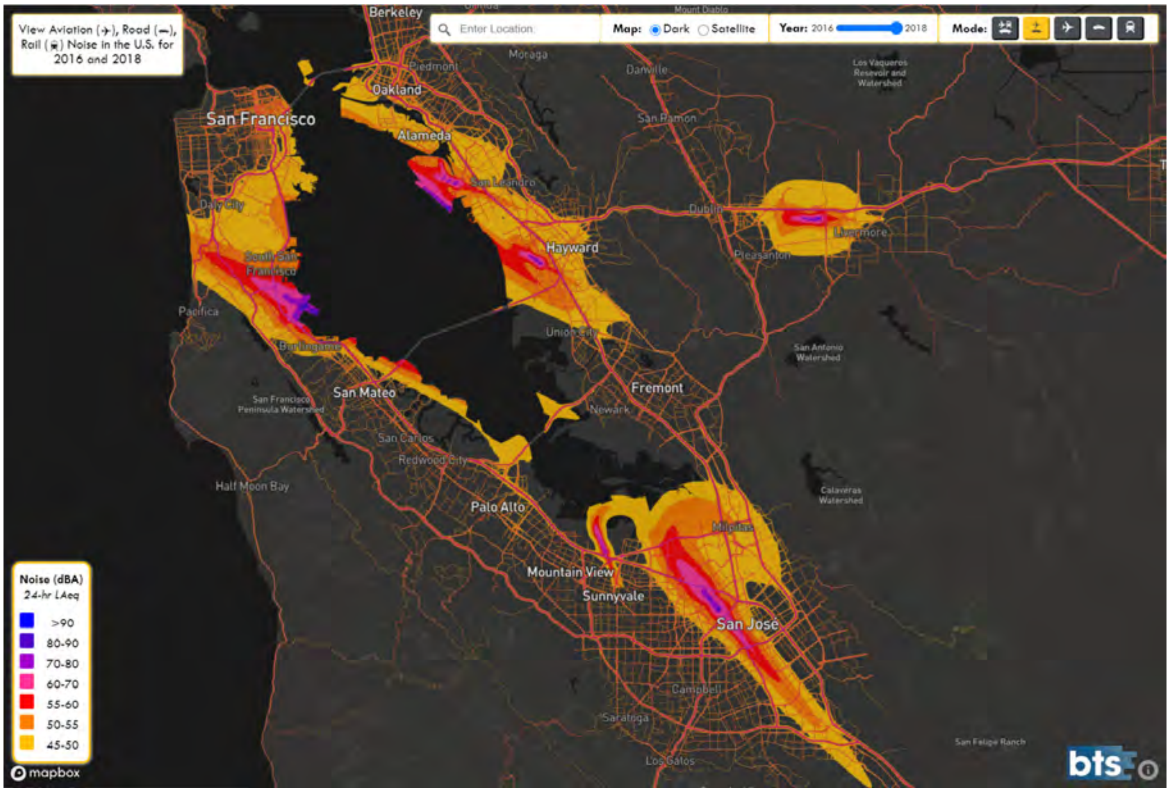
[12] The creation of a dedicated funding source for wildlife crossings and other connectivity enhancements for transportation projects that is based on a set of quantifiable metrics.

Transportation Noise

Noise pollution from transportation sources can span a range of potential impacts, including disruption to normal activities like conversation. Research has also shown that there may be longer-term health impacts associated to noise pollution including hearing loss, elevated stress, anxiety, depression, high blood pressure, and heart disease [NIH].

The effects of transportation noise are mostly concentrated along major roadways and near airports. While the loudest transportation noise sources are most commonly associated with the departing and landing of aircraft, the largest of these noise levels only occur within the boundaries of the airport property (figure 7-14).

FIGURE 7-14 Road and Aviation Noise for San Francisco Bay Area: 2018



NOTES: Noise-level contours are graphical representations of noise levels on a map, similar to elevation contours on a topographic map. Noise-level contours are lines that join points of equal sound levels with areas between the contour lines having noise levels between the two contour values. The noise levels shown are for the LAeq noise metric and represent the combined noise from both the airport and federal highways sources.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Noise Map (2020), available at https://data.bts.gov/stories/s/ri89-bhxh as of September 2020.

To help address the effects of transportation noise, airport and highway operators and others have implemented program and taken steps. To shield communities near highways from excessive road noise, highway operators have constructed 3,284 miles of noise barriers through 2016 at a cost of $7.4 billion. To mitigate the impact from aircraft operation near airports, over $6 billion has been spent through 2019 to sound insulate or acquire homes exposed to significant noise levels (DNL 65dBA or greater).

Major technological advances in the design of both airframes and engines have also contributed to a very significant reduction of the aircraft noise at the source. Airplane manufacturers introduced these technologies in new production aircraft and the fleet become increasingly quieter through stringency requirements. In 1975, the aviation system exposed an estimated 7 million Americans to significant noise levels supporting 202 million annual passenger enplanements. In 2019 this number has decreased by more than 90 percent to only 430,000 people exposed to significant noise, while annual passenger enplanements have increased to more than 927 million, a growth of almost 460 percent.

Table 7-3 shows that in 2018 about 23 percent of the U.S. population had the potential to be exposed to combined aviation and road noise at levels greater than 45 decibels, which is comparable to the noise level of a humming refrigerator; up 3.4 percent from 2016. About 0.1 percent of the population was potentially exposed to noise levels of 80 decibels or more in 2018, comparable to the sound of a garbage disposal. The group potentially exposed to such noise levels grew the most between 2016 and 2018, increased from about 300,000 individuals in 2016 to 344,000 individuals in 2018.

Energy and Environmental Effects of Transportation Innovations

The U.S. transportation system has a long and successful history of innovation. The effects of these innovations on transportation's energy use and environmental effects are highly uncertain and will depend greatly on the extent to which travelers are willing to share vehicles and trips. Two studies by U.S. Department of Energy Laboratories estimated that shared, connected, and automated vehicles could reduce passenger car and light truck energy use by 80 to 90 percent or increase it by 100 to 200 percent [DOE EIA 2017a]. On the other hand, the Energy Information Administration (EIA) anticipates more modest changes through 2050 [DOE EIA 2018]. Compared to its reference case,

TABLE 7-3 Estimated Percent of the U.S. Population with Potential Exposure to Road and Aviation Noise: 2016 v. 2018

	2016		2018		
A-weighted 24-hour LAEQ (dBA)	Population exposed	Percent of total population exposed	Population exposed	Percent of total population exposed	Percent change from 2018 to 2016
45 to 49	32,014,330	9.9	33,017,559	10.2	3.1
50 to 54	20,209,932	6.3	20,938,255	6.5	3.6
55 to 59	11,090,488	3.4	11,257,598	3.5	1.5
60 to 69	7,014,513	2.2	7,452,126	2.3	6.2
70 to 79	1,615,974	0.5	1,711,810	0.5	5.9
80 or more	298,680	0.1	344,716	0.1	15.4
Total combined noise	72,243,917	22.4	74,722,064	23.1	3.4

KEY: dBA = Decibels; LAEQ = Equivalent Continuous Sound Pressure Level

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Noise Map (2020), available at https://data.bts.gov/stories/s/ri89-bhxh as of September 2020.

the EIA assumed increased travel and projected autonomous hybrid or battery electric vehicles to increase transportation energy use by only 3 to 4 percent.

There are also several new vehicle types that could potentially enter the national airspace in the coming years. Unmanned aerial systems are already entering the national air space to fulfill a broad range of uses. Industry is also developing a new generation of air vehicles that could enable improved mobility across urban areas. Further, the supersonic civil aircraft being developed would reduce travel times across the globe. While these new air vehicles will certainly improve the traveling experience of the public and open new economic opportunities, they could also have an impact on the energy use, noise, and emissions of aviation.

Data Gaps

The main data gaps related to transportation energy data and environmental consequences are:

- On-road fuel economy for light-duty, medium, and heavy-duty vehicles to better understand their energy efficiency and ensure that the anticipated benefits of fuel economy improvements are realized.
- Estimating energy use in freight transportation, particularly ton-miles by truck type which are key to accurately estimating energy intensity—a key measure of productivity.
- Tracking energy use and energy intensity of delivery trucks used for the final mile to better understand the implications of emerging trends enabled by information technology.
- Factors affecting large-truck energy use (load, speed, trip lengths, annual miles, daily travel distributions).
- Usage patterns of, and the barriers to use of, EVs and PHEVs by households and businesses to understand their market potential, as well as needs for public charging infrastructure.
- Usage of EV public charging infrastructure and effect on miles traveled by EVs to better understand their value to PEV owners and the effect on PEV sales.
- Energy use and energy intensity of innovative transportation: transportation network companies, e-bikes, e-scooters, e-skateboards, connected and automated vehicles etc., to understand how these innovations may affect energy use and the environment.
- Limited data on the energy intensity of freight modes, which may be improving at a slower rate than passenger modes. However, additional data and further study to confirm this observation.

References

AAA. *Your Driving Costs: Spike in Finance Costs Drives Increase*, available at https://newsroom.aaa.com/ as of September 2019.

Argonne National Laboratory (ANL), 2019. "E-drive Sales", available at https://www.anl.gov/ as of September 2019.

Auto Alliance, 2019. "Automotive Recycling," available at https://autoalliance.org/.

Bloomberg NEF, 2019. "Electric Vehicle Outlook 2019", available at https://about.bnef.com/ as of September 2019.

BP, 2019. *Statistical Review of World Energy- all data, 1965-2018*, "Oil – Proved reserves history" and "Oil – Production barrels", available at https://www.bp.com/ as of February 2020.

Cariveau, A., W. Caldwell, E. Lonsdorf, C. Nootenboom, K. Tuerk, E. Snell-Rood, E. Anderson, K. Baum, J. Hopwood, K. Oberhauser, 2020. "Evaluating the Suitability of Roadway Corridors for Use by Monarch Butterflies". The National Academy Press. NCHRP 942.

Colorado Department of Transportation (CDOT), 2019. "Roadkill Data 2018", available at https://www.codot.gov/ as of November 2019.

Construction Materials Recycling Association (CMRA), 2019. "Concrete Recycling", available at http://www.concreterecycling.org/ as of November 2019.

Davis, S.C., and R.G. Boundy, 2019. *Transportation Energy Data Book: Ed. 37.2*, ORNL/TM-2018/987/R, Oak Ridge National Laboratory, available at https://tedb.ornl.gov/ as of November 2019.

Electrify America, 2019. "Locate a Charger", available at https://www.electrifyamerica.com/ as of November 2019.

Gohlke, D. and Y. Zhou, 2018. "Impacts of Electrification of Light-Duty Vehicles in the United States, 2010-2017", ANL/ESD-18/1, Argonne National Laboratory, Argonne, IL.

Greene, D.L., E. Kontou, B. Borlaug, A. Brooker, and M. Muratori, 2019. "Public Charging Infrastructure for Plug-in Electric Vehicles: What is it Worth?", forthcoming, *Transportation Research D: Environment*, Special Issue on Alternative Fuel Infrastructure.

Guarino, Ben. "Climate Solutions, Safe Passages. Rocky Mountain animals will move as the climate warms. These corridors could give them an easier path", available at https://www.washingtonpost.com/ as of November 2019.

Insideevs.com, 2019. "Global Sales December & 2018: 2 Million Plug-In Electric Cars Sold", available at https://insideevs.com/ as of December 2019.

Insurance Institute for Highway Safety, 2019. "Collisions with fixed objects and animals", available at https://www.iihs.org/ as of November 2019.

McArthur, J., C. Cherry, M. Harpool and D. Scheppke, 2018. *A North American Survey of Electric Bicycle Owners*, NITC-RR-1041, National Institute for Transportation and Communities, Portland, Oregon, available at https://pdxscholar.library.pdx.edu/ as of November 2019.

McCaran, T. and N. Carpenter, 2018. *Electric Bikes: Survey and Energy Efficiency Analysis*, Efficiency Vermont, available at https://www.efficiencyvermont.com/ as of November 2019.

McNutt, B., and D. Rodgers. 2004. "Lessons Learned from 15 Years of Alternative Fuels Experience – 1988-2003." In The Hydrogen Energy Transition, edited by D. Sperling and J.S. Cannon. San Francisco: Academic Press.

National Association of City Transportation Officials (NACTO), 2019. *Shared Micromobility in the U.S.: 2018*, available at https://nacto.org/ as of November 2019.

National Institutes of Health (NIH), 2019. "Noise Pollution", available at https://toxtown.nlm.nih.gov/ as of November 2019.

Natural Gas Vehicles America (NGVA), 2019, available at https://www.ngvamerica.org/ as of November 2019.

Samanns, E., P. Baigas, R. Ament, M. Huijser, 2020. "Valuing Wildlife Crossings and Enhancements for Mitigation Credits" The National Academy Press. NCHRP 280.

State Farm Mutual Automobile Insurance Company (State Farm), 2019. "Deer Crashes Down", available at https://newsroom.statefarm.com/ as of November 2019.

Sullivan, J., 2018. "Let's Count the Ways e-scooters Could Save the City", *Wired*, 12/07/2018, available at https://www.wired.com/ as of December 2019.

Transportation Research Board (TRB), 2005. Cooperative Research for Hazardous Materials Transportation, Special Report 283, available at https://www.nap.edu/ as of November 2019.

U.S. Army Corps of Engineers (USACE), 2020. "Ocean Dredged Material Site Database", available at https://odd.el.erdc.dren.mil/ as of January 2020.

U.S. Department of Energy, Alternative Fuels Data Center (DOE AFDC):

–2019a. "Ethanol Fuel Basics", available at https://afdc.energy.gov/ as of November 2019.

–2019b. "Biodiesel Blends", available at https://afdc.energy.gov/ as of November 2019.

–2019c. "Natural Gas Vehicles", available at https://afdc.energy.gov/ as of November 2019.

–2019d. "Alternative Fuel Station Counts by State", U.S. Department of Energy, available at https://afdc.energy.gov/ as of November 2019.

U.S. Department of Energy, Energy Information Administration (DOE EIA):

–2020a. *International: Petroleum and Other Liquids*, "Annual crude and lease condensate reserves", available at https://www.eia.gov/ as of February 2020.

–2020b, *Monthly Energy Review*, available at https://www.eia.gov/ as of May 2020.

–2020c, *How much carbon dioxide is produced when different fuels are burned,* available at https://www.eia.gov/ as of September 2020.

–2020d, *Natural Gas Explained: Use of Natural Gas*, available at https://www.eia.gov/ as of September 2020.

–2018. *Autonomous Vehicles: Uncertainties and Energy Implications*, available at https://www.eia.gov/ as of November 2019.

–2017a. *Study of the Potential Energy Consumption Impacts of Connected and Automated Vehicles*, available at https://www.eia.gov/ as of November 2019.

–2017b. "Tight oil expected to make up most of U.S. oil production increase through 2040," available at https://www.eia.gov/ as of November 2019.

U.S. Department of Transportation, Bureau of Transportation Statistics (DOT BTS), 2019. National Transportation Statistics, available at https://www.bts.gov/ as of November 2019.

U.S. Department of Transportation, Federal Highway Administration (DOT FHWA), 2017. *2017 Road Weather Management Performance Update*, available at https://ops.fhwa.dot.gov/ as of November 2019.

U.S. Department of Transportation, National Highway Traffic Safety Administration (DOT NHTSA), 2018. *Traffic Safety Facts Annual Report Tables*, table 29, "Crashes by First Harmful Event, Manner of Collision, and Crash Severity, 2017", available at https://cdan.nhtsa.gov/ as of November 2019.

U.S. Environmental Protection Agency (EPA):

–2020. "Dredging and Sediment Management", available at https://www.epa.gov/ as of February 2020.

–2020a. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018. available at https://www.epa.gov/ as of May 2020.

–2019b. *Advancing Sustainable Materials Management: 2017 Fact Sheet*, available at https://www.epa.gov/ as of November 2019.

–2019c. "Nonpoint Source: Roads Highways and Bridges", available at https://www.epa.gov/ as of November 2019.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers (EPA USACE), 2015. *The Role of the Federal Standard in the Beneficial Use of Dredged Material from U.S. Army Corps of Engineers New and Maintenance Navigation Projects: Beneficial Uses of Dredged Materials*, available at https://www.epa.gov/ as of January 2020.

U.S. Geological Survey (USGS), 2019. "Salt Statistics Information," National Minerals Information Center, "Salt", available at https://www.usgs.gov/ as of November 2019.

Williams, B.A., J.R. Willis, and T.C. Ross, 2019. Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage: 2018. FHWA-HICP-40, Federal Highway Administration, Washington, DC.

Volkswagen Group of America, 2017. *National ZEV Investment Plan: Cycle 1*, Public Version, available at https://www.epa.gov/ as of November 2019.

CHAPTER 8

State of Transportation Statistics

The 2019 edition of the *Transportation Statistics Annual Report* featured an extensive review of legislation that emphasizes the importance of reliable statistics, how emerging technologies affect transportation, and how to measure those effects. The report highlighted how the *Foundations for Evidence-Based Policymaking Act*[1] and the *Geospatial Data Act of 2018*[2] reinforce long-standing responsibilities of the Bureau of Transportation Statistics (BTS) to support decisions with objective, accurate, and timely information. The report comprehensively assessed the strengths and challenges of existing transportation statistics.

While the 2019 edition of the *Transportation Statistics Annual Report* advanced the public's understanding of the state of statistics and long-term BTS work, COVID-19 has added a new dimension to the state of statistics and the BTS agenda. Transportation officials need to respond rapidly to changes brought about by the pandemic and they value fast delivery of daily, weekly, and monthly statistics to inform decisions. More frequent data also helps officials understand short-term effects of system disruptions, provides insights on resiliency, and deepens knowledge on whether and when transportation activity will return to traditional trends or to a "new normal." Short-term changes, particularly those restricted to a portion of the transportation system, often disappeared in the annual statistics that have historically dominated traditional BTS products. BTS now needed to provide timely and geographically detailed data and to deliver that data quickly.

Fortunately, BTS had begun to develop experimental data products in recent years that helped meet the demands for more frequent and timely information than available in the past. BTS also has an extensive network of contacts for compilations, such as more than 100 agencies that comprise the Federal Interagency Council on Statistical Policy, that can be tapped for new, faster measures. The result is a new agenda as described below for BTS to meet both traditional and emerging needs of the Bureau's customers.

Transformation of Data Programs During the Pandemic

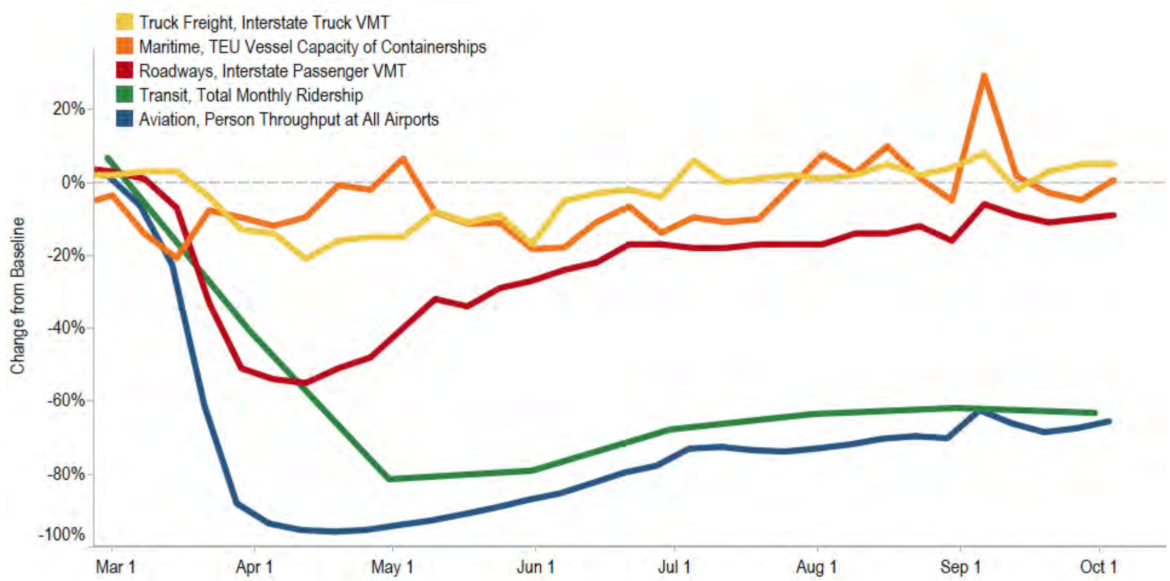
BTS started publishing *The Week in Transportation*, a compilation of statistics on transportation activity during the preceding week, on its website in April 2020.[3] BTS is also reporting daily statistics to the Secretary (an example in figure 8-1). Some of these daily and weekly statistics are based upon proxy instead of traditional transportation measures, such as passenger screening counts at airports by the Transportation Security Administration (TSA) as an indicator of airline travel demand. Screenings

[1] Pub. L. 115-435 (Jan. 14, 2019).

[2] Pub. L. 115-254, Secs. 751–759, 115th Cong. (Oct. 5, 2018).

[3] www.bts.gov/twit.

Figure 8-1 Rapid Statistics on COVID-19 Impact: March – October 2020



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Special Tabulation, October 2020.

are not a precise measure because they include airline employees and others who work at airports, but changes in the number of screenings are a reasonable proxy of changes in air travel. Other statistics on the website are partial indicators of traditional transportation measures, such as the turnstile counts from the rail transit systems in New York, Washington, and the Bay Area as a measure of how transit ridership changed during the pandemic.

The Week in Transportation includes estimates of trips by trip length for each county in the United States. Prepared by the University of Maryland for BTS, these estimates are based on location-based services on mobile devices carried by thousands of individuals. Estimates for each day of the week are processed and published at the end of the week, providing a new window on travel that has been extended back to the beginning of 2019 to compare daily patterns to a more typical year. Future research will be needed to understand the changes in travel patterns and any potential biases or other quality issues in the data.

Prior to COVID-19, the most frequently published data by BTS were released monthly. Publication of monthly data typically required more than 8 weeks to accommodate the time respondents are given to report and the time BTS needed for thorough quality assurance. To speed up the delivery of monthly data prior to the pandemic, BTS released preliminary estimates based on historical trends. Because historical trends were upended by the pandemic, BTS replaced its preliminary estimates with partial observations that are statistically accurate and objective, but often include incomplete data due to reporting lag. For example, BTS now uses data from large airlines that are generally reported more quickly than from small air carriers as a preliminary indicator of change. These indicators are based on incomplete data and subject to revision when the data are complete. The differences between the preliminary and final statistics are typically small.

The desire for speedier delivery of statistics does not replace the more deliberative attention to data quality in the publication of final monthly statistics. The importance of data quality was demonstrated by how the Department of the Treasury relied on airline employee salary and benefits data, collected by BTS, to direct $27 billion in financial assistance under the *Coronavirus Aid, Relief, and Economic Security (CARES) Act*.[4] BTS has played a key role in programs to increase the timeliness and utility of statistical information while maintaining objectivity and data integrity.

Data Initiative To Improve Safety

The Department of Transportation's Safety Data Initiative began in 2018 to use innovative ways to visualize and analyze safety data in order to improve its relevancy to transportation decisionmaking [USDOT BTS 2020]. The Department challenged the public and private partners to develop tools that all levels of government can use to bring together very large datasets, artificial intelligence, and visualization techniques to address safety issues, including some in real time. The Safety Data Initiative has several components:

- The *Solving for Safety Visualization Challenge*, led by BTS, attracted 54 participants to propose data visual analytics tools[5] that would provide insights into serious crashes on roads and rail systems. The University of Central Florida[6] was declared the winner in December 2019 for its real-time crash risk visualization tools for traffic safety management.

- The *Waze Pilot Project*, sponsored by BTS and undertaken by the USDOT's Volpe National Transportation Systems Center, combines traffic condition data collected by Waze from cell phones and crash data transferred electronically from the State of Maryland. Using machine learning techniques,[7] Volpe found that reasonably good estimates of police-reported crashes could be developed, showing a promising step to develop a nationwide crash count tool.

- The *Rural Speed Pilot Project* seeks to better understand how a vehicle's prevailing speed, speed limit, and average travel speed affect the number and severity of crashes on rural highways. It also seeks to shed light on how roadway design and traffic volumes relate to speed and crash outcomes. In addition to traditional data sources, the pilot uses the National Performance Management Research Data Set (NPMRDS)—anonymized data from vehicle probes—to learn about speed's role in crashes. The NPMRDS provides prevailing speeds at 5-minute intervals across the entire National Highway System. NPMRDS data when used in conjunction with traditional datasets could provide a more in-depth understanding of the correlation between prevailing speeds and crash rates in rural areas.

- The *Pedestrian Fatality Pilot* examined the relationship between pedestrian fatalities and the characteristics of the built environment, integrating data from the Federal Highway Administration (FHWA), the National Highway Traffic Safety Administration (NHTSA), the Environmental Protection Agency, and the Census Bureau. It found that pedestrian fatality risk from traffic was significantly greater on urban arterial highways without access control than on other urban roadways and all roadway types in rural areas. Lessons learned from this pilot would be used to better understand place-specific risks.

[4] Public Law 116-136, Mar. 27, 2020.

[5] https://www.transportation.gov/solve4safety/solve4safetysubmissions.

[6] https://www.ucf.edu/news/ucf-wins-national-competition-to-make-driving-safer/.

[7] According to one source, SAS, machine learning is a "… method of data analysis that automates analytical model building. It is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention." See SAS, Machine Learning: What it is and why it matters, available at https://www.sas.com/en_us/insights/analytics/machine-learning.html as of July 2020.

- NHTSA is exploring ways to present and supplement existing data summaries on specific topics in its Traffic Safety Fact Sheets series through a *Fatality Analysis Reporting System (FARS) Data Visualizations*[8] project. By offering information in more interactive formats, NHTSA hopes to present the data in more helpful ways to policymakers.

VIUS 2021

The transportation community has lacked information on the Nation's vehicle fleet ever since the Vehicle Inventory and Use Survey (VIUS) was suspended nearly two decades ago. In response to this critical gap, a joint effort by BTS, the Department of Energy, the FHWA, and the U.S. Census Bureau will restore the VIUS in 2021. The VIUS will provide operational characteristics by truck type (including heavy and light trucks, pickups, vans, minivans, and sport utility vehicles), axle configuration, trailers hauled, operating weight, and equipment added after manufacture. The survey also will estimate truck use in 2021 for business and personal transportation, goods transported, miles traveled, and vehicle fuel economy.

Conducted by the Census Bureau every 5 years from 1963 until budget shortfalls forced the survey's discontinuation following the 2002 survey, the VIUS had been the principal data source on the physical and operational characteristics of the U.S. light- and heavy-truck fleet. Data from the VIUS are important to the U.S. Department of Transportation's efforts to estimate the contribution of transportation to the Nation's economy, quantify the reliance of major economic sectors on transportation services, allocate highway damage to truck types, identify safety and other operational issues related to larger and heavier trucks, and analyze highway safety trends. Data from the 2002 VIUS are still used today in policy analyses.

[8] https://icsw.nhtsa.gov/nhtsa/fars/speeding_data_visualization/.

Improving Economic and Financial Statistics

BTS has an initiative underway to improve the economic and financial statistics related to transportation. Traditional sources of data on public investment in transportation take years to process, require complicated reconciliations of fiscal and calendar years and authorizations versus obligations versus final spending, and assume a clear distinction between public and private investment. That distinction is less clear with the increasing use of innovative financial instruments and public-private partnerships, and by the influx of funds through the CARES Act. Working with the National Academy of Public Administration, BTS has developed a roadmap for producing more robust, timely statistics that more accurately account for public and private spending than have past efforts.[9] BTS has begun discussions with key stakeholders, such as the American Association of State Highway and Transportation Officials, to implement elements of the roadmap.

A New Statistical Window on Commercial Aviation

Among the most challenging "big data" projects underway at BTS is an initiative to capture in near real-time key information about each commercial flight in the United States. BTS is working closely with the Federal Aviation Administration to capture data from the NextGen System Wide Information Management (SWIM) program, as described in box 2-B. The data processing challenges of extracting, organizing, and verifying data on key aspects of each flight from the massive stream of messages constantly flowing through the air traffic control system are formidable. BTS is placing special emphasis on confirming that its conversion of messages into key data points for each flight, such as times that wheels left the runway at the

[9] National Academy of Public Administration, Bureau of Transportation Statistics: *Developing a Statistical Roadmap to Inform Transportation Financing Decisions*, available at https://www.napawash.org/studies/academy-studies/bureau-of-transportation-statistics-developing-a-statistical-roadmap-to-inf as of August 2020.

origin and touched down at the destination, is correct. Once the Commercial Flight Database is operational, BTS will be able to produce airline on-time statistics throughout the day rather than wait for carrier reports at the end of the month. Data will be timelier, and the respondent burden associated with monthly carrier reports will be eliminated if the new data system proves to be an effective replacement.

Meeting Ongoing Data Needs

In addition to the initiatives mentioned above, BTS collaborates with its partners throughout the Department to continue providing the basic statistical information and services that its customers have required throughout the Bureau's history. Major ongoing products include, but are not limited to:[10]

- the *Transportation Statistics Annual Report* to the President and Congress, and the annual reports on port performance and railroad tank car safety to Congress;
- the biennial National Census of Ferry Operators that provides apportionment factors for the FHWA's Construction of Ferry Boats and Ferry Terminal Facilities Formula Program;[11]
- annual reports of the confidential close calls program, such as the SafeOCS reports for the Department of the Interior's Bureau of Safety and Environmental Enforcement covering offshore drilling;
- continuous updates to National Transportation Statistics, a compendium of over 240 tables summarizing key elements of the transportation system for the last 50 years, with highlights featured in the popular *Pocket Guide to Transportation*;
- statistical summaries of transportation for each of the 50 states and the District of Columbia;
- continuous updates to the National Transportation Atlas Database, an integrated digital map of transportation facilities throughout the United States, and related geospatial products, such as the National Transit Map and the National Transportation Noise Map;
- annual updates to the Freight Analysis Framework, benchmarked every 5 years on the Commodity Flow Survey conducted by the Census Bureau for BTS;
- continuation of the Transborder Freight Statistics Program, Border Crossing/Entry Data Program, and the Port Performance Freight Statistics Program;
- continuation and modernization of the commercial aviation data programs covering enplanements and cargo carried, ticket prices and itineraries, on-time performance, and airline employment and finance;
- maintenance and improvement of the Repository and Open Science Access Portal, an online repository of documents and data of interest to the transportation community, including all research data and reports funded by DOT; and
- consultation with DOT operating administrations in meeting statistical quality standards to obtain Office of Management and Budget approval for over 100 information collection requests annually.[12]

Each of these products continue to evolve. For example, the state transportation profiles have been extended to include data for each of the 3,141

[10] https://www.bts.gov/browse-statistical-products-and-data.

[11] https://www.fhwa.dot.gov/safetealu/factsheets/ferryboats.htm.

[12] The Office of Management and Budget approves all requests for information from the public under the Paperwork Reduction Act. When a request by DOT involves a survey or statistical analysis, BTS reviews the proposed design to assist the DOT office in obtaining approval.

counties and county equivalents[13] in the United States, which are available at https://www.bts.gov/ctp.

New BTS Products in Development

The demand for frequent, geographically detailed information on transportation will continue even if and when concern with COVID-19 subsides. Most likely, past demands for information on the demographic and economic characteristics of users of the transportation system will intensify as transportation providers begin to rebuild to serve post-pandemic markets. BTS is in the early phases of data development to meet these demands.

Enhanced Quick Response Data

Whether nationwide or localized, disruptions to the transportation system affect the availability and use of transportation infrastructure for evacuations, for operating around disabled facilities, and for rebuilding affected localities. BTS has been developing the Transportation Disruption and Disaster Statistics (TDADS) program for transportation agencies to compile and archive data on traffic operations into a system that can support nationally standardized statistics on transportation system disruption, resilience, and disasters. TDADS also supports the Emergency Planning Transportation Data Initiative that combines weather information with data from transportation operations centers for emergency transportation planning.

Characteristics of Long-Distance Travelers

As explained in chapter 3, our current understanding of passenger travel is based primarily on monthly counts of airline trips and other limited data sources. Passenger travel is being estimated most recently by tracking the movement of mobile devices, such as cell phones, but the relationship of mobile devices to the demographic and economic characteristics of travelers as well as to the trip characteristics is not fully specified. Algorithms to distinguish movements of mobile devices by type of user, mode of transportation, and likely trip purpose exist and are continually being refined, but the results are difficult to validate.

Public policy decisions are hampered by the lack of basic national measures of long-distance passenger travel by trip purpose and by demographic and economic characteristics of travelers. Changes in travel measures of trip purpose data or characteristics of travelers would indicate the extent of major disruptions (like COVID-19) to the economy and help guide public action. National trends in mode choice for long-distance trips would inform billions of dollars of investment in airports, aircraft, high-speed rail facilities, other infrastructure, and motor vehicles.

Should resources permit, BTS will explore options for conducting a small-sample, national survey of long-distance travel to develop long-distance travel patterns by mode and trip purpose for major demographic and economic segments of the population. Even small-sample surveys for national statistics are expensive, so implementation of any option must wait until additional resources become available.

Integrating Multi-Modal and Multi-Topic Data

BTS is not the only federal agency that provides transportation statistics. Additional sources include each of the USDOT operating administrations, the Census Bureau, and other partners among the principal federal statistical agencies, and the Army Corps of Engineers. While BTS products, such as National Transportation Statistics, provide a gateway to these sources, data users are often frustrated by the variety of formats, data definitions, and user interfaces that must be overcome to combine data for multi-modal and multi-topic analyses.

BTS is investigating and applying strategies for integrating data across modes of transportation and across topics, such as safety and system use. While new tools, such as Tableau, are available for data visualizations and analytics, experience with the National Transportation Atlas Database

[13] https://www.bts.gov/ctp.

suggests that effective integration will involve may institutional and technical challenges that require a long-term commitment to resolve. BTS will continue to work with its partners in the department, the federal statistical system, the mapping community, and the library science community to move toward effective integration of data to support decision making in transportation.

Conclusion

BTS has undergone a major transformation in the last 2 years, shifting its emphasis from the development of annual reports supported by national data to the development of interactive statistical and mapping products that are continually updated with geographically and temporally detailed data. BTS recognizes that it must continue to evolve its traditional and new information products, data collection methods, and expertise to provide effective services to the transportation community in a rapidly changing world. As an effective statistical agency, BTS works continually to:

- collect, validate, integrate, and make available fresh and relevant information to a wide range of users in the formats they need;
- anticipate emerging transportation issues and address emerging data needs;
- deploy the best of new technology for collection and delivery of information; and
- adhere to Statistical Policy Directives of the Office of Management and Budget and provisions of the Bureau's authorizing legislation to assure that statistics are objective, accurate, timely, and credible.

BTS strives to create increasingly robust, timely, and credible products in each of the topic areas identified in legislative mandates and to meet the goals of the Department of Transportation. BTS endeavors to produce statistics that are relevant and useful throughout the Nation, and to fulfill Abraham Lincoln's vision that: "Statistics will save us from doing what we do, in wrong places."[14]

[14] A. Lincoln, "Internal Improvements," Speech of Mr. A. Lincoln of Illinois in the House of Representatives (Washington, DC: June 28, 1848), *Congressional Globe,* 30th Cong., 1st Sess., pp. 709–711.

APPENDIX A Legislative Responsibilities

BTS compiles these and other statistics as required by 49 U.S. Code § 6302 - *Bureau of Transportation Statistics*, which requires information on:

- transportation safety across all modes and intermodally;
- the state of good repair of United States transportation infrastructure;
- the extent, connectivity, and condition of the transportation system;
- building on the national transportation atlas database developed;
- economic efficiency across the entire transportation sector;
- the effects of the transportation system on global and domestic economic competitiveness;
- demographic, economic, and other variables influencing travel behavior, including choice of transportation mode and goods movement;
- transportation-related variables that influence the domestic economy and global competitiveness;
- economic costs and impacts for passenger travel and freight movement;
- intermodal and multimodal passenger movement;
- intermodal and multimodal freight movement; and
- consequences of transportation for the human and natural environment.

FIGURE/Table No. & Title	Transportation Safety i	State of Good Repair ii	Extent, Connectivity, and Condition iii	Economic Efficiency iv	Global and Domestic Economic Competitiveness v	Demographic, Economic, and Other Variables Influencing Travel Behavior vi	Transportation-Related Variables that Influence Economy vii	Economic Costs and Impacts for Travel and Freight Movement viii	Intermodal and Multimodal Passenger Movement ix	Intermodal and Multimodal Freight Movement x	Consequences of Transportation for the Human and Natural Environment xi
Chapter 1-Extent & Use											
Figure 1-1 Estimated Value of Transportation Capital Stock			X				X				
Figure 1-2 National Highway System, Intermodal Connectors, & Principal Arterials			X						X	X	
Figure 1-3 Licensed Drivers, Vehicle Registrations, Vehicle-Miles Traveled, & Population			X			X					
Figure 1-4 Top 50 Transit Stations by Total Ridership			X						X		
Figure 1-5 U.S. Cities with Bikeshare & E-Scooter Service			X						X		
Figure 1-6 Enplanements at the Top 50 U.S. Airports			X						X		
Figure 1-7 Class 1 Railroad System Mileage & Ton-Miles of Freight			X							X	
Figure 1-8 Positive Train Control System Illustration			X								
Figure 1-9a Top 25 Busiest Amtrak Stations			X						X		
Figure 1-9b Amtrak Stations Along the Northeast Corridor			X						X		
Figure 1-10 Vessel Size & Corresponding Port Infrastructure			X							X	
Figure 1-11 Ferry Passenger & Vehicle Boardings			X						X		
Figure 1-12 U.S. Petroleum & Natural Gas Pipelines			X							X	
Figure 1-13 Intermodal Passenger Facilities by Mode			X						X		
Figure 1-14 Levels of Automation			X								
Figure 1-15 Automated Vehicle Legislation by State			X								
Table 1-1 Public Roads, Streets, & Bridges			X						X		
Table 1-2 Transit Vehicles & Ridership			X						X		
Table 1-3 U.S. Air Transportation System			X						X		
Table 1-4 Rail Transportation System			X							X	
Table 1-5 Passenger Rail Transportation System			X						X		
Table 1-6 Water Transportation System			X							X	
Chapter 2-Condition & Performance											
Figure 2-1 Percent Miles of the NHS System with Poor Pavement		X									
Figure 2-2 Daily Roads With Poor Pavement Condition, Urban v. Rural		X									
Figure 2-3 Daily Vehicle-Miles Traveled on NHS Roads with Poor Pavement Condition, Urban v. Rural		X									
Figure 2-4 Bridges in Poor Condition & Average Daily Traffic on Bridges		X									
Figure 2-5 Bridges in Poor Condition in Rural Areas		X									
Figure 2-6 Annual Hours of Delay per Commuter		X							X		
Figure 2-7 Peak-Period Congestion on the High-Volume Truck Routes on the NHS		X							X		
Figure 2-8 Average Age of Urban Transit Vehicles		X							X		
Figure 2-9 Percent On-Time Flight Departures & Arrivals		X				X			X		
Figure 2-10 Percent of Flight Delay by Delay Cause		X				X			X		
Figure 2-11 Percent of Flights by Length of Time Delayed and Average Flight Delay		X				X			X		
Figure 2-12 Daily Number of People Screened at TSA Checkpoints		X				X			X		
Figure 2-13 Hours of Delay and On-time Performance of Amtrak		X				X			X		
Figure 2-14 Average U.S. Container Vessel Dwell Times by Month		X								X	
Figure 2-15 Number of U.S.-Flagged Vessels by Age Group and Propelled Type		X								X	
Table 2-1 Select Waterway Transportation Characteristics & Performance Measures		X								X	
Chapter 3-Moving People											
Figure 3-1 Weekly Flight Cancellations by U.S. Air Carriers						X	X		X		
Figure 3-2 Population Projections by Age Group						X	X		X		
Figure 3-3 Transportation Spending by Non-workers & Workers						X	X		X		

FIGURE/Table No. & Title	Transportation Safety i	State of Good Repair ii	Extent, Connectivity, and Condition iii	Economic Efficiency iv	Global and Domestic Economic Competitiveness v	Demographic, Economic, and Other Variables Influencing Travel Behavior vi	Transportation-Related Variables that Influence Economy vii	Economic Costs and Impacts for Travel and Freight Movement viii	Intermodal and Multimodal Passenger Movement ix	Intermodal and Multimodal Freight Movement x	Consequences of Transportation for the Human and Natural Environment xi
Figure 3-4 Long-term Trends in Demographic & Travel						X	X		X		
Figure 3-5 Long Term Trend in Vehicles per Household						X	X		X		
Figure 3-6 Percent Change in Population by County						X	X		X		
Figure 3-7 Shifts in the Metropolitan & Non-Metropolitan Population						X	X		X		
Figure 3-8 Long-term Trend in Daily Person Trip by Purpose & Length						X	X		X		
Figure 3-9 Bikeshare & E-scooter Operation Changes in Response to COVID-20						X	X		X		
Figure 3-10 Year-Over-Year Change in Docked Bikeshare Trips						X	X		X		
Figure 3-11 Trends in Working From Home						X	X		X		
Figure 3-12 Mode Usage for Commute Trips by Age Group (all modes)						X	X		X		
Figure 3-13 Mode Usage for Commute Trips by Age Group (excluding driving alone)						X	X		X		
Figure 3-14 Average Travel Time to Work by Gender						X	X		X		
Figure 3-15 Airport Origin-Destination Pairs with More than 1 Million Passengers						X	X		X		
Figure 3-16 COVID-19 Effect on Daily TSA Checkpoint Screenings						X	X		X		
Figure 3-17 People Entering into the U.S. via Land Border Crossing or International Airports						X	X		X		
Figure 3-18 Foreign Visitors to the U.S. by Select Region/Country						X	X		X		
Figure 3-19 U.S. Resident Travel Aboard by Select Country/Region						X	X		X		
Table 3-1 Domestic U.S. Passenger-Miles						X	X		X		
Table 3-2 Household Transportation, 65 & Older v. All Household						X	X		X		
Table 3-3 Long-Term Trends in Daily Person Trip by Purpose & Rate						X	X		X		
Table 3-4 Average Annual Person-Trips per Household by Mode & Metropolitan Area Size						X	X		X		
Table 3-5 Trends in Choice of Commute Mode						X	X		X		
Table 3-6 Leading Visitors to the U.S.						X	X		X		
Table 3-7 International Visitor Spending on Transportation in the U.S.						X	X		X		
Chapter 4-Moving Goods											
Figure 4-1 Value & Weight by Domestic Shipments by Mode					X		X			X	
Figure 4-2 Freight Flows by Highway, Railway, & Waterway					X		X			X	
Figure 4-3 Weight & Value of Top 10 Commodities by Transportation Mode					X		X			X	
Figure 4-4 Percent of U.S. Grain Tonnage Moved by Truck					X		X			X	
Figure 4-5 Top Commodity Categories Transported by Class I Rail by Gross Revenue & Tonnage					X		X			X	
Figure 4-6 Top 25 U.S.-International Freight Gateways by Value of Shipments					X		X			X	
Figure 4-7 Value & Weight of U.S.-International Freight Flows by Transportation Mode					X		X			X	
Figure 4-8 Top 25 Water Ports by TEU					X		X			X	
Figure 4-9 Top 25 Water Ports by Tonnage					X		X			X	
Table 4-1 Weight & Value of Shipments by Transportation Mode					X		X			X	
Table 4-2 Value of U.S.-International Freight Flows by Geography & Transportation Mode					X		X			X	
Table 4-3 Value & Weight of U.S. Freight Flows with Canada & Mexico by Transportation Mode					X		X			X	
Chapter 5 - Transportation Economics											
Figure 5-1 Shares of U.S. GDP				X	X	X	X				
Figure 5-2 Enhanced GDP Attributed to Transportation by Mode				X	X	X	X				
Figure 5-3 Transportation Services Required per Dollar of Output by Sector				X	X	X	X			x	
Figure 5-4 Industrial Production, Manufacturers' Shipments, and Freight TSI				X	X	X	X			x	
Figure 5-5 Average Monthly Change in Modal Data Included in Freight TSI				X	X	X	X			x	

FIGURE/Table No. & Title	Transportation Safety i	State of Good Repair ii	Extent, Connectivity, and Condition iii	Economic Efficiency iv	Global and Domestic Economic Competitiveness v	Demographic, Economic, and Other Variables Influencing Travel Behavior vi	Transportation-Related Variables that Influence Economy vii	Economic Costs and Impacts for Travel and Freight Movement viii	Intermodal and Multimodal Passenger Movement ix	Intermodal and Multimodal Freight Movement x	Consequences of Transportation for the Human and Natural Environment xi
Figure 5-6 Freight Transportation Services Index and the Economic Growth Cycle				X	X	X	X			X	
Figure 5-7 Year-Over-Year Change in Transportation Employment by Month and Mode				X	X	X	X		X	X	
Figure 5-8 Relationship Between the Transportation and Warehousing Sector and Transportation-Related Occupations				X	X	X	X			X	
Figure 5-9 Employment and Wages in Select Transportation Occupations				X	X	X	X		X	X	
Figure 5-10 Total and Year-Over-Year Growth in Transportation Expenditures				X	X	X	X	X			
Figure 5-11 Federal, State, and Local Transportation Expenditures by Mode				X	X	X	X	X			
Figure 5-12 Federal Transportation Revenue by Mode				X	X	X	X	X			
Figure 5-13 State and Local Transportation Revenue by Mode				X	X	X	X	X			
Figure 5-14 Sales Price of Transportation Fuel to End-Users				X	X	X	X	X	X	X	
Figure 5-15 Business Costs for Purchasing Transportation Services				X	X	X	X	X	X	X	
Table 5-1 Total Transportation Investment				X	X	X	X	X			
Table 5-2 Consumer Costs for Transportation-Related Goods and Services				X	X	X	X	X	X	X	
Chapter 6-Safety											
Figure 6-1 Total Transportation Fatalities	X					X					
Figure 6-2 Share of Transportation Fatalities by Mode	X					X					
Figure 6-3 Motor Vehicle Traffic Fatalities, by Year and Location	X										
Figure 6-4 Fatality Rates per 100 Million Vehicle-Miles Traveled (VMT), by Year and Location	X										
Figure 6-5 Transit Fatalities by Category	X					X					
Figure 6-6 Highway Fatalities in Crashes Involving at Least One Driver with a BAC of .08 g/dL or Higher by Role	X					X					
Figure 6-7 Distracted Driving Fatalities	X					X					
Figure 6-8a State Laws on Distracted Driving—Handheld Ban	X					X					
Figure 6-8b State Laws on Distracted Driving—Texting Ban						X					
Figure 6-9 Rail Trespassing Fatalities by County	X										
Figure 6-10 State Laws on Motorcycle Helmet Use						X					
Figure 6-11 Number of Hazardous Liquid-Related or Gas–Related Pipeline Incidents											X
Table 6-1 Transportation Fatalities by Mode	X					X					
Table 6-2 Transportation Injuries by Mode	X					X					
Table 6-3 Driver Involvement in Fatal Passenger Vehicle Crashes, by Driver Age and Sex	X					X					
Table 6-4 Fatalities by Highest Driver Blood Alcohol Concentration (BAC) in Highway Crashes	X										
Table 6-5 Safety Belt & Motorcycle Helmet Use	X										
Table 6-6 Hazardous Materials Transportation Incidents	X										X
Table 6-7 All Reported Hazardous Liquid & Gas Incidents	X										X
Chapter 7-Transportation Energy Use & Environmental Impacts											
Figure 7-1 U.S. Energy Consumption from Primary Sources by Sector					X		X	X			X
Figure 7-2 Petroleum Use by Sector of the U.S. Economy					X		X	X			X
Figure 7-3 U.S. Petroleum Use, Domestic Supply, & Net Imports					X		X	X			X
Figure 7-4 Transportation Energy Use by Mode				X			X	X	X	X	X
Figure 7-5 Transportation Energy Use by Fuel Type				X		X	X	X			X
Figure 7-6 Transportation Use of Biofuels in the U.S.				X			X	X			X
Figure 7-7 Sales of Hybrid, Plug-in Hybrid & Battery Electric Vehicles					X	X	X	X			X
Figure 7-8a EV Public Charging Stations in the U.S.			X			X	X	X			X
Figure 7-8b EV Public Charging Stations in the U.S.			X			X	X	X			X

FIGURE/Table No. & Title	*Transportation Safety* i	*State of Good Repair* ii	*Extent, Connectivity, and Condition* iii	*Economic Efficiency* iv	*Global and Domestic Economic Competitiveness* v	*Demographic, Economic, and Other Variables Influencing Travel Behavior* vi	*Transportation-Related Variables that Influence Economy* vii	*Economic Costs and Impacts for Travel and Freight Movement* viii	*Intermodal and Multimodal Passenger Movement* ix	*Intermodal and Multimodal Freight Movement* x	*Consequences of Transportation for the Human and Natural Environment* xi
Figure 7-9 U.S. Carbon Dioxide Emissions from Energy Consumption	X						X	X			X
Figure 7-10 Transportation's Greenhouse Gas Emissions by Gas	X						X	X	X	X	X
Figure 7-11 Estimated National Average Emission Rates by Vehicle Type & Polluntant	X						X	X			X
Figure 7-12 Number of Days with Unhealthy AQI by MSA	X						X	X			X
Figure 7-13 Petroleum Spills into Navigable Waterways							X			X	X
Figure 7-14 Road & Aviation Noise for San Francisco Bay Area							X	X			X
Table 7-1 Energy Intensities of Passenger Modes				X		X	X		X		X
Table 7-2 Energy Intensities of Freight Modes				X		X	X			X	X
Table 7-3 Estimated Percent of the U.S. Population with the Potential Exposure to Transportation Noise							X	X			X
Chapter 8-State of Transportation Statistics											
Figure 8-1 Rapid Statistics on COVID-19 Impact					X	X	X		X	X	

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.

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.

Multiple Modes and Mail: the Freight Analysis Framework (FAF) and the Commodity Flow Survey (CFS) use "Multiple Modes and Mail" rather than "Intermodal" to represent commodities that move by more than one mode. Intermodal typically refers to containerized cargo that moves between ship and surface modes or between truck and rail, and repeated efforts to identify containerized cargo in the CFS have proved unsuccessful. Multiple mode shipments can include anything from containerized cargo to bulk goods such as coal moving from a mine to a railhead by truck and then by rail to a seaport. Mail shipments include parcel delivery services where shippers typically do not know what modes were involved after the shipment was picked up.

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.rita.dot.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.

APPENDIX C Abbreviations and Acronyms

AAA—American Automobile Association

AAR—American Association of Railroads

AASHTO—American Association of State Highway and Transportation Officials

ABA—American Bus Association

ACEA—European Automobile Manufacturers Association

ACS—American Community Survey

AEO—*Annual Energy Outlook* report

AFDC—Alternative Fuels Data Center

AGS—American Gas Association

AIP—Airport Improvement Program

AIS—Automatic Identification System

AMTRAK—National Rail Passenger Corporation

AQI—Air Quality Index

ARA—Automotive Recyclers Association

ARRA—*American Recovery and Reinvestment Act*

ASR—automotive shredder residue

ATA—American Trucking Association

ATIP—Automated Track Inspection Program

ATUS—American Time Use Survey

ATV—all-terrain vehicle

AV—automated vehicle

BAC—blood alcohol concentration

BEA—Bureau of Economic Analysis

BEV—battery electric vehicle

BLS—Bureau of Labor Statistics

BTS—Bureau of Transportation Statistics

Btu—British thermal unit

CAFCP—California Fuel Cell Partnership

CAFE—Corporate Average Fuel Economy

CBP—Customs and Border Protection

CDC—Centers for Disease Control

CDL—commercial drivers license

CEC—California Energy Commission

CEP—Commission on Evidence-Based Policymaking

CFR—Code of Federal Regulations

CFS—Commodity Flow Survey

CMC—Crisis Management Center

CO—carbon monoxide

CO_2—carbon dioxide

CPI—Consumer Price Index

CPI-U—Consumer Price Index—Urban

CROS—California Roadkill Observation System

CRSS—Crash Reporting Sampling System

CTS—Center for Transportation Studies—University of Minnesota

dBA-a—weighted decibel

DOT—Department of Transportation

DUI—driving under the influence

ECI—Employment Cost Index

EDTA—Electric Drive Transportation Association

EIA—Energy Information Agency

ESC—electronic stability control

EU—European Union

FAA—Federal Aviation Administration

FAF—Freight Analysis Framework

FAF4—Freight analysis Framework, 4th generation

FCC—Federal Communications Commission

FCEV—fuel cell electric vehicle

FHWA—Federal Highway Administration

FMCSA—Federal Motor Carrier Safety Administration

FRA—Federal Railroad Administration

FTA—Federal Transit Administration

FTD—Foreign Trade Division

FTSI—Freight Transportation Services Index

FY—fiscal year

GA—general aviation

GAO—General Accountability Office

GDP—gross domestic product

GES—General Estimates System

GHG—greenhouse gas

GHSA—Governors Highway Safety Association

GIS—geographic information system

GPS—global positioning system

GTFS—General Transit Feed Specifications

Haz Liq—hazardous liquid

HEV—hybrid electric vehicle

HFC—hydrofluorocarbon

hh:mm—hours and minutes

IGU—International Gas Union

IIHS—Insurance Institute for Highway Safety

IPCD—Intermodal Passenger Connectivity Database

IRI—International Roughness Index

IT—information technology

IWR—Institute for Water Resources

LAEQ—24-hour equivalent sound level

LNG—liquefied natural gas

MARAD—Maritime Administration

MODU—mobile offshore drilling unit

MPF—multifactor productivity

MPG—miles per gallon

MSA—metropolitan statistical area

NACTO—National Association of City Transportation Officials

NAR—National Association of Realtors

NAS—National Academy of Science

NAS—National Aviation System

NASS—National Automotive Sampling System

NBI—National Bridge Inventory

NCFO—National Census of Ferry Operators

NCO—National Coordination Office

NDC—Navigation Data Center

NEC—Northeast Corridor

NextGen—Next Generation Air Transportation System

NHC—National Hurricane Center

NHS—National Highway System

NHTS—National Household Travel Survey

NHTSA—National Highway Traffic Safety Administration

NIAAA—National Institute on Alcohol Abuse and Alcoholism

NIH—National Institutes of Health

NMMA—National Marine Manufacturers Association

NOAA—National Oceanic and Atmospheric Administration

NO_x—oxides of nitrogen

NPIAS —National Plan of Integrated Airport Systems

NPTS—National Personal Travel Survey

NRC—National Research Council

NTAD—National Transportation Atlas Database

NTD—National Transit Database

NTS—*National Transportation Statistics*

NTSB—National Transportation Safety Board

NTTO—National Travel and Tourism Office

ONI—Office of Naval Intelligence

ORNL—Oak Ridge National Laboratory

OTAQ—Office of Transportation and Air Quality

PEV—plug-in electric vehicle

PHEV—plug-in electric hybrid vehicles

PHMSA—Pipeline and Hazardous Materials Safety Administration

PM—passenger-mile

PMT—person-miles of travel

PNT—Position, Navigation, and Timing

PTC—Positive Train Control

PTSI—Passenger Transportation Services Index

RF—radio frequency

RPM—revenue passenger-mile

RTM—revenue ton-mile

RV—recreational vehicle

SO_2—sulfur dioxide

SUV—sport utility vehicle

TEU—twenty-foot equivalent units

TIGER—Transportation Income Generating Economic Recovery

T-M—ton-mile

TNC—transportation network company

TRB—Transportation Research Board

TSA—Transportation Security Administration

TSA—Transportation Satellite Accounts

TSI—Transportation Services Index

TTI—Texas Transportation Institute

UAS—unmanned aerial systems

USACE—U.S. Army Corps of Engineers

USCG—U.S. Coast Guard

USDHHS—U.S. Department of Health and Human Services

USDOC—U.S. Department of Commerce

USDOE—U.S. Department of Energy

USDHS—U.S. Department of Homeland Security

USDOJ—U.S. Department of Justice

USDOT—U.S. Department of Transportation

USEPA—U.S. Environmental Protection Agency

VMT—vehicle-miles traveled

WAAS—Wide Area Augmentation System