CHAPTER 3

Moving Goods

Highlights

- The U.S. freight transportation system moved 55.0 million tons of goods valued at more than $49.3 billion each day in 2013—about 63.4 tons of freight per capita per year. This was an increase of 2.0 percent from 2012.
- In 2013 freight tonnage and value rose by 6.3 and 8.0 percent, respectively, over 2007 levels, fully rebounding from declines during the 2008–2009 recession.
- This trend continued with trucks carrying the largest shares by value, tons, and ton-miles for shipments moved 750 or fewer miles. Rail is the dominant mode by tons and ton-miles of shipments ranging from 750 to 2,000 miles, while air, multiple, and other/unknown modes accounted for a majority of the value of shipments moved more than 2,000 miles, according to the latest available FAF data.
- The value of U.S.-international trade increased from $2.6 trillion in 2000 to nearly $4.0 trillion in 2014 (adjusted for inflation using the Consumer Price Index), a 44.5 percent increase. Trade with Canada and Mexico increased by 32.8 percent over the same period. Trade growth has created additional traffic between international gateways and domestic destinations.
- More than 400 freight transportation gateways, including airports, border crossings, and seaports, handled international cargo in 2013, but the top 25 gateways handled nearly $2,406 billion (62.3 percent) of total U.S.-international trade.
- Shifts in oil production have affected transportation patterns of energy commodity movements in recent years. Class I railroads carried almost 500 thousand carloads of crude oil in 2014, a 50-fold increase from 9,500 carloads in 2008.

The U.S. freight transportation system moved nearly 20.1 billion tons of goods valued at $18.0 trillion in 2013, according to estimates derived from the Freight Analysis Framework (FAF) (table 3-1). This total means the freight transportation system carried, on average, about 55.0 million tons of goods worth more than $49.3 billion each day, or about 63 tons of freight per capita per year in the United States in 2013, an 11 percent increase from 57 tons in 2011. See box 3-A for information about the FAF and the Commodity Flow Survey (CFS).

In 2013 freight tonnage rose to 6.3 percent over 2007 levels, fully rebounding from declines during the recession of 2008 and 2009. FAF paints a similar picture for the value of freight shipments. Table 3-1 shows that the total weight and value of freight in 2013 surpassed prerecession levels in all categories (except import tonnage). FAF forecasts over the long term that freight weight will grow 1.3 percent annually between 2013 and 2040. The value of goods moved, in real dollars, is expected to increase faster than tonnage

TABLE 3-1 Weight and Value of Shipments by Transportation Mode: 2007, 2013, and 2040

Weight

	2007				2013				2040			
Millions of tons	**Total**	**Domestic**	**Exports[2]**	**Imports[2]**	**Total**	**Domestic**	**Exports[2]**	**Imports[2]**	**Total**	**Domestic**	**Exports[2]**	**Imports[2]**
Truck	12,778	12,587	95	97	13,955	13,732	120	103	18,786	18,083	368	335
Rail	1,900	1,745	61	93	1,858	1,681	82	94	2,770	2,182	388	201
Water	950	504	65	381	808	410	89	309	1,070	559	164	347
Air, air & truck	13	3	4	6	15	3	5	7	53	6	20	27
Multiple modes & mail[1]	1,429	433	389	606	1,554	459	559	536	3,575	645	1,546	1,383
Pipeline[1]	1,493	1,314	4	175	1,539	1,391	11	137	1,740	1,257	17	467
Other & unknown	316	266	36	14	333	274	47	13	526	362	130	34
Total	**18,879**	**16,851**	**655**	**1,372**	**20,063**	**17,950**	**914**	**1,199**	**28,520**	**23,095**	**2,632**	**2,794**

Value

	2007				2013				2040			
Billions of 2007 dollars	**Total**	**Domestic**	**Exports[2]**	**Imports[2]**	**Total**	**Domestic**	**Exports[2]**	**Imports[2]**	**Total**	**Domestic**	**Exports[2]**	**Imports[2]**
Truck	10,780	10,225	267	287	11,444	10,841	312	291	21,465	19,315	985	1,166
Rail	512	374	45	93	577	424	54	99	898	555	148	195
Water	340	158	15	167	284	131	20	133	337	138	46	153
Air, air & truck	1,077	151	422	505	1,167	134	425	609	5,043	834	1,997	2,212
Multiple modes & mail[1]	2,884	1,646	394	844	3,065	1,695	500	870	9,925	5,203	1,911	2,811
Pipeline[1]	716	651	4	61	1,083	1,003	15	65	776	605	17	154
Other & unknown	341	252	48	41	363	270	53	40	821	482	199	139
Total	**16,651**	**13,457**	**1,196**	**1,997**	**17,983**	**14,496**	**1,380**	**2,107**	**39,265**	**27,131**	**5,303**	**6,831**

[1] 2007 total and domestic numbers for multiple modes and mail and the pipline categories were revised as a result of Freight Analysis Framework database improvements.

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

NOTES: Numbers may not add to totals due to rounding. The 2013 data are provisional estimates that are based on selected modal and economic trend data. All truck, rail, water, and pipeline movements that involve more than one mode, including exports and imports that change mode at international gateways, are included in multiple modes & mail to avoid double counting. As a consequence, rail and water totals in this table are less than other published sources.

SOURCE: U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics, and USDOT, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 3.5, 2015.

BOX 3-A The Commodity Flow Survey and the Freight Analysis Framework

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

The FAF supplements CFS results with data from a variety of other sources to include imports and shipments from domestic establishments not in scope of the CFS. FAF provides tonnage and value information by commodity type, mode, origin, and destination for years the CFS is conducted, provides annual estimates for years in between the CFS, and long range (30 year) forecasts in 5 year increments. It also includes an assignment of truck flows to the highway network for the CFS year and 30 year forecast to provide a picture of current and projected freight truck volumes.

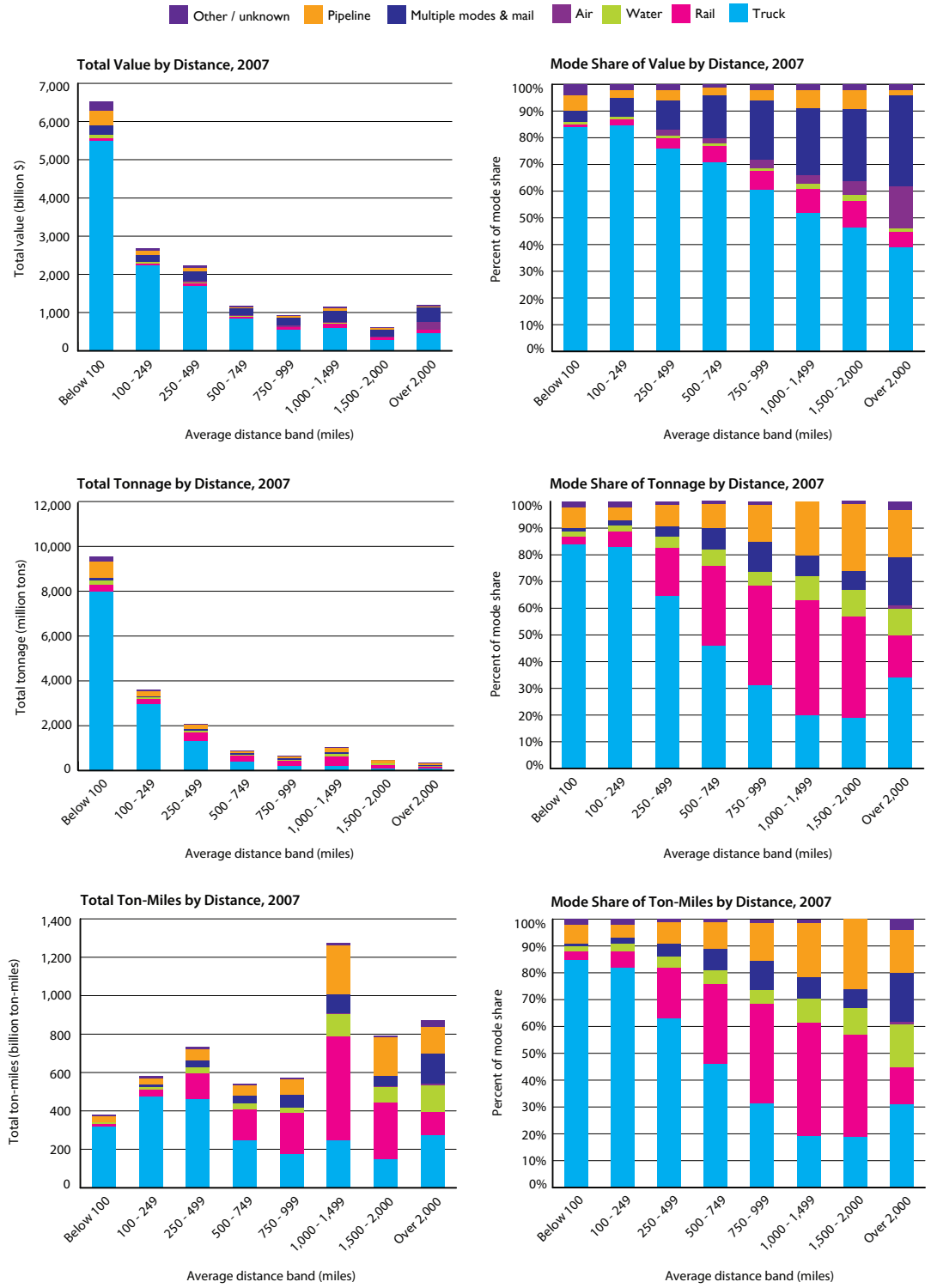
While the FAF is more complete, the CFS provides greater commodity detail and additional shipment characteristics, such as hazardous materials class. BTS released final 2012 CFS estimates in December 2014, which are available at https://www.census.gov/econ/cfs/.

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

and nearly double during this time span as higher value goods are moved [USDOT BTS and FHWA 2015]. U.S. exports and imports accounted for 4.5 and 6.0 percent of the weight and 7.6 and 11.8 percent of the value of freight transported in 2013, respectively. FAF forecasts that U.S. exports and imports will account for an even greater share of freight movements in 2040, reaching 19.0 percent of the weight and 30.9 percent of the value of goods shipped throughout the country [USDOT BTS and FHWA 2015].

Population growth and economic activity are the primary factors that determine freight demand. As population increases or economic activity expands, more goods are produced and used, resulting in additional freight movement. Between 2009 and 2014, the U.S. population increased by 3.9 percent [USDOC CENSUS], and U.S. gross domestic product grew by 20.8 percent in terms of current dollars over the depressed post-recession level [USDOC BEA 2015]. In addition, changes in the composition of goods demanded and shifts of economic centers of gravity to Asia had an effect on what goods were moved, what modes were used to transport them, and where they were shipped. Freight carried by the for-hire transportation industry rose as the economy rebounded from

FIGURE 3-1 Value, Tons, and Ton-Miles of Freight by Distance: 2007



SOURCES: U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics, and USDOT, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 3.5, 2015.

the past recession. According to the Bureau of Transportation Statistics' (BTS's) freight Transportation Services Index, the level of freight shipments in April 2015 was 27.2 percent above the April 2009 low recorded during the most recent recession [USDOT BTS 2015c].

How Domestic Freight Moves

The freight transportation industry moved goods over a network of truck routes, railroads, waterways, airports, and pipelines. The distance a shipment must travel, either by single mode or during any particular leg of a multimodal journey, plays a major part in determining what mode or modes are used (see figure 3-1).

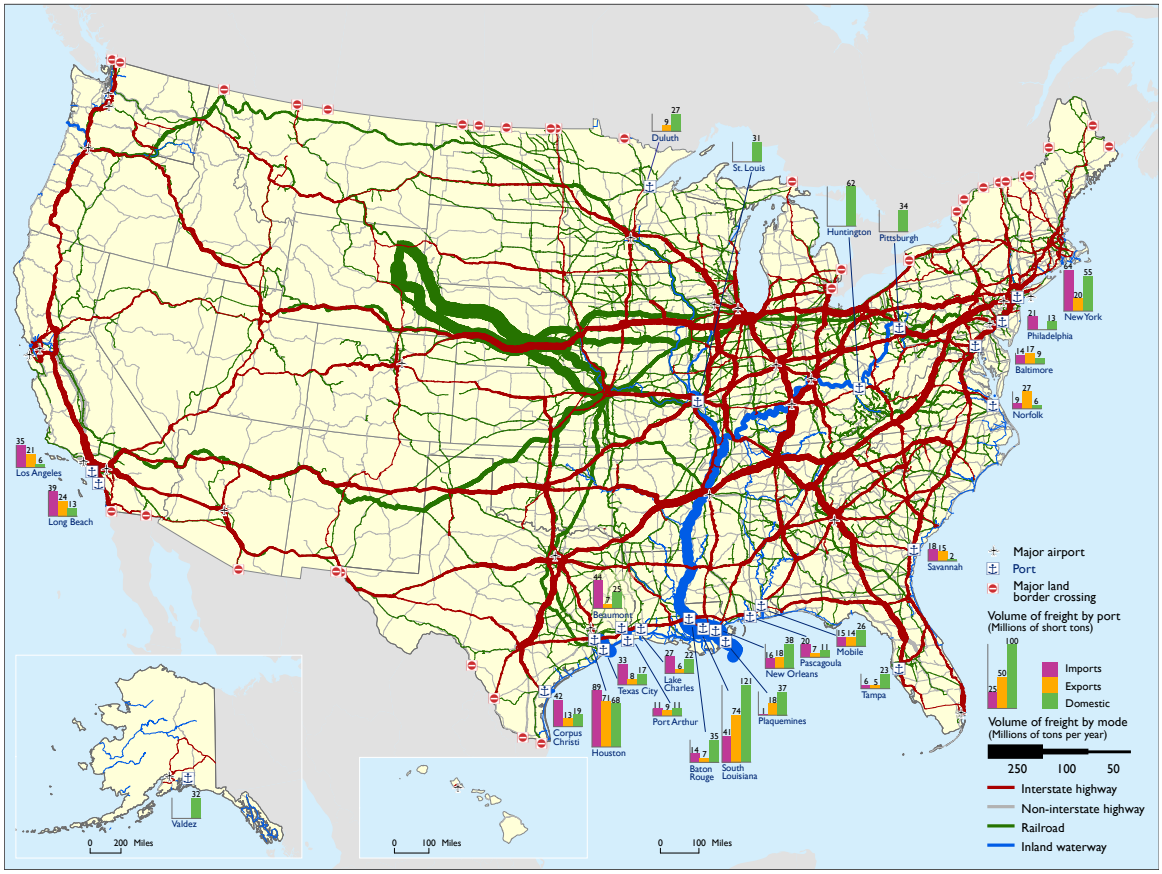
Most goods are moved short distances (less than 250 miles), and accounted for 55.7 percent of the value, 70.7 percent of the weight, and 16.7 percent of the ton-miles for all shipments within the United States in 2007. Although accounting for less than 30 percent of the total weight of all shipments in 2007, shipments of more than 250 miles constituted the bulk of ton-miles logged—83.3 percent. Modal shares of freight vary considerably by distance. While trucks carry the largest shares by value, tons, and ton-miles for shipments moving 750 miles or less; rail is the dominant mode by tons and ton-miles of shipments ranging from 750 to 2,000 miles; and air, multiple, and other/unknown modes account for 51.8 percent of the value of shipments moving more than 2,000 miles [USDOT BTS and FHWA 2015].

Overall, trucks carry the highest percentage of the weight and value of goods in the United States. However, figure 3-2 shows that railroads and inland waterways carry large volumes and tonnages of commodities, like coal and petroleum products, over long distances. Rail and water combined accounted for 13.2 percent of the total tonnage and 4.8 percent of the total value of freight moved in the United States in 2013. Air carriers moved high-value, low-weight products. This is underscored by the relatively extreme value-to-weight ratio of air cargo, which is about $77,800 per ton. In comparison, the overall value-to-weight ratio of cargo carried by all modes combined is less than $900 per ton. In 2013 pipelines moved 1.5 billion tons of goods valued at nearly $1.1 trillion ($577 per ton), while rail moved more tonnage of lesser value—1.9 billion tons valued at $551 billion ($275 per ton). Rail represented 9.3 percent of the total tonnage and 3.2 percent of the total value of shipments in 2013. Rail shipments by tonnage are projected to increase by 49.1 percent between 2013 and 2040 [USDOT BTS and FHWA 2015].

The water mode typically carries low-value, bulk products similar to rail.[1] In 2013 the water transportation industry moved 808 million tons worth $284 billion ($285 per ton), representing 4.0 percent of the tonnage and 1.6 percent of the value of all freight shipments [USDOT BTS and FHWA 2015]. In 2013 approximately 566.7 million short tons of cargo were moved by vessel along the inland waterways,

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

FIGURE 3-2 Freight Flows by Highway, Railroad, and Waterway: 2011



SOURCES: *Highways*: U.S. Department of Transportation, Federal Highway Administration, Freight Analysis Framework, Version 3.5, 2015; *Rail*: Based on Surface Transportation Board, Annual Carload Waybill Sample and rail freight flow assignments done by Oak Ridge National Laboratory; *Inland Waterways*: U.S. Army Corps of Engineers, Institute or Water Resources, Annual Vessel Operating Activity and Lock Performance Monitoring System data, September 2015.

including the Mississippi River—the Nation's busiest waterway [USACE NDC 2013].

In comparison with the rail and water modes, air transport carries high-value products, such as electronics, precision instruments, and pharmaceuticals that require quick delivery. Of all modes, the value of air-freight shipments is projected to increase the fastest from 2013 to 2040, growing by 332.1 percent [USDOT BTS and FHWA 2015]. In 2013 U.S. airlines[2] carried a total of 34,804 million international and domestic revenue freight and mail cargo revenue ton-miles, of which 12,428 million were domestic [USDOT BTS 2015b].

Over the last 20 years, the U.S. transportation system has become increasingly interconnected. Although multimodal services accounted for a relatively small share (7.7

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

percent) of freight tonnage, they moved 17.0 percent of the value of the goods in 2013. FAF forecasts the value of multimodal shipments will increase significantly between 2013 and 2040 [USDOT BTS and FHWA 2015].[3]

The growth in intermodal freight movement is driven, in part, by global supply chain requirements. Between 1990 and 2013, the railroad industry reported a 106.7 percent increase in trailer and container traffic [AAR 2014a]. The Association of American Railroads reports that rail intermodal traffic accounted for 12.9 percent of U.S. Class I railroad revenue in 2012. Only coal along with chemicals and allied products accounted for a larger share of revenue [AAR 2013]. With the growth in container trade and improvements in information and logistics technologies, the stage is set for increased reliance on intermodal transportation to move goods from manufacturers to consumers.

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

Commodities Moved Domestically

Table 3-2 shows that heavy, low-value bulk products, such as gravel, cereal grains; coal, non-metallic mineral products; waste/scrap; and natural gas, coke, and asphalt comprised a large share of the tonnage moved in 2013, but accounted for a small share of the Nation's freight value. In fact, in 2013 the top 10 commodities by weight accounted for 64.6 percent of total tonnage but only 16 percent of the value of goods. Rounding out the top 10 by weight were coal, gasoline, crude petroleum, fuel oils, and natural sands [USDOT BTS and FHWA 2015].

The picture changes considerably when looking at the value of goods shipped. The highest value goods were those that are time-sensitive, including machinery, electronics, motorized vehicles, mixed freight, and pharmaceuticals. Other top commodities by value are gasoline; miscellaneous manufactured products; textiles/leather; natural gas, coke, asphalt; and plastics/rubber. In 2013 the top 10 commodities by value accounted

TABLE 3-2 Top Commodities by Weight and Value: 2013

Weight	Millions of tons	Value	Billions of 2007 dollars
Gravel	2,427	Machinery	$1,877
Cereal grains	1,665	Electronics	$1,485
Non-metallic mineral products	1,514	Motorized vehicles	$1,484
Waste/scrap	1,441	Mixed freight	$1,110
Natural gas, coke, asphalt[1]	1,403	Pharmaceuticals	$914
Coal	1,263	Gasoline	$796
Gasoline	1,029	Miscellaneous manufactured products	$740
Crude petroleum	839	Textiles/leather	$736
Fuel oils	757	Natural gas, coke, asphalt1	$650
Natural sands	620	Plastics/rubber	$618
Total, all commodities	**20,063**	**Total, all commodities**	**$17,983**

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

SOURCE: U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics, and USDOT, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 3.5, 2015.

for 58.0 percent of total value but only 18.8 percent of total tonnage [USDOT and FHWA 2015].

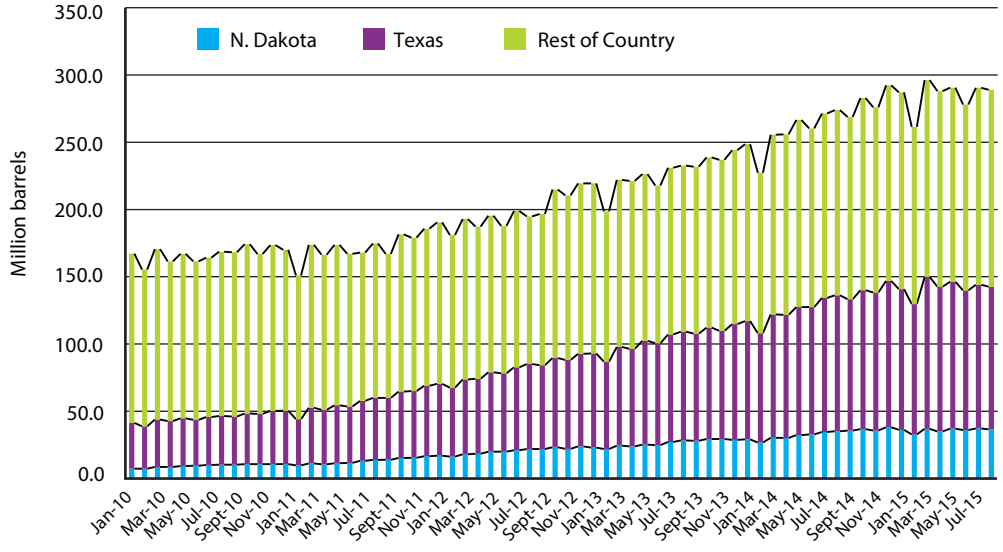
Energy Commodities Transportation

The transportation of four major energy commodities/resources is discussed here: crude oil and refined petroleum products, natural gas, coal, and ethanol. The delivery of these energy commodities involve various modes, depending on the characteristics of the commodity, the distance from wellhead or mine to processing facilities and then to the final consumer. Increasingly, energy commodity movements are multimodal, utilizing a combination of pipeline, rail, barge, and truck.

Crude Oil and Petroleum Refined Products

Pipelines are the predominant mode for transporting crude oil and petroleum products in the United States. Historically, pipelines delivered crude oil from the Gulf of Mexico to refineries located near U.S. coastlines. However, changes in where oil is produced have affected transportation patterns in recent years. For example, expanded production in regions distant from refineries, such as the Bakken formation in North Dakota, has increased the use of rail, barge, and truck to move oil from the wellhead to refineries. Moreover, pipelines that previously delivered crude oil from the Gulf of Mexico to refineries now also deliver domestic and Canadian oil to the Gulf of Mexico to be refined and/or exported [USDOE 2015]. U.S. crude oil production increased by 72.9 percent from 167 billion barrels in January 2010 to 289 billion barrels in August 2015 (figure 3-3). Texas and North Dakota accounted for about half of U.S. crude oil production in August 2015.

FIGURE 3-3 Field Production of Crude Oil (thousand barrels): January 2010–July 2015



SOURCES: U.S. Department of Energy, Energy Information Administration, *Field Production of Crude Oil*. Available at http://www.eia.gov as of November 2015.

The recent growth in oil shipments by rail is demonstrated by the increase in the number of railcars carrying crude oil. According to the American Association of Railroads (AAR), U.S. Class I railroads (including U.S. Class I subsidiaries of Canadian railroads) carried 493,146 carloads of crude oil in 2014, a 50-fold increase from 9,500 carloads in 2008 [AAR 2015]. The U.S. Department of Energy, Energy Information Administration estimates that rail moved more than 1 million barrels of crude oil per day in 2014 [USDOE EIA 2015c]. The Bakken region has accounted for the majority of new rail shipments. The North Dakota Pipeline Authority estimates that about 700,000 barrels of crude oil per day were moving out of the state by rail as of early 2015, which is equivalent to roughly 60 percent of the State's total crude oil production [NDPA 2015]. Railroads own less than one percent of the tank cars that transport crude oil. Nearly all of them are owned by companies served by the railroads and by leasing companies [AAR 2015a].

Shifts in oil production also have spurred growth in the waterborne transport of oil. According to the U.S. Army Corps of Engineers, U.S. ports and inland waterways handled nearly 7 billion barrels of crude and petroleum products in 2013, the latest year for which data are available [USACE NDC 2015]. This is about half of the total volume of oil transported by transmission pipelines in 2013 [AOP]. Of the total moved by the water mode, 2.5 billion barrels were transported by barges on U.S. inland waterways from port to port along the coast or on the Great Lakes [USDOE 2015]. The use of barges for oil transport has risen in recent years, as shown by the increase in refinery receipts by barge from 61.6 million barrels of domestic crude in 2009 to nearly 244.3 million barrels in 2014. Over the same period, barge deliveries of foreign crude have risen by little more than 2.2 percent, due in part to a decrease in oil imports [USDOE EIA 2014c]. Presently, all oil transport is intermodal, where oil may be transported by pipeline or rail to a terminal and then be transferred to a barge for delivery to a refinery.

Trucks are used for short-haul drayage of crude oil from the wellhead to gathering pipelines or rail loading terminals for long-distance transport. Because oil production has outstripped the construction of pipeline gathering systems in the Bakken area, trucks deliver about 40 percent of Bakken oil to pipeline and rail terminals. Trucks also are used to move crude oil over short distances to refineries. The demand for truck transport is illustrated by the doubling of refinery receipts of crude oil by truck, from 67.8 million barrels in 2009 to 152.5 million barrels in 2013 [USDOE EIA 2014c].

After the crude oil is refined into gasoline, diesel fuel, jet fuel, and heating oil, among other products, these commodities are shipped via pipeline to a bulk storage terminal that serves many companies. Gasoline, for example is loaded on tanker trucks for delivery to various retail gas stations. Jet fuel is pumped directly from the storage terminal to major airports that have receiving facilities on site.

Natural Gas

A complex network of pipelines transports natural gas from the wellhead to the final customer. Pipeline gathering systems,

which consist of low-pressure, small-diameter pipelines, move raw natural gas from the wellhead to the processing plant where impurities and other hydrocarbons are removed. Gathering pipelines also may transport the gas directly to the mainline transmission grid, depending on the quality of the wellhead gas. After processing, the gas is then transported by interstate and intrastate pipeline to consumers or is put into underground storage for future use to meet customer requirements during peak-usage periods. In 2014 U.S. natural gas production reached 27.3 trillion cubic feet (tcf) [USDOE EIA 2015b]. Pipelines deliver about one-third of natural gas production to power plants to produce electricity, and about one-fifth is delivered to homes for heating [USDOE EIA 2014a].

Coal

The way in which coal is transported to where it will be used depends on the distance that needs to be covered. Trucks are used for short distances, and trains and barges are used for longer distances. Alternatively, coal can be crushed and mixed with water to form a slurry and transported through a pipeline.

According to FAF, rail moved the greatest share of domestic coal shipments in 2012, accounting for 69.0 percent (619 million short tons) of the total 1.3 billion short tons. Trucks are the second largest mover of domestic coal shipments, hauling 16.9 percent (nearly 224 million tons) (figures 3-4 and 3-5). The Association of American Railroads reports that coal represents 39.5 percent of total tonnage moved by rail and 19.9 percent of total industry revenues and is viewed by many in the industry as its most important single commodity [AAR 2014b].

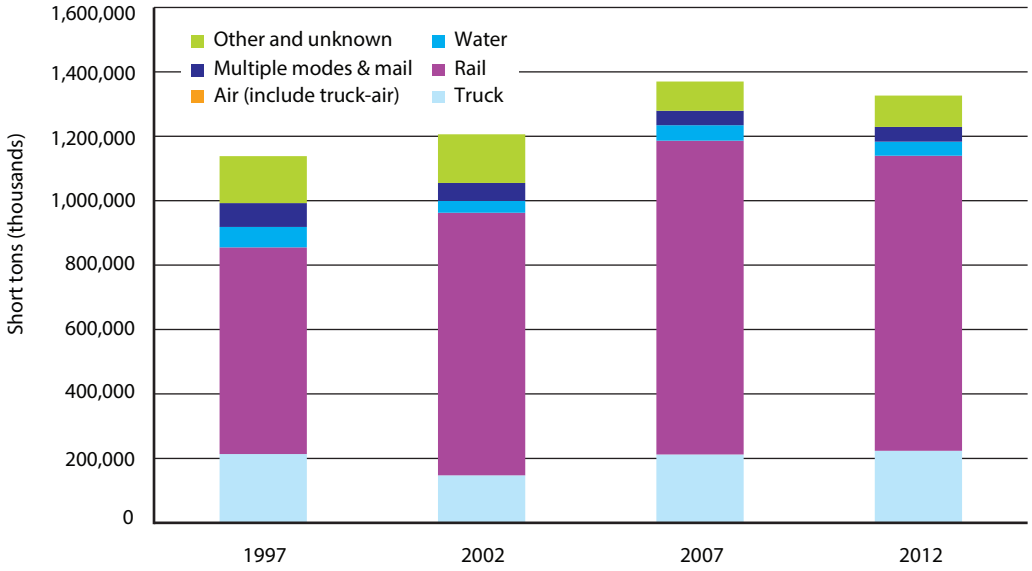
More than two-thirds of coal used to generate electricity is delivered to power plants by rail. Approximately, two-fifths of all U.S. coal is produced in Wyoming's Powder River Basin. The vast majority of Wyoming's coal is sent to power plants in 34 states, almost all of which is moved by rail [USDOE EIA 2014b].

Inland waterways are an important transportation option for coal shipments. Barges typically have the lowest transportation prices per-ton, but they are limited by access to navigable waterways and cannot take coal everywhere that it is needed. Coal used at an electric power plant that is located near a mine can be moved by trucks. Slurry pipelines also are used to deliver coal to power plants.

Ethanol

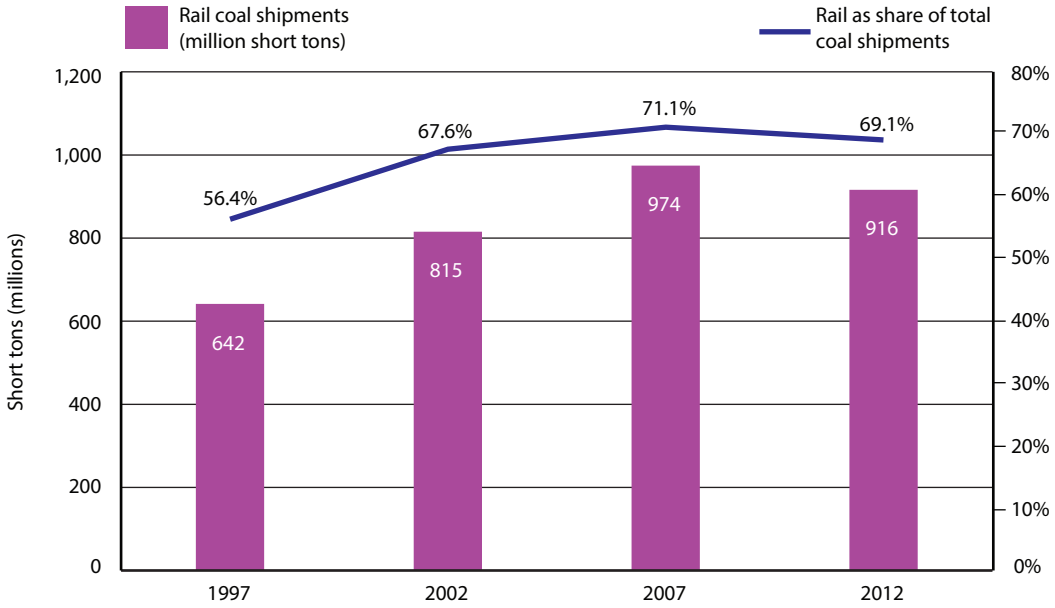
U.S. ethanol production has grown steadily from 17.8 million barrels in 1990 to 341.4 million barrels in 2014 [USDOE EIA 2015b]. Ethanol now displaces approximately 10 percent of U.S. gasoline demand by volume. Ethanol production is primarily located in the Midwest where most of the corn feedstocks are grown, while the blending of ethanol with gasoline takes place at petroleum product distribution terminals across the country. Typically, rail moves ethanol from production plants to distribution terminals, which accounts for around 70 percent of ethanol shipments. More than 306,000 carloads of ethanol were transported by railroads in 2012 (latest year for which data are available). Most ethanol carried by railroads moves in 30,000-gallon tank cars.

FIGURE 3-4 Domestic Coal Shipments by Mode: 1997, 2002, 2007, 2012



SOURCES: U.S. Department of Transportation, Bureau of Transportation Statistics, Freight Analysis Framework, Version 3.4, November 2015.

FIGURE 3-5 Rail Coal Shipments: 1997, 2002, 2007, 2012



SOURCES: U.S. Department of Transportation, Bureau of Transportation Statistics, Freight Analysis Framework, Version 3.4, November 2015.

Almost all of these cars are owned by shippers or leasing companies, not by railroads [AAR 2014c]. The final product is delivered by truck to retail outlets.

Hazardous Materials

According to the CFS, more than 22.6 billion tons of hazardous materials were moved in 2012, an increase of 15.6 percent over 2007 tonnage. The value of hazardous materials rose by 61.2 percent between 2007 and 2012, fueled by increases in the price of refined petroleum products [USDOT BTS and USDOC Census 2015]. Flammable liquids accounted for the largest share of hazardous materials shipped by value (80.8 percent) and by tons (78.6 percent), followed by gases, a distant second (table 3-3).

Trucks moved more than half of all hazardous materials shipments, calculated both by weight and value. Pipelines handled about 24.3 percent of the tonnage, followed by waterways (6.7 percent) and rail (5.6 percent). Trucks accounted for approximately 31.4 percent of all hazardous materials ton-miles because of the relatively short distances these products are transported. Rail accounted for 27.6 percent of the hazardous materials ton-miles (table 3-4). The average distance of hazardous material shipments is 114 miles across all modes [USDOT BTS and USDOC Census 2015].

TABLE 3-3 Hazardous Materials Shipments by Transportation Mode: 2012

	Value		Tons		Ton-miles[1]		Miles
Transportation mode	$ Billions	Percent	Millions	Percent	Billions	Percent	Average distance per shipment
All modes, total	**2,334.4**	**100.0**	**2,580.2**	**100.0**	**307.5**	**100.0**	**114**
Single modes, total	**2,304.7**	**98.7**	**2,552.9**	**98.9**	**275.6**	**89.6**	**68**
Truck[2]	1466.0	62.8	1,531.4	59.4	96.6	31.4	56
For-hire	870.9	37.3	882.3	34.2	62.0	20.2	150
Private	595.1	25.5	649.1	25.2	34.5	11.2	33
Rail	79.2	3.4	111.0	4.3	844.9	27.6	808
Water	217.8	9.3	283.6	11.0	54.9	17.9	212
Air	4.4	0.2	0.3	Z	0.3	0.1	1,120
Pipeline[3]	537.3	23.0	626.7	24.3	S	S	S
Multiple modes, total	**29.7**	**1.3**	**27.3**	**1.1**	**31.9**	**10.4**	**654**
Truck and rail	13.3	0.6	17.0	0.7	16.6	5.4	954
Truck and water	S	S	S	S	S	S	1,181
Rail and water	2.5	0.1	4.6	0.2	1.4	0.4	S
Parcel, U.S. Postal Service, or Courier	10.3	0.4	0.3	Z	0.2	0.1	650
Other multiple modes	0.0	0.0	0.0	0.0	0.0	0.0	0
Other modes	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0**

KEY: S = data are not published because estimate did not meet publication standards. By far, the most common reason for suppressing a cell is a high coefficient of variation (greater than 50 percent).; Z = rounds to zero.

[1] Ton-miles estimates are based on estimated distances traveled along a modeled transportation network. [2] Truck as a single mode includes shipments that went by private truck only or by for-hire truck only. [3] Excludes crude petroleum shipments.

NOTE: Value-of-shipment estimates have not been adjusted for price changes. Numbers and percents may not add to totals due to rounding.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics and U.S. Department of Commerce, Census Bureau, *2012 Commodity Flow Survey, Hazardous Materials* (Washington, DC: February 2015), table 1a. Available at www.census.gov/econ/cfs/2012/ec12tcf-us-hm.pdf as of June 2015.

TABLE 3-4 Hazardous Materials Shipments by Hazard Class: 2012

Hazard class	Description	Value		Tons		Ton-miles[1]		Miles
		$ Billions	Percent	Millions	Percent	Billions	Percent	Average distance per shipment
Class 1	Explosives	18.4	0.8	4.0	0.2	1.0	0.3	840
Class 2	Gases	125.1	5.4	164.8	6.4	33.2	10.8	57
Class 3	Flammable liquids	2,016.7	86.4	2,203.5	85.4	204.6	66.5	93
Class 4	Flammable solids	5.4	0.2	11.3	0.4	5.8	1.9	565
Class 5	Oxidizers and organic peroxides	7.6	0.3	12.0	0.5	5.5	1.8	437
Class 6	Toxic (poison)	15.2	0.7	7.6	0.3	3.6	1.2	513
Class 7	Radioactive materials	12.3	0.5	S	S	0.4	Z	34
Class 8	Corrosive materials	75.9	3.2	125.3	4.9	37.8	12.3	264
Class 9	Miscellaneous dangerous goods	58.0	2.5	51.0	2.0	16.1	5.2	530
Total		**2,334.4**	**100.0**	**2,580.2**	**100.0**	**307.5**	**100.0**	**114**

[1] Ton-miles estimates are based on estimated distances traveled along a modeled transportation network.

NOTE: Value-of-shipments estimates have not been adjusted for price changes. Numbers and percents may not add to totals due to rounding.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics and U.S. Department of Commerce, Census Bureau, *2012 Commodity Flow Survey*, Hazardous Materials (Washington, DC: February 2015), table 2a. Available at www.census.gov/econ/cfs/2012/ec12tcf-us-hm.pdf as of June 2015.

Safety and environmental issues associated with the transportation of hazardous materials are discussed in chapters 6 and 7, respectively.

International Trade

The value of total U.S.-international merchandise trade increased from $2.6 trillion in 2000 to nearly $4.0 trillion in 2014—a 44.5 percent inflation-adjusted increase[4] [USITC]. Six of the top 15 U.S. trading partners were Asian countries in 2014. Trade with China grew the fastest, from 5.8 percent of the total value of U.S. merchandise trade in 2000 to 14.9 percent in 2014. In 2000 China ranked 10th among U.S. trading partners. Today it is second only to Canada, while Mexico, Japan, and Germany, respectively, round out the top five [USDOC ITA 2015].

U.S. retailers are increasingly dependent on the U.S. transportation system, especially those that build up their inventories in October in anticipation of holiday sales in November and December. In particular, businesses use liner[5] services to move intermodal shipping containers through the global transportation system. Container ports provide a link between the global and domestic freight network, utilizing intermodal barge, truck, and rail connections to transport containers to their final destinations.

Freight with Canada and Mexico

The U.S. North American Free Trade Agreement partners—Canada and Mexico—accounted for 30.1 percent ($1.19 trillion) of the value of U.S. merchandise trade in 2014.

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

[5] A vessel advertising sailings on a specified trade route on a regular basis. It is not necessary that every named port be called on every voyage.

Over the 2000 to 2014 period, combined trade adjusted for inflation with Canada and Mexico increased 32.8 percent[6] [USITC].

Trucks carried 26.8 percent of the tonnage and 59.9 percent of the value of U.S. merchandise trade with Canada and Mexico, while rail carried 19.5 percent of the tonnage and 14.9 percent of the value in 2014 (table 3-5). U.S. freight with Canada and Mexico reached nearly $1.2 trillion in 2014, an increase of 4.5 percent from 2013 and 67.6 percent since 2004. Mineral fuels and oils transported by the pipeline and water modes accounted for 25.8 percent of the increase in freight value between 2004 and 2014. In 2014 U.S. imports from Canada and Mexico exceeded exports in terms of total merchandise trade value. In 2014 mineral fuels and oil were the top commodity category transported between the United States and Canada. Vehicle and vehicle parts (other than railway vehicles and parts) was the next highest commodity category transported by the truck and rail modes [USDOT BTS 2015d].

A sharp drop in oil prices that began in 2014 has contributed to a decrease in the value of freight moved between the United States and Canada in 2015. The value of trade totaled $48.0 billion in August 2015, down 13.6 percent from August 2014. Mineral fuels transported by pipeline and vessel declined 35.1 and 40.2 percent, respectively, in August 2015 from the previous year [USDOT BTS 2015e]. The Canadian economy was officially declared to be in a recession, after contracting 0.8 percent in first quarter and 0.5 percent in the second quarter 2015, which has been widely attributed to the drop in oil price [COMTE 2015].

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

TABLE 3-5 Value and Tonnage of U.S. Merchandise Trade with Canada and Mexico: 2000, 2010, 2013, and 2014

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

	2000		2010		2013		2014	
Mode	**Value**	**Weight**	**Value**	**Weight**	**Value**	**Weight**	**Value**	**Weight**
Truck[1]	429	NA	560	176	684	196	715	206
Rail[1]	94	NA	131	114	175	143	178	150
Air	45	<1	45	<1	43	<1	44	<1
Water	33	194	81	210	103	198	104	212
Pipeline[1]	24	NA	65	107	84	140	94	160
Other[1]	29	NA	37	8	51	33	58	40
Total[1]	**653**	**NA**	**920**	**614**	**1,140**	**709**	**1,193**	**767**

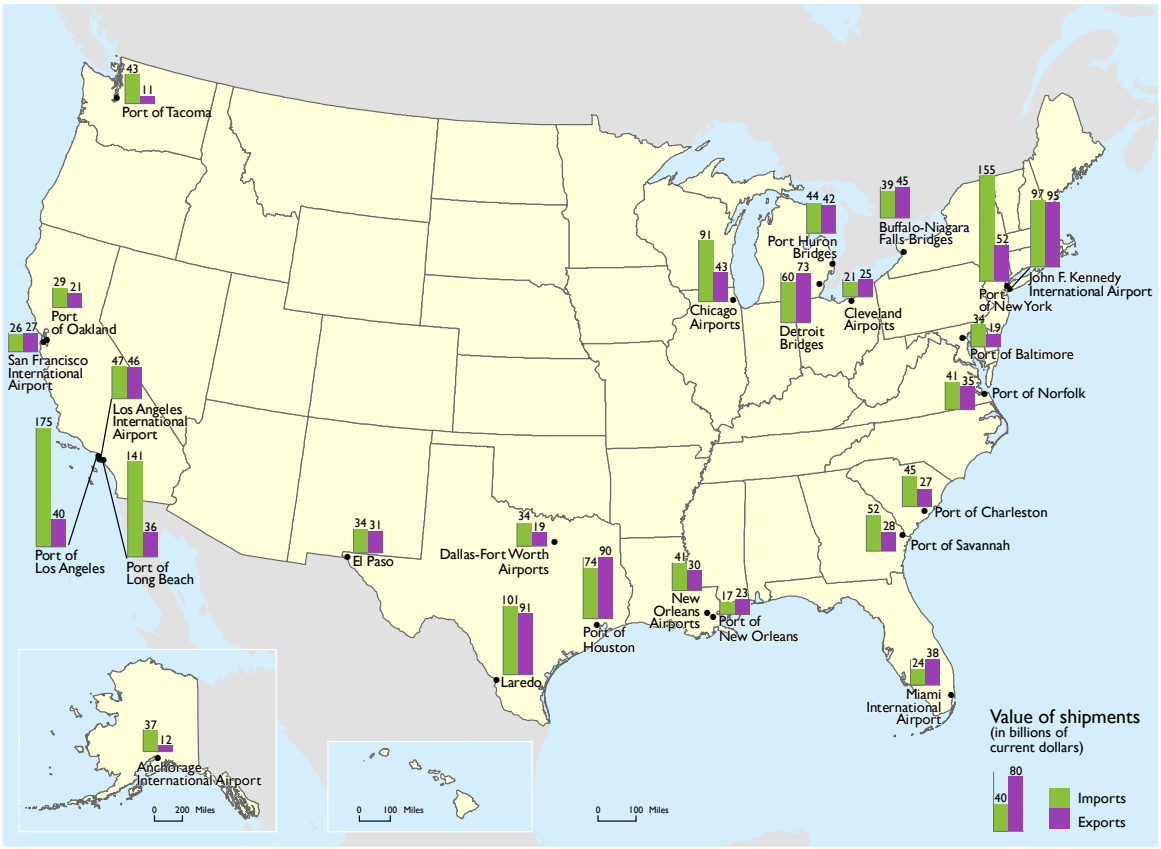
KEY: NA = not available.

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

NOTES: 1 short ton = 2,000 pounds. "Other" includes shipments transported by mail, other and unknown modes, and shipments through Foreign Trade Zones. Totals for the most recent year differ slightly from the Freight Analysis Framework (FAF) due to variations in coverage and FAF conversion of values to constant dollars. Numbers may not add to totals due to rounding. The weight of U.S. exports by land modes of transportation is not available because this data is not required to be reported on the paper Shipper's Export Declarations (SEDs) documents that are required by the U.S. Census Bureau. BTS uses value to weight ratio of U.S. imports at two-digit commodity code to calculate the export weights where available.

SOURCES: **Truck, Rail, Pipeline, and Other**: U.S. Department of Transportation, Bureau of Transportation Statistics, North American Transborder Freight Data. Available at www.bts.gov/transborder as of June 2015; **Air and Water**: U.S. Department of Commerce, Census Bureau, Foreign Trade Division, *FT920 - U.S. Merchandise Trade: Selected Highlights* (Washington, DC: annual issues).

FIGURE 3-6 Top 25 U.S. International Trade Freight Gateways by Value: 2014



SOURCES: *Air*: U.S. Department of Commerce, U.S. Census Bureau, Foreign Trade Division, USA Trade Online, October 2015; *Water*: U.S. Army Corps of Engineers, Navigation Data Center, special tabulation, October 2015; *Land*: U.S. Department of Transportation, Bureau of Transportation Statistics, North American TransBorder Freight Data, available at www.bts.gov/programs/international/transborder/ as of October 2015.

Michigan, which accounts for 13.0 percent of the U.S.-Canada border mileage, was the leading state for trade with Canada. Michigan has border crossing/entry ports between Detroit, Port Huron, and Sault Ste. Marie and southern Ontario; both Michigan and Ontario have a high concentration of automakers [USDOT BTS 2015d].

Electrical machinery was the top commodity transported between the United States and Mexico. Texas, which accounts for 64.2 percent of the U.S.-Mexico border mileage and is home to 11 border crossing/entry ports, led all other states in surface freight with Mexico [USDOT BTS 2015d]. In total, there are 87 ports-of-entry along the U.S.-Canada border and 25 on the U.S.-Mexico border.

Freight Transportation Gateways

A large volume of U.S.-international merchandise trade passes through a relatively small number of freight gateways—the entry and exit points for trade between the United States and other countries (figure 3-6). More

than 400 gateways, including airports, border crossings, and seaports handled international cargo in 2013 [USDHS CBP 2014], but the top 25 gateways in terms of value handled the greatest share of trade—$2,406 billion or 62.3 percent of the nearly $3,863 billion total U.S.-international trade in goods. Sixteen of the top 25 gateways handled more imports than exports.

In 2014 the Port of Los Angeles was the top water gateway, handling more than $215.0 billion in cargo, mostly imports, while on the Atlantic coast the port of New York and New Jersey ranked second, handling $206.5 billion. Laredo, the top land-border crossing, handled $192.1 billion in trade across the U.S.-Mexico border. John F. Kennedy International Airport was the leading air gateway, handling $191.8 billion in exports and imports.

Water is the leading transportation mode for U.S.-international trade both in terms of weight and value. Ships accounted for more than 71.6 percent of trade weight and 44.2 percent of trade value in 2014. Air handles less than 1 percent of trade weight but 24.8 percent of trade value, due to its focus on high-value, time-sensitive, and perishable commodities. In 2013 the top U.S.-international air gateways by value were John F. Kennedy International, NY; Chicago area airports; and Los Angeles International, CA [USDOT BTS 2015a]. Memphis International, TN; Ted Stevens Anchorage International, AK; and Louisville International, KY were the top U.S.-international air gateways by weight in 2013, the latest year for which data are available [USDOT FAA 2014]. Trucks, which haul a large share of imports and exports between U.S. international gateways and inland locations, carried 18.0 percent of the value of total U.S.-international trade (figure 3-7a) and 10.4 percent of the tonnage in 2014 (figure 3-7b).

Trade growth with Canada and Mexico and the tapping of natural resources, such as oil from the Bakken formation, generates increased north-south traffic flows on a domestic transportation infrastructure that was initially developed along east-west corridors during the westward development of the Nation.

Water Trade

As a result of the growth in international trade, the number of container vessels calling at U.S. ports has increased. Between 2007 and 2012, vessel calls at U.S. seaports increased by 3.9 percent. The average displacement of container vessels increased 10.2 percent, from 47,732 deadweight tons (dwt) in 2007 to 52,589 dwt in 2012 [USDOT MARAD 2014]. In 2013 tankers accounted for 38.7 percent of the vessel calls, followed by containerships with 23.6 percent of the more than 74,000 vessel calls [USDOT MARAD 2015]. The new Post-Panamax containerships also increased in average capacity by 12.7 percent, as measured in twenty-foot equivalent units (TEU), from 2006 to 2012, the latest year for which data are available [USDOT MARAD 2014].

In 2014 U.S. seaports handled 31.7 million TEU of containerized cargo, which is 6 percent more than reported in 2007 and an increase of 23.9 percent from 25.6 million TEU in 2009, following the last recession. The ports of Los Angeles and Long Beach on the Pacific coast and the port of New York and New Jersey on

FIGURE 3-7a U.S. International Merchandise Trade by Value: 2014

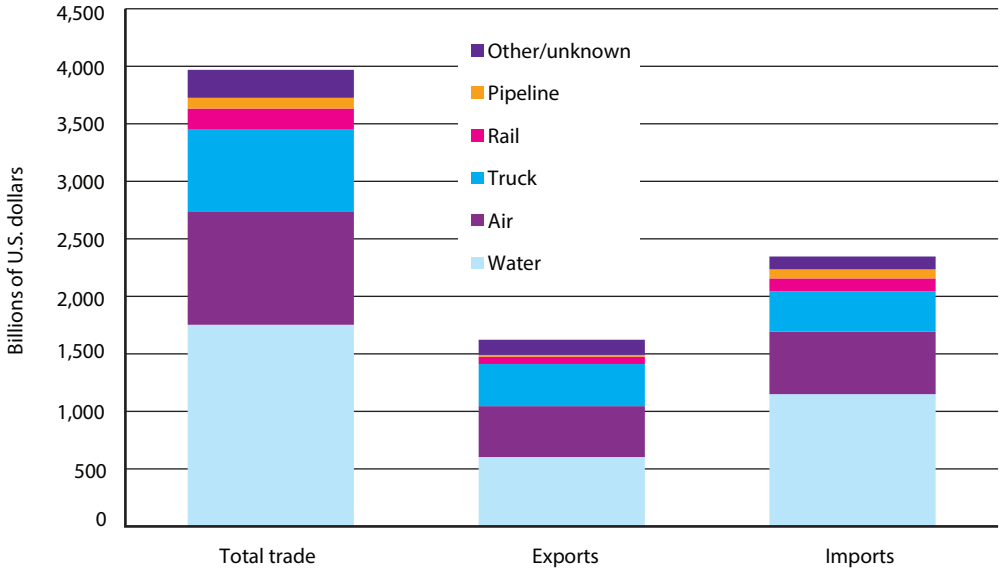
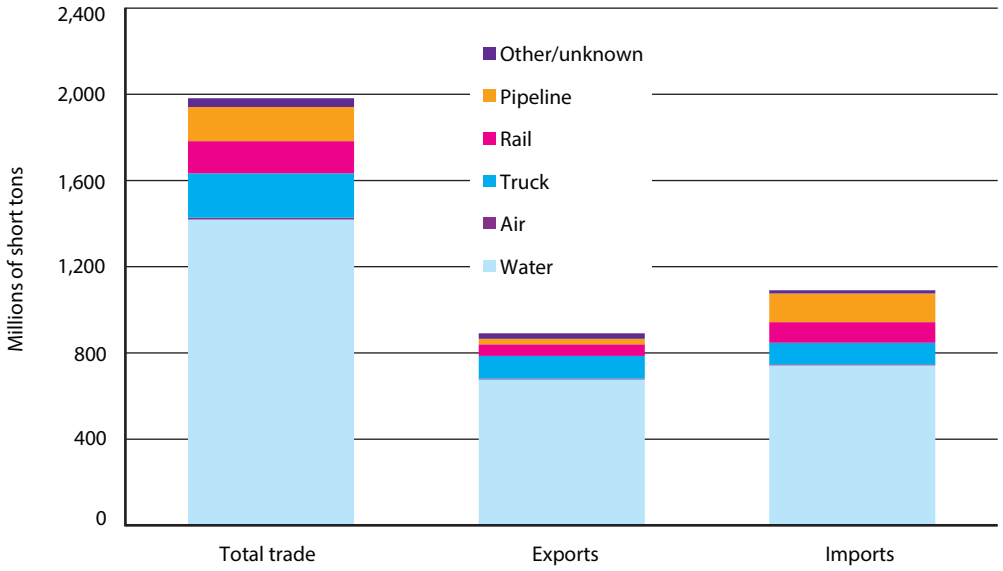


FIGURE 3-7b U.S. International Merchandise Trade by Weight: 2014



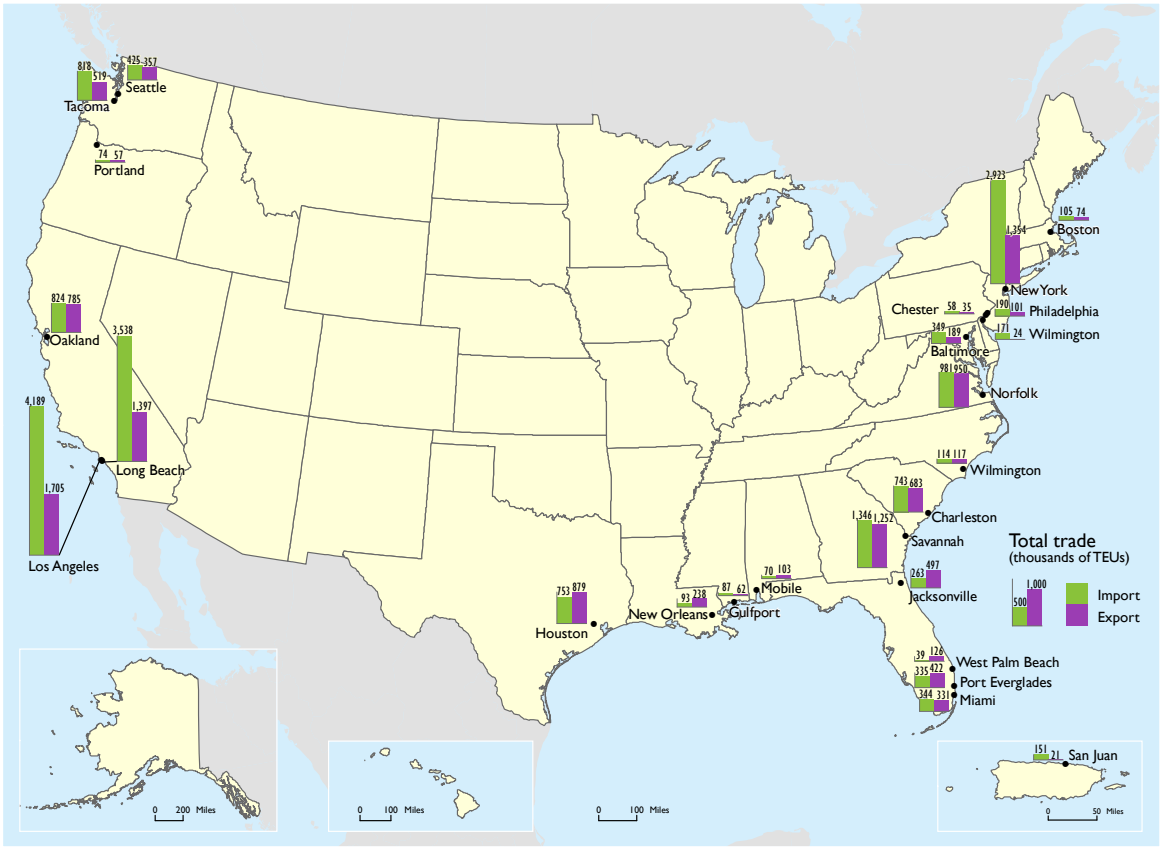
NOTES: 1 short ton = 2,000 pounds. The U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics estimated 2012 weight data for truck, rail, pipeline, and other and unknown modes using value-to-weight ratios derived from imported commodities. Totals for the most recent year differ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

SOURCES: *Total, water and air data*: U.S. Department of Commerce, U.S. Census Bureau, Foreign Trade Division, *FT920 - U.S. Merchandise Trade: Selected Highlights* (Washington, DC: February 2015). *Truck, rail, pipeline, and other and unknown data*: U.S. Department of Transportation, Bureau of Transporation Statistics, North American Transborder Freight Data. Available at www.bts.gov/transborder as of June 2015.

the Atlantic coast are the leading container ports [USDOT MARAD 2015]. As shown in figure 3-8, the geographic distribution of container ports is more concentrated along the Pacific and Atlantic coasts, while large volumes of bulk commodities are transported through gulf coast ports (figure 3-2). In 2012 the Atlantic coast, including Puerto Rico, accounted for 37.8 percent of all types of vessel calls, followed by the gulf coast with 37.5 percent, and then the Pacific coast with 24.8 percent [USDOT MARAD 2015].

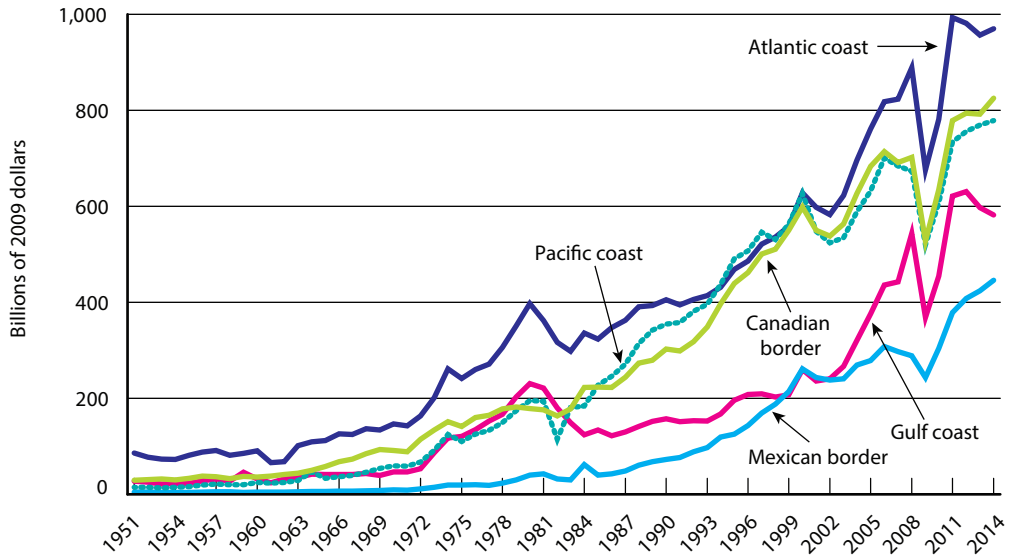
The major increase in trade with China has resulted in a large share of trade moving through Pacific coast ports (figure 3-9). The trend toward larger containerships has led to a concentration of liner service at ports with ample overhead clearance and water draft, intermodal connections such as double stack rail, and room to grow. This trend is expected to continue, especially when the expanded Panama Canal locks open. The Panama Canal's existing locks allow Panamax vessels, carrying up to 5,000 TEU, to transit

FIGURE 3-8 Top 25 Water Ports by Containerized Cargo: 2014



SOURCES: U.S. Department of Transportation, Maritime Administration, U.S. Waterborne Container Trade by U.S. Custom Ports, available at www.marad.dot.gov/resources/data-statistics/ as of June 2015.

FIGURE 3-9 Value of U.S. International Merchandise Trade by Coasts and Borders: 1951–2014



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

SOURCES: **1951-1970**: U.S. Department of Commerce, Census Bureau, *Historical Statistics of the United States, Colonial Times to 1970, Bicentennial Edition* (Washington, DC: 1975); **1971-1999**: U.S. Department of Commerce, Census Bureau, *Statistical Abstract of the United States* (Washington, DC: annual issues); **2000-2015**: U.S. Department of Commerce, Census Bureau, Foreign Trade Division, *FT920 - U.S. Merchandise Trade: Selected Highlights* (Washington, DC: annual issues). **Implicit GDP Deflator**: U.S. Department of Commerce, Bureau of Economic Analysis, *Current-Dollar and Real Gross Domestic Product*. Available at www.bea.gov as of June 2015.

between the Atlantic and Pacific Oceans. A third set of locks is scheduled to open in 2016, which will handle Post-Panamax vessels up to 13,000 TEUs. The Panama Canal expansion will increase the potential for direct all-water access to South Atlantic and gulf coast ports, especially for U.S. imports from Asia [USDOT MARAD 2013].

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