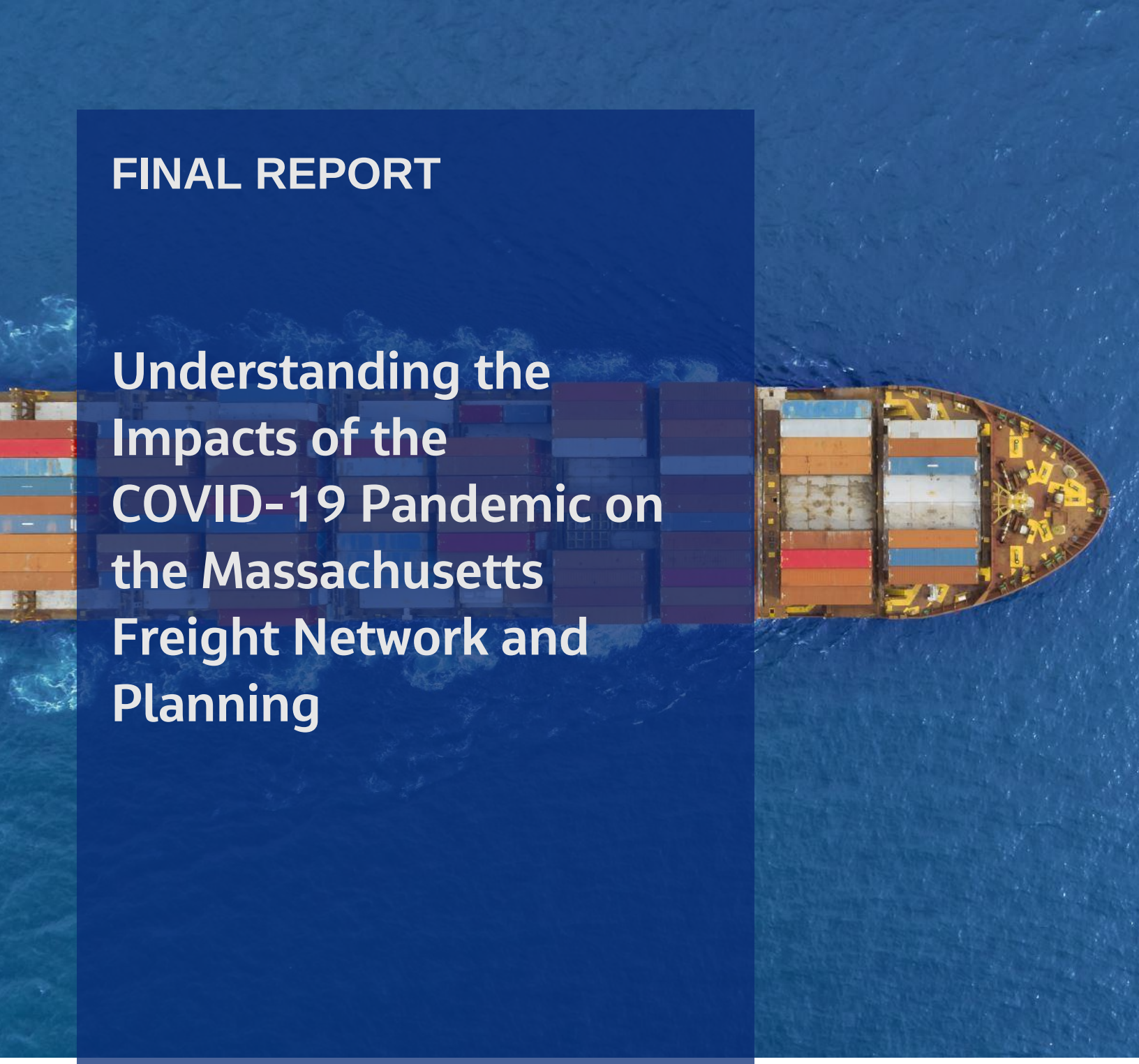
FINAL REPORT

Understanding the Impacts of the COVID-19 Pandemic on the Massachusetts Freight Network and Planning



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MASSACHUSETTS DEPARTMENT OF TRANSPORTATION

massDOT Office of Transportation Planning

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Table of Content

Figures

Tables

Acronyms and Abbreviations

CHIPS	Creating Helpful Incentives to Produce Semiconductors for America
CMV	Commercial Motor Vehicle
COVID-19	Coronavirus Disease 2019
EPA	U.S. Environmental Protection Agency
FMSCA	Federal Motor Carrier Safety Administration
GDP	Gross Domestic Product
GHG	Greenhouse Gas
I-	Interstate Highway
IIJA	Infrastructure Investment and Jobs Act
IPA	Isopropyl Alcohol
MassDOT	Massachusetts Department of Transportation
MERT	Manufacturing Emergency Response Team
MPO	Metropolitan Planning Organization
N/A	Not Applicable
NYC	New York City
OS/OW	Oversize/Overweight
OTP	Office of Transportation Planning
PNYNJ	Port of New York and New Jersey
PMI	Purchasing Managers' Index
PPE	Personal Protective Equipment
TEU	Twenty-Foot Equivalent Unit

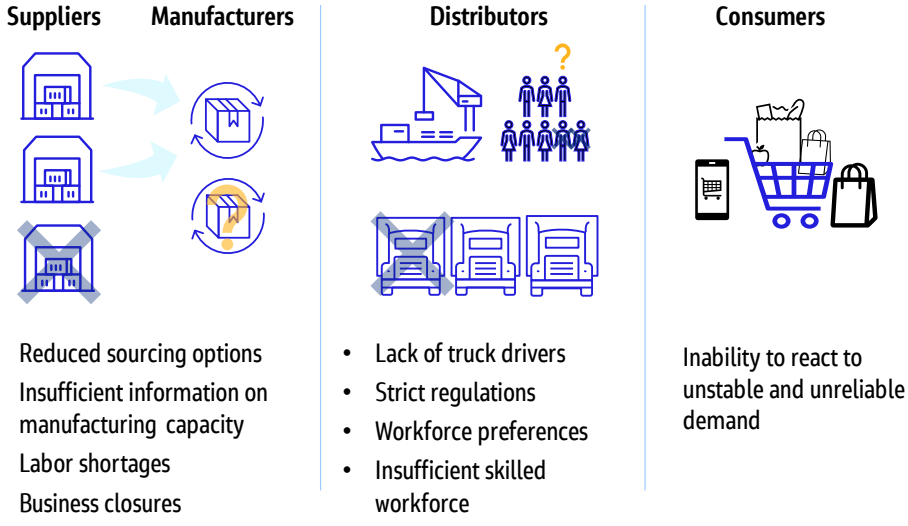
Introduction

The 2017 Massachusetts Freight plan was developed by the Massachusetts Department of Transportation (MassDOT) to establish guiding principles in pursuing an innovative and efficient freight system in the Commonwealth. The plan incorporated provisions from the Fixing America's Surface Transportation Act (FAST Act) of 2015. It focused on meeting safety, security, and resiliency goals for providers and consumers alike to facilitate the economic competitiveness of Massachusetts and provide an efficient and reliable system within the state and its neighboring states.

Two years after the plan's release, the coronavirus disease 2019 (COVID-19) emerged, creating major disruptions to the global economies, consumer behavior, jobs, supply chains, and goods movement. Increased adoption of e-commerce, same-day pickup, online grocery purchases, and online restaurant orders are a few examples of changes experienced during the pandemic's peak. The impacts of these disruptions on land use and the transportation network are observed in the increased truck and passenger vehicle deliveries, increased demand for warehouses and distribution centers, closures of brick-and-mortar retail facilities, and competition for curb space parking. As depicted in **Figure 1**, the pandemic also uncovered challenges in the global supply chain, including the:

- Need for greater transparency in the supply chain,
- Lack of multiple sourcing options,
- Insufficient information on manufacturing capacity, and
- Challenges exacerbated by industry protocols, strict regulations, and administrative oversight.

Figure 1. Global Supply Chain Vulnerabilities Highlighted by the COVID-19 Pandemic[1]



STUDY HIGHLIGHTS

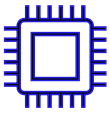
This study evaluates the impact of the COVID-19 pandemic on the Massachusetts freight network. A robust qualitative and quantitative analysis clarifies the short-term impacts from the medium- to long-term impacts. Opportunities and challenges are identified with considerations to address in the next statewide freight plan. The following are highlights from the study's findings:

Literature Review

A surge in e-commerce and an increase in transportation costs were observed globally.

Hybrid work arrangements became more acceptable in some industries.

Supply chain vulnerabilities were exposed including limited sourcing options.



Supply chain issues persisted in 2022, particularly for electronic components and semiconductors.

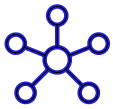
Other global events, such as the Russia-Ukraine war, prolong the recovery from the pandemic.

Quantitative Analysis

Different industries experienced different impacts due to the pandemic, with manufacturing and wholesale remaining relatively stable.

The increase in e-commerce led to a surge in the number of new warehouses and distribution centers leading to increased traffic, noise, and safety issues.

Travel restrictions led to a significant impact to passenger air and transit.



Massachusetts' diverse economy facilitated its resilience to the pandemic with manufacturing jobs in the science and technology industry remaining steady during 2020.

Increased truck volumes on major highways such as the I-90, I-84, and I-93 could be attributed to decreased port calls at the Port of Boston and increased traffic from the Ports of New York and New Jersey.

In August 2022, Amazon announced that it is closing five of its delivery warehouses. However, it plans on opening additional grocery stores around the state.

Qualitative Analysis

Labor shortage was a recurring theme during the peak and recovery periods of the pandemic.

Vaccination mandates impacted the transportation industry resulting in hampered growth and decreased revenue across the rail and trucking industries.

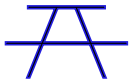
In addition to higher wages, benefits and better work-life balance became critical to hiring and retaining workers.

New COVID-19 compliance measures put in place in addition to existing safety protocols made operations more complex and increased business operating costs.

There was an uptick in reckless driving, mostly by passenger vehicles, as there were fewer vehicles on the roads.

Increased demand for curb space, and companies have begun consolidating delivery services.

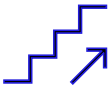
Data Assessment and Recommendations



Develop and deploy a truck parking availability system that detects, monitors, and provides real-time parking availability to truck drivers.

Develop and promote a safety campaign that prepares drivers to return to normal life after long periods of lockdowns.

Collaborate with on-demand mobility service providers to ensure adequate driver training and monitoring during last-mile deliveries.



Promote workforce upskilling to meet demand and address the labor shortage.

Promote multistate collaboration in addressing interstate over-dimensional load movements.

Take advantage of recent legislation (for example, the CHIPS and Science Act and the IIJA) to favor Massachusetts' long-term economic growth.

Create and promote clear communication channels to address inquiries regarding oversized and overweight vehicle movement.

Literature Review

Massachusetts ranks amongst the top 20 largest export and import states, by value in the United States. The state's largest manufacturing exports include computer & electronic products, machinery for semiconductor manufacturing, chemicals, and primary metal manufacturing.

The COVID-19 pandemic was disruptive, greatly impacting travel and consumer behavior. At the peak of the pandemic, many resorted to panic-buying to meet their essential needs and, with time, became more dependent on others to deliver groceries, meals, medical supplies, and other necessities. As summarized on **Figure 2**, the changes in consumer behavior resonated through the global supply chain network: rapid growth in e-commerce increased delivery vehicle traffic, greater demand for warehousing and distribution centers, competition for curb space, and a shift from traditional retail jobs. Furthermore, businesses stopped production, work-from-home policies were mandated, and millions were affected.

Figure 2. General Impact of the COVID-19 Pandemic
Photo: Noah Berger/Associated Press. The Wall Street Journal

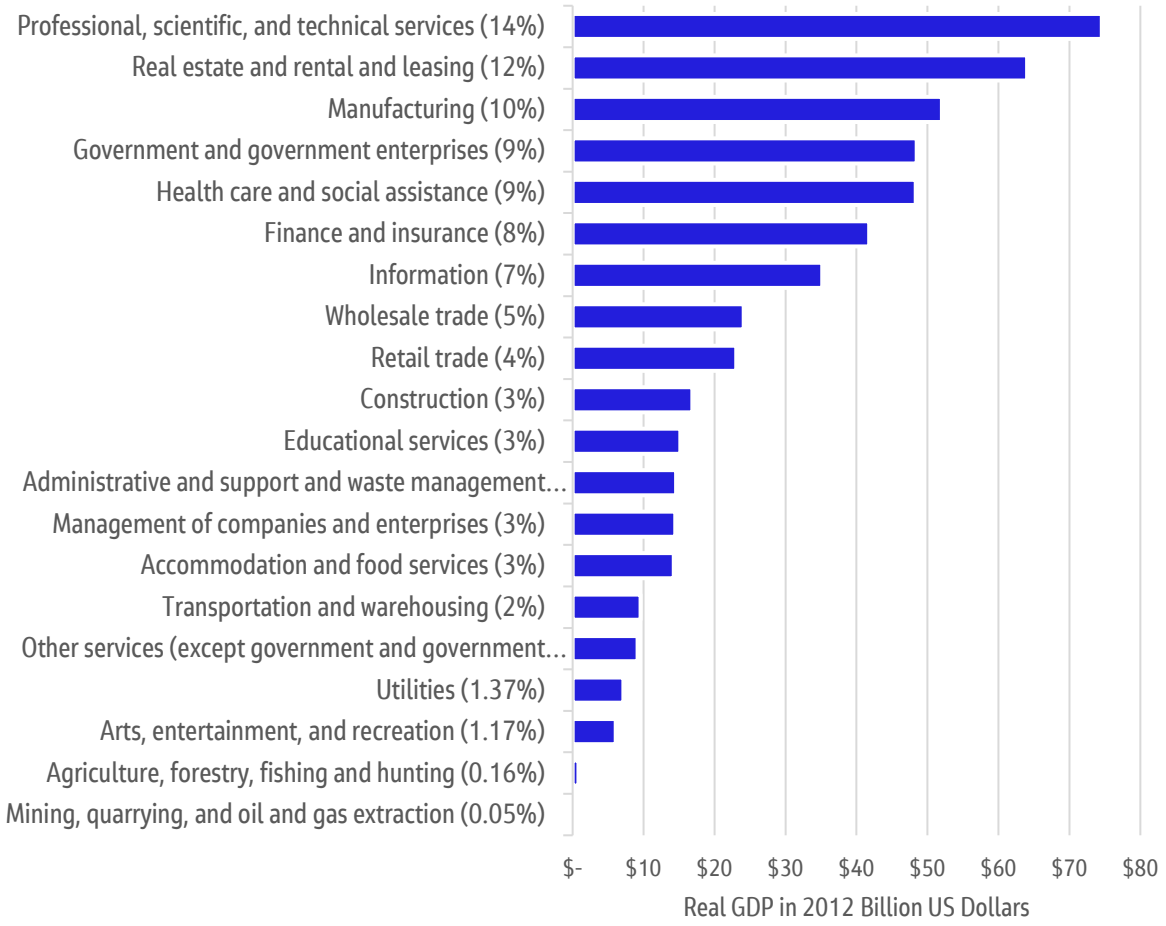
This chapter evaluates how the pandemic affected freight shipping and distribution in Massachusetts informed by a thorough understanding of the local, national, and international literature related to how the pandemic changed supply chains and distribution patterns. Case studies are presented to examine the pandemic's impact on specific industries and the role of globalized supply chains. The vulnerability of Massachusetts' major trade gateways to disruptions in the global distribution network is also presented.

The Massachusetts Freight Network: Pre-COVID-19

The economy of the Commonwealth of Massachusetts is based largely on technological research and development, as wells as other service sector industries. The U.S. Bureau of Economic Analysis estimates that the Commonwealth's real gross domestic product (GDP) was $518 billion[2], representing 2.72% of the U.S. gross domestic product and making it the 11th largest state economy in the nation in 2019.[3] Its real per capita income of $65,853[2] ranks second in the nation after Connecticut.[4] As shown on **Figure 3**, the largest industry (professional, scientific, and technical services) accounted for 14% of Massachusetts' GDP in 2019, and the second largest industry (real estate) accounted for 12% of the state's GDP. Freight-intensive industries (that is, industries directly involved in the movement of goods and services) accounted for 24% of the state's GDP. These industries are manufacturing (10%), wholesale trade (5%), retail trade (4%), construction (3%), and transportation and warehousing (2%). Agriculture (including fishing) and mining (including quarrying) contributed a combined 0.21% to the state's GDP in 2019.

Figure 3. Massachusetts Real GDP Contribution by Industry in 2019

Source: US Department of Commerce Bureau of Economic Analysis



Massachusetts' gateways for imports and exports include the interstate network, rail terminals, seaports, and airports, as shown on **Figure 4**.

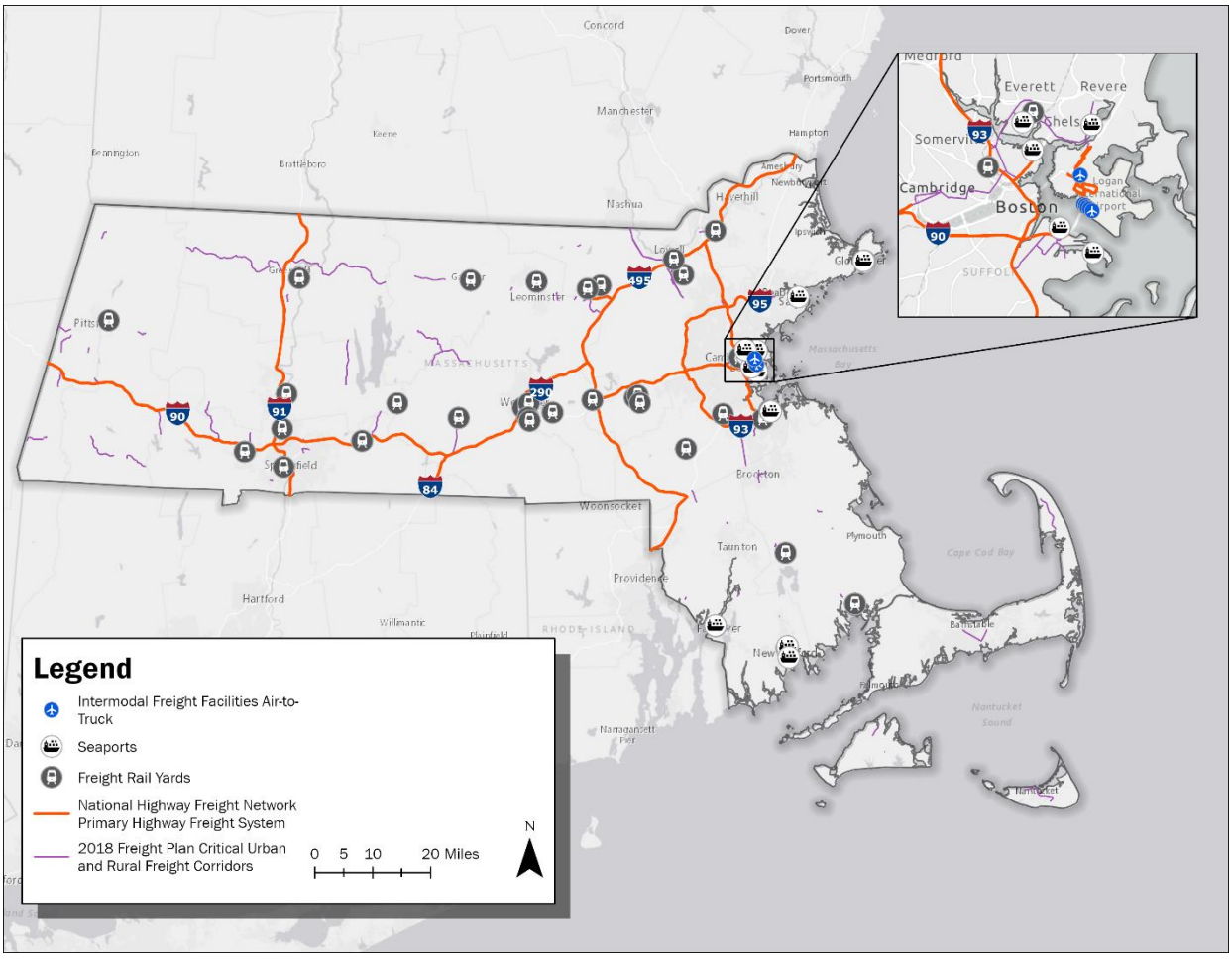
Massachusetts is a regional connector for freight rail in New England, with major rail yards including NEP Yard, Devens Intermodal Rail Terminal, Valley Area, West Springfield CSX Yard, and Holyoke Yard. Additional rail yards include P&W Railroad Southbridge Street, Wiser Avenue, and TVT CSX Yards.

There are five major freight seaports: Boston, Fall River, Gloucester, New Bedford, and Salem. Port of Boston's Conley Terminal is a major container port for the New England Region. New Bedford and Gloucester are also key seafood landing ports for the Commonwealth.

The majority of air cargo moves through Logan International Airport in Boston, as the remaining airports are primarily passenger airports.

Figure 4. Massachusetts Freight Network, Rail Terminals, Seaports, and Airports

Source: Massachusetts geoDOT



In 2019, trucks accounted for approximately 83% of tonnage and 71% of freight value moved in Massachusetts; air transport accounted for 0.08% of freight tonnage and 4.4% of value; and multiple modes and mail accounted for 2.7% of freight tonnage and 22.4% of value, as shown on **Figure 5.**

Before the COVID-19 pandemic, Massachusetts freight tonnage was forecasted to grow by 48% in 2050, as shown on **Figure 6** and **Figure 7**. Freight value was also expected to grow by 97% within the same period. Imports and exports were forecasted to increase as well—43% increase in tonnage, 110% increase in value for imports, 149% increase in tonnage, and 81% increase in value to exports by 2050.

High-value commodities moved by trucks include mixed freight, electronics, and pharmaceutical products. These account for 29% of truck movement by value. Air and multiple modes and mail account for 50% of pharmaceutical products and 48% of electronics moved by value. Fuels (such as gasoline, coal, and petroleum products) and gravel account for 42% of the tonnage of all commodities moved, regardless of mode.

Domestic outbound and inbound movement in 2019 demonstrated that 68% to 69% of freight by tonnage is to and from Massachusetts and over 90% of Massachusetts freight stays in the Northeastern area of the US.

Figure 5. Modal Share by Tonnage and Value – 2019

Source: Freight Analysis Framework, version 5.5

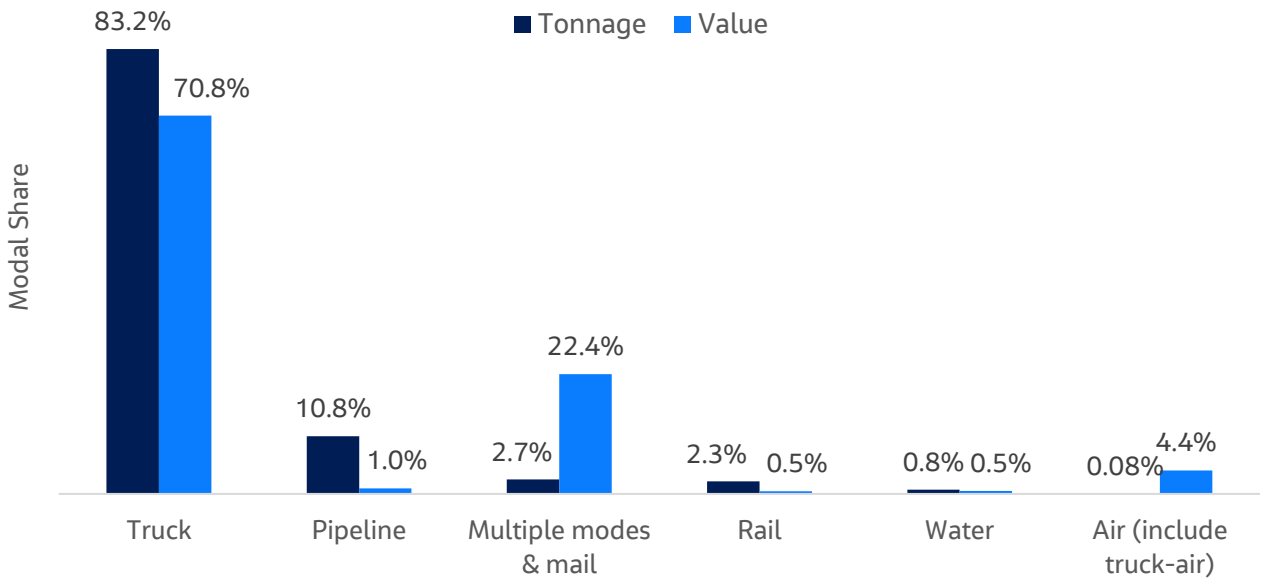


Figure 6. Massachusetts Freight Tonnage Forecast (in millions)

Source: Freight Analysis Framework, version 5.5

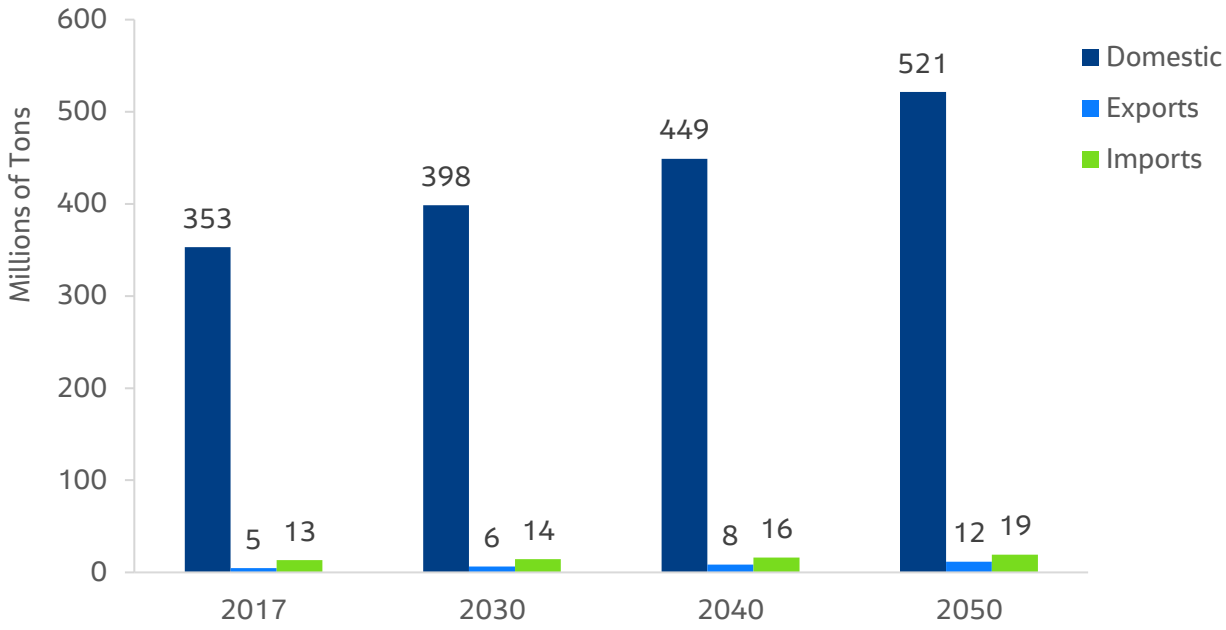
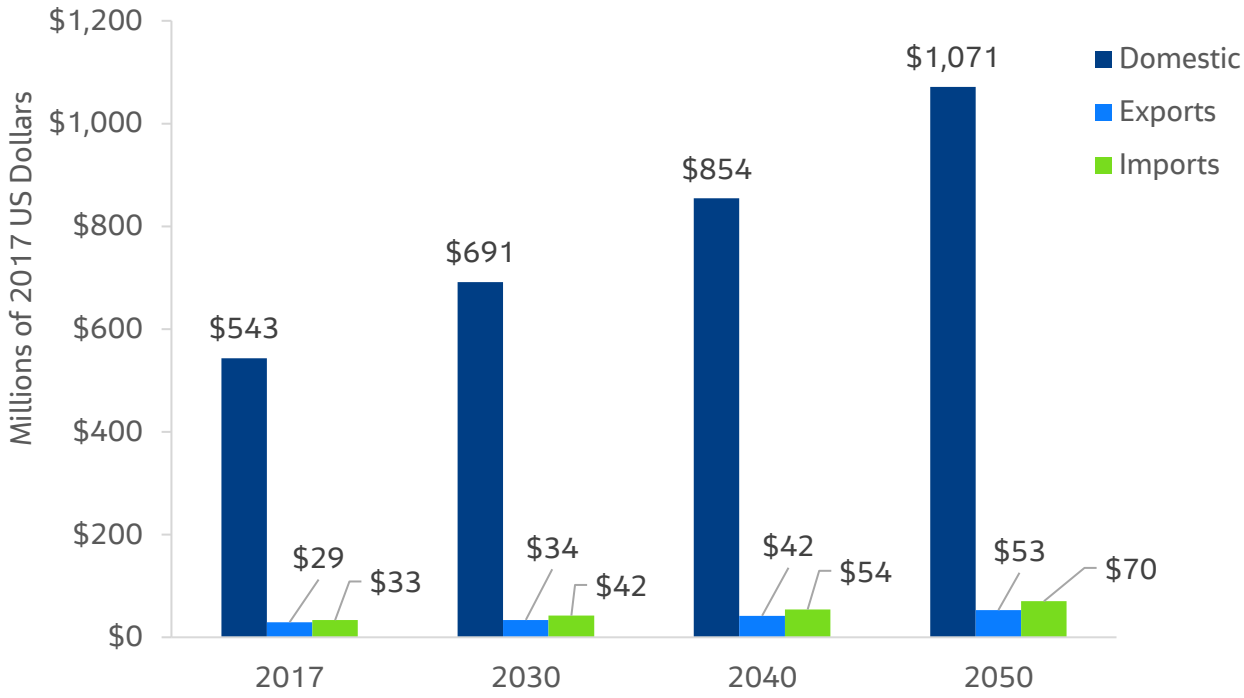


Figure 7. Massachusetts Freight Value Forecast (in millions of 2017 US Dollars)

Source: Freight Analysis Framework, version 5.5



Timeline of the COVID-19 Pandemic's Impacts

Phase 1: January to June 2020

The first case of COVID-19 was identified in late 2019 in China. By the end of January, China introduced travel restrictions in response to the rising COVID-19 cases. Workers stayed at home as manufacturing centers shut down.

The disruptions in China led to ripple effects on global supply chains. Shipments scheduled to depart after the Lunar New Year holiday were delayed, leading to the beginning of a global supply chain crisis. As the rest of the world instituted travel restrictions in response to COVID-19 being declared a pandemic in March 2020, businesses closed down, and manufacturers and shipping companies prepared for a sharp decline in the global demand for goods and services.

With hospitals overrun with COVID-19 cases, safety protocols were set in place globally, resulting in a surge in demand for masks and other personal protection equipment (PPE).

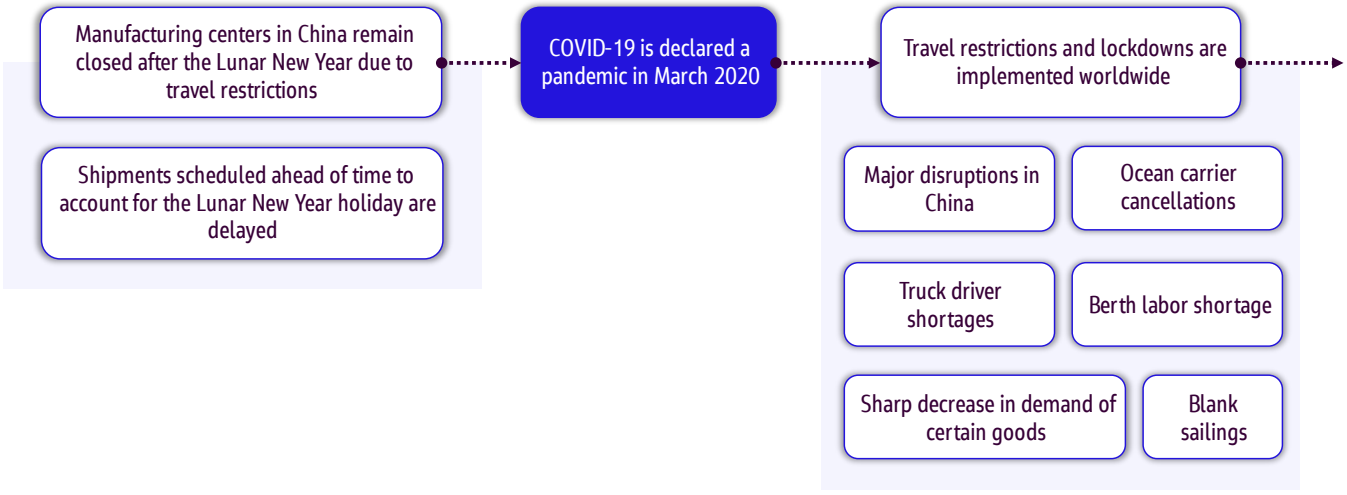
Because of the urgent demand, PPE production became a priority for factories in China. These factories relied on air cargo and marine containers to deliver PPE gear around the globe.

Limited exports from the United States (US) and European Union (EU) created an unexpected shift in the direction of trade, further exacerbating the disproportionate distribution of shipping containers. Stay-at-home policies, truck driver shortages, and berth labor shortages affected cargo handling and transit times.

With restricted economic activity and limited movement of cargo, carriers announced blank sailings[5] to reduce costs and save the resources that would have otherwise been spent sending empty containers. Consequently, shipping containers began to pile up at major seaports in the US.

Figure 8 depicts the chain of events from January to June 2020.

Figure 8. Phase 1 Chain of Events (January to June 2020)



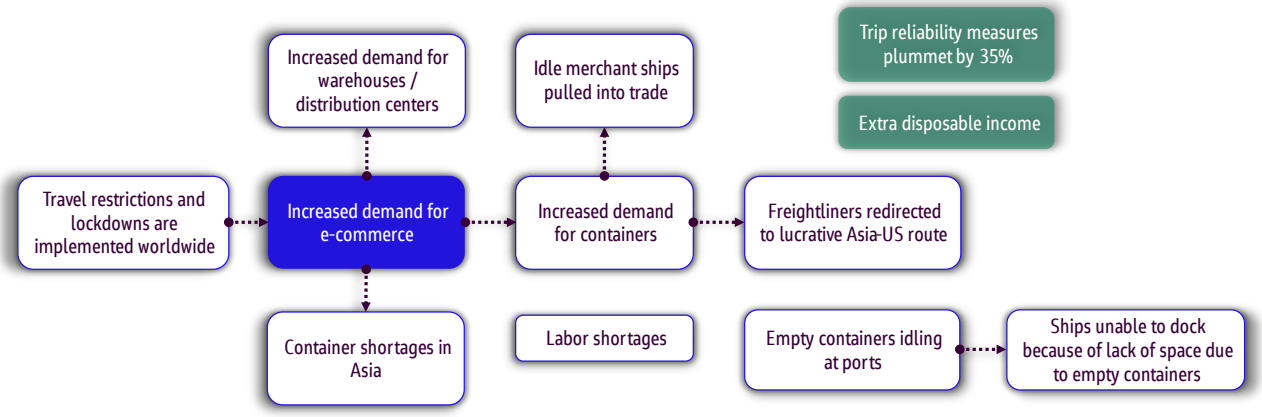
Phase 2: June to December 2020

Travel restrictions and lockdown measures led nonessential workers[6] to spend most of their days at home. Social in-person events were canceled, restaurants could not seat customers indoors, and many retail stores closed their doors. Consumer behavior shifted from in-person experiences to online activities, including shopping. Demand for grocery and food deliveries at home resulted in rapid growth in e-commerce. More than before, consumers relied heavily on online shopping and shipping, surging e-commerce to record popularity levels. In mid-2020, the US Congress passed an emergency aid package to relieve millions of Americans affected by COVID-19.[7] A major part of the package included economic impact payments. Overall, the stimulus incentivized spending by consumers.

The surge in e-commerce resulted in a strong demand for durable goods from Asia and freightliners began to take advantage of the lucrative Asia-US routes. Ports became overwhelmed as they grappled with increased imports, vessel calls, berth labor shortages, and insufficient chassis to move containers. Cargo ships were anchored for weeks outside of West Coast ports awaiting their turn to unload, and the shortage of truck drivers fueled delays in international shipping. Transportation costs skyrocketed and shipping containers piled up as products waited to be transported. The growing port congestion starting at the end of 2020 cumulated in delivery times from factories in China to the US west coast reaching all-time highs in 2021.

Figure 9 depicts the chain of events from June to December 2020.

Figure 9. Phase 2 Chain of Events (June to December 2021)



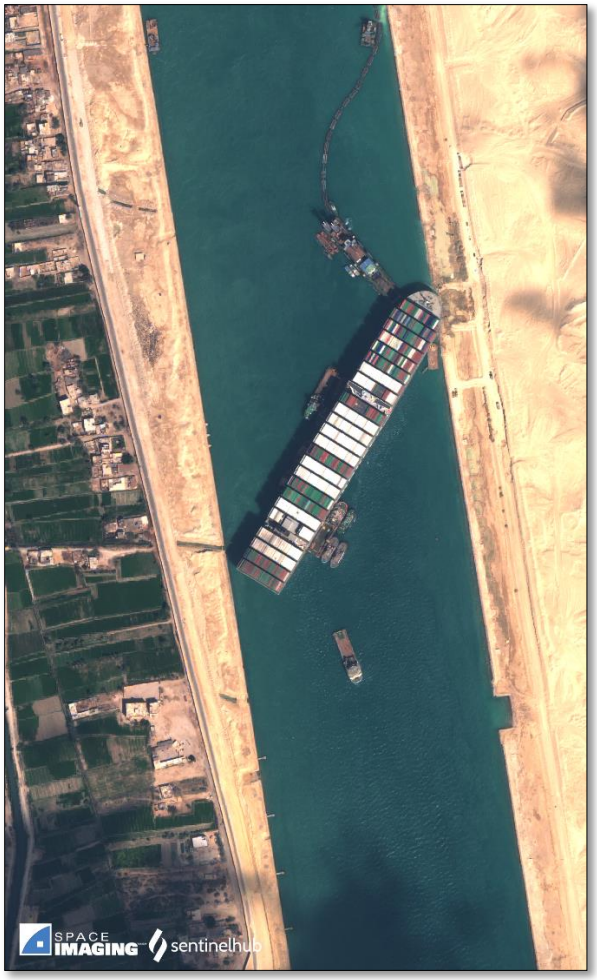
Phase 3: January to December 2021

By the rollout of the COVID-19 vaccine in January 2021, the consumer market had adapted to increased e-commerce spending.

Shipping from Asia-US routes increased rapidly to meet growing demand. This resulted in severe, long-term backlogs at US

ports along the West Coast. To alleviate the bottlenecks, the Ports of Long Beach and Los Angeles operated 24 hours and 7-day shifts to address the supply chain issues.[8] These efforts included commitments from six of the largest companies to use expanded hours to move more cargo off the docks and reduce the backlog of ships anchored outside the ports. These commitments were expected to move an estimated 3,500 additional containers per week at night through the end of 2021.[8]

Figure 10. *Ever Given* stuck in the Suez Canal
Source: European Space Imaging Maxar data processed by Sentinel Hub



In March 2021, the cargo ship *Ever Given* caused a blockage in the Suez Canal; given that the Canal connects Asia and Europe through the Mediterranean Sea, this massively delayed shipments around the globe.

The *Ever Given*, one of the world's largest container ships, had been delivering 18,300 containers to ports in the Netherlands, England, and Germany. On its trip to China, it wedged across the canal after running aground amid high winds (pictured on **Figure 10**). The blockage of the canal set back shipping times for six days[9], holding up an estimated $9.6 billion worth of trade per day.[10]

With increased West Coast port delays and rising shipping costs, carriers began diverting traffic to the US East Coast Ports of New York, New Jersey, Charleston, and Savannah.[11] Following this increased activity, the Port Authority of New York and New Jersey started experiencing congestion (though not to the extent of the West Coast ports)—for example, the number of anchored ships at New York–New Jersey reached twelve immediately after the Christmas holiday, but some were unloaded and able to resume their voyages. In comparison, ships were waiting for months along the West Coast ports.[11]

According to the Journal of Commerce, the Ocean Alliance shipping line stopped calling at the Port of Boston in November 2021 through the end of January 2022 on its Asia-US East Coast route due to delays at the Port of Savannah during the peak of that port's backlog. In response, shippers started routing containers through the Port of New York and New Jersey instead of through the Port of Boston despite the upgrades to Conley

Terminal. It is said that as many as 500 containers moved weekly through the New York-New Jersey gateway destined for the Boston region.[11]

Figure 11 depicts the chain of events from January to December 2021. **Figure 12** shows the effects of the Suez Canal blockage on ocean delivery times. The Ocean Timeliness Indicator[12] from April 2019 to April 2022 demonstrates that before the pandemic, ocean delivery times averaged from 50 to 60 days. At the beginning of the pandemic, from February to April, ocean transit times increased to 60 to 75 days. The peak and the most drastic increase in ocean travel times occurred in November 2021 when the indicator reached 110 days, before the onset of the Omicron variant. The 2021 increases were mainly because of backlogs at destination ports and increased time to process container ships.

Figure 11. Phase 3 Chain of Events (January to December 2021)

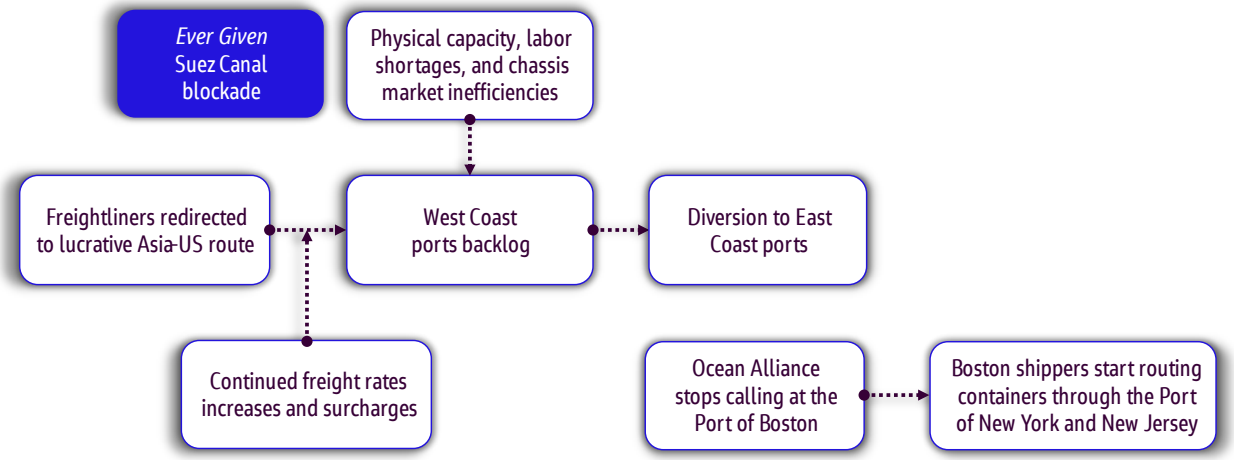
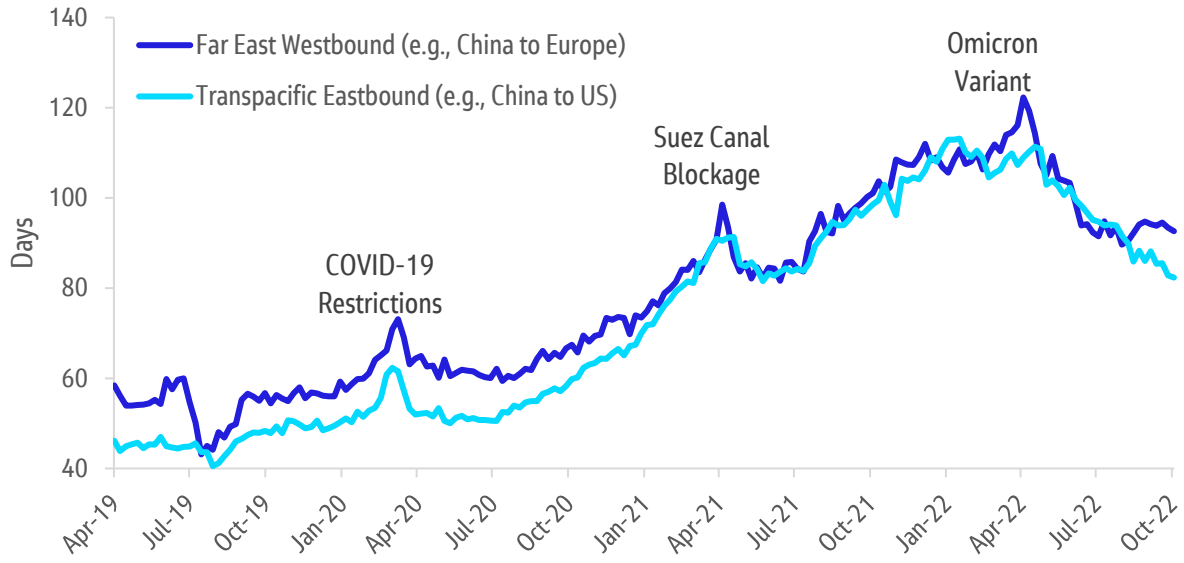


Figure 12. Ocean Delivery Times – April 2019 to May 2022

Source: Flexport Research



Omicron Variant: *As vaccines were distributed and became required for travel and most social settings, new variants of COVID-19 emerged. Specifically, the Omicron variant discovered in November 2021 sent nations including China back into lockdown. This variant created a sudden but short-lived spike in freight transit times due to China's zero-COVID policies (see* ***Figure 12****). However, it was discovered that increased doses of the vaccine could protect against the Omicron variant,[13] thus helping to alleviate the long-term impact of the variant on global supply chains. Furthermore, global concerns regarding a major economic meltdown, food shortages, and general lockdown fatigue made countries less inclined to institute further travel restrictions to this variant.*

Efforts to Address Bottlenecks at Ports of Long Beach and Los Angeles[8]

In June 2021, President Biden launched the Supply Chain Disruptions Task Force to address short-term supply chain discontinuities. Port Envoy John Porcari was appointed in August 2021 to help drive coordination between the major private firms that control the transportation and logistics supply chain. By October 2021, a number of these private firms had made commitments to support efforts to alleviate port congestion.

The Ports of Long Beach and Los Angeles committed to expanding their operations to 24 hours and 7 days a week. Walmart committed to increasing its use of nighttime hours significantly to increase throughput by as much as 50%. UPS committed to increasing its operations to 24 hours and 7 days a week as well as improving its data sharing with ports to increase throughput by up to 20%.

FedEx committed to combining an increase in nighttime hours with changes to trucking and rail use to double the volume of containers moving out of the ports at night. Samsung committed to moving nearly 60% more containers out of the Ports of Long Beach and Los Angeles by operating 24 hours and 7 days a week for 90 days.

Home Depot committed to moving up to 10% additional containers per week during the newly available off-peak port hours at the Ports of Long Beach and Los Angeles. And Target committed to increasing the number of containers moved at night from 50% to 60% for 90 days to help ease congestion at the ports.

Phase 4: Post-COVID-19 Pandemic Peak Period and the Russia-Ukraine Conflict

In early 2022, supply chain issues persisted, particularly for electronic components and semiconductors. COVID-19 caused a major shift toward the use of technology, as more people began to work from home, and many jobs continue to accommodate hybrid or fully remote options. Moreso than before, consumers relied heavily on online shopping and shipping, which continued e-commerce's popularity trend. With surplus wealth from the economic impact payments and household savings, decreased supply of raw materials, and increased demand for goods and services during the recovery, the result was high inflation and increased prices.[14]

Tensions between Russia and Ukraine, which resulted in the Russian invasion in February 2022, affected global markets, especially in the energy sector.

In June 2022, inflation hit a 40-year high of 9.1% in the US, driven by the increased cost of food, housing, energy, and transportation.[15]

By July 2022, there was minimal change in inflation. **Figure 13** shows the 12-month percent change from July 2021 to July 2022 in the consumer price index for household energy, transportation, housing, food, and all items combined.[16] When compared to the Northeast and the US city average, inflation in the Boston-Cambridge-Newton metro area was highest for household energy and lowest for all items, transportation, and food. Housing inflation in the metro area (5.8%) was higher than in the Northeast (5.7%) and lower than the US city average (7.4%).

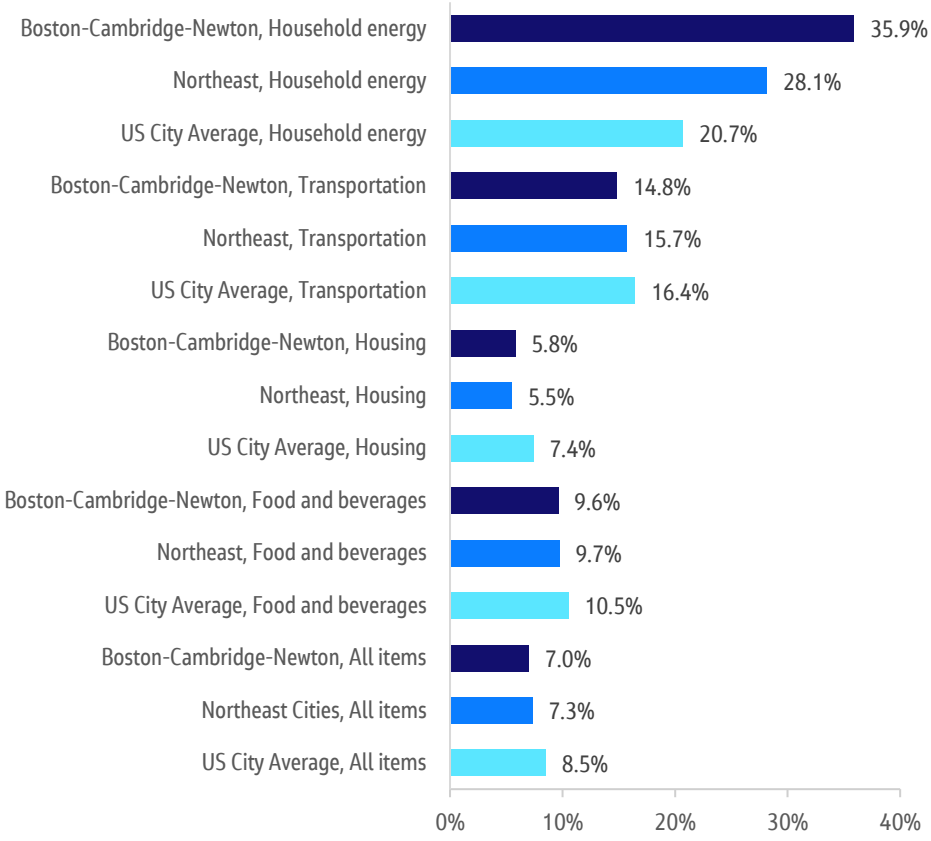


Figure 13. Consumer Price Index for All Urban Consumers, 12-month percent change, July 2021 to July 2022

Source: US Bureau of Labor Statistics

The current trend in inflation is attributed to multiple factors including supply chain disruptions during the peak of the pandemic, increased consumer spending during the recovery, monetary policies, and the war in Ukraine. As a result, the pandemic's long-term effect on trade and residents in the Commonwealth persists. Despite the challenges, West Coast ports saw a reduction in idling vessels as the global pool of shipping containers increased by 13% in 2021, resulting in a 6 million twenty-foot equivalent unit (TEU) surplus globally by July 2022.[17] In the same month, queues at the Port of Los Angeles also fell by 80% from January 2022.[18]

Case Studies and Trends

Electronics Industry

In 2019, there were 695 computer and electronic product establishments in Massachusetts employing 53,596 workers. Middlesex, Suffolk, Essex, and Worcester counties have the largest number of employees and establishments in the computer and electronic product sector.[19]

As early as 2018, a tariff war between the US and China sparked disruptions to supply chains, forcing several high-profile electronics manufacturers to relocate from China to Southeast Asia.[20,21,22] Semiconductor manufacturing equipment used to make older varieties of chips, and components used in an electronic assembly, such as diodes, capacitors, and substrates, were difficult to obtain.[23] The demand for chips also grew as industries shifted to more semiconductor-intensive products such as electric vehicles and devices that utilize 5G technology.[23]

At the pandemic's peak, factory shutdowns in China and supply delays caused a significant and prolonged drop in manufacturing utilization. Consumer electronics was the most widely impacted sector, followed closely by automotive and industrial electronics in the first quarter of 2021.[24] During the pandemic, chip shortages resulted from high demand for products like laptops and computer monitors, while sales of cars and trucks declined less than initially anticipated.[25]

Beyond electronic products, the production of equipment critical to manufacturing was also impacted. Furthermore, companies that resumed production had limited capacity because of labor scarcity.[26] Labor and the cost of materials were also of concern. From a Department of Commerce Request for Information to semiconductor industry leaders in September 2021, it was found that the primary bottleneck in the industry appeared to be wafer production capacity, which requires a longer-term solution. Companies also identified the availability of raw materials, assembly, testing, and packaging capacity as bottlenecks.[23]

In early 2021, General Motors, Ford Motor Company, and Stellantis paused the production of vehicles as they waited for parts to arrive. Auto manufacturers expect tight supply constraints in 2022 and 2023 and may produce cars without certain

features. Estimates indicate that the industry's expected revenue will decrease by $210 billion in 2021, forecasting a shortfall in producing 7.7 million vehicles worldwide.[26] Likewise, air and ocean freight capacity is still limited and expensive, causing longer lead times and higher production costs.

The semiconductor industry in the U.S. is estimated to directly employ over a quarter of a million workers and supports more than 1.6 million additional jobs. Semiconductors are America's fifth-largest export after aircraft, refined oil, and crude oil. In 2021, semiconductors from Massachusetts ranked third in value of exports from the state and ranked sixth in the U.S. for total semiconductor jobs. The wage impact on semiconductor manufacturers in Massachusetts is estimated at $6.9 billion.

- Semiconductor Industry Association[27]

In Massachusetts, tech companies like iRobot, General Electric, and Cognex cited chip shortages cutting into sales or creating delays in customer deliveries. With increased concerns over chip shortages and their impact on US industries, the *Creating Helpful Incentives to Produce Semiconductors for America (CHIPS) and Science Act* of 2022[28] was signed by President Biden on July 29, 2022. The legislation will spend $280 billion on domestic semiconductor manufacturing and research.

Intermodal Shipping

Intermodal logistics is complicated by the multitude of entities involved in the flow of commodities from and to different geographical areas. These include ocean carriers, port operators, chassis suppliers, brokers, truckers, warehouse operators, retailers, and railroads. A bottleneck anywhere in the system affects the overall performance of the supply chain. The following sections provide a summary of the pandemic's impacts on intermodal rail and ocean container carriers.

Intermodal Rail Movement

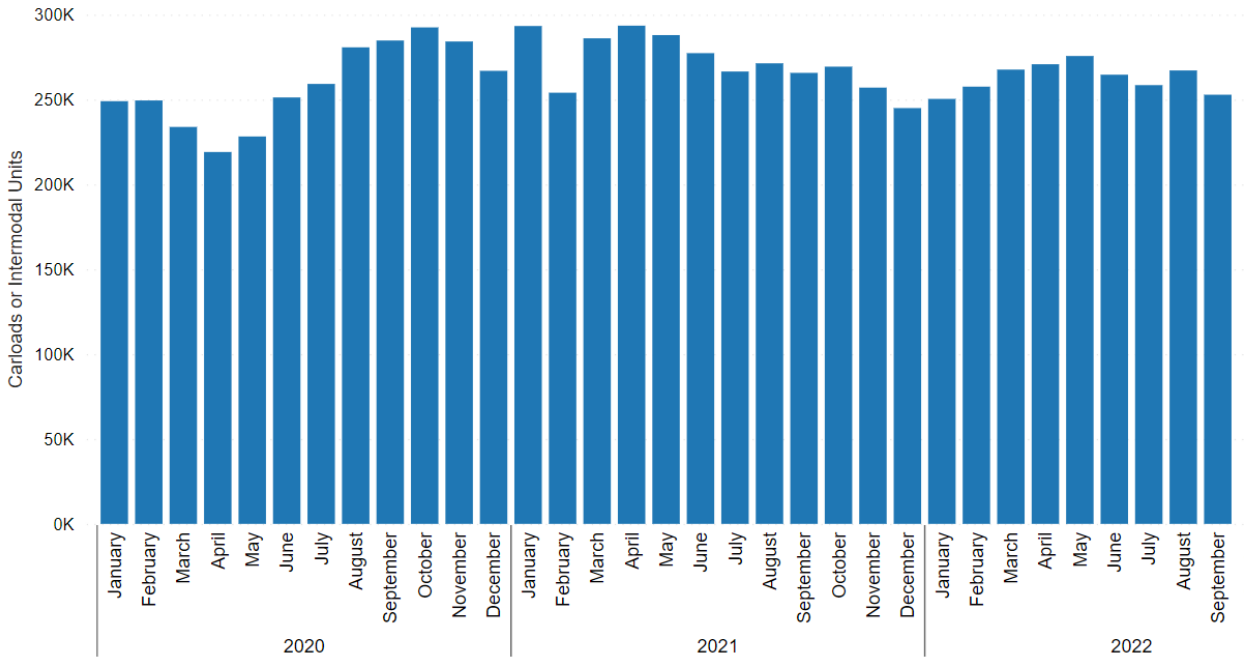
CSX is the largest Class I railroad in Massachusetts with annual revenues, which exceeded approximately $450M in 2019. The total estimated rail tonnage originating from Massachusetts in 2019 was 3.5 million, of which 55 percent was waste and scrap and 26 percent was intermodal. In carloads, intermodal rail was three times that of waste and scrap.

Total rail traffic terminating in Massachusetts was much higher at 8.7 million tons and 235,800 carloads.[29] The majority of terminating traffic was intermodal with 1.8 million tons and 133,700 carloads. Food products, chemicals, pulp, and paper made up about 3.5 million tons of cargo but only 38,100 carloads.

As shown on **Figure 14**, US intermodal freight rail experienced a rapid rebound from a steep drop in March and April 2020, achieving a near-full recovery by July 2020.[30] This rebound is attributed to shifts in consumer spending; accelerated growth in e-commerce through large retailers; and tightening capacity in trucking, which is more labor-dependent per amount of goods moved. Rail's advantage in e-commerce is attributed to intermodal movements' capacity and cost efficiency.[31]

Figure 14. Intermodal Units Shipments: US Average Weekly Rail Carloads Originated, January 2020 to September 2022

Source: Association of American Railroads

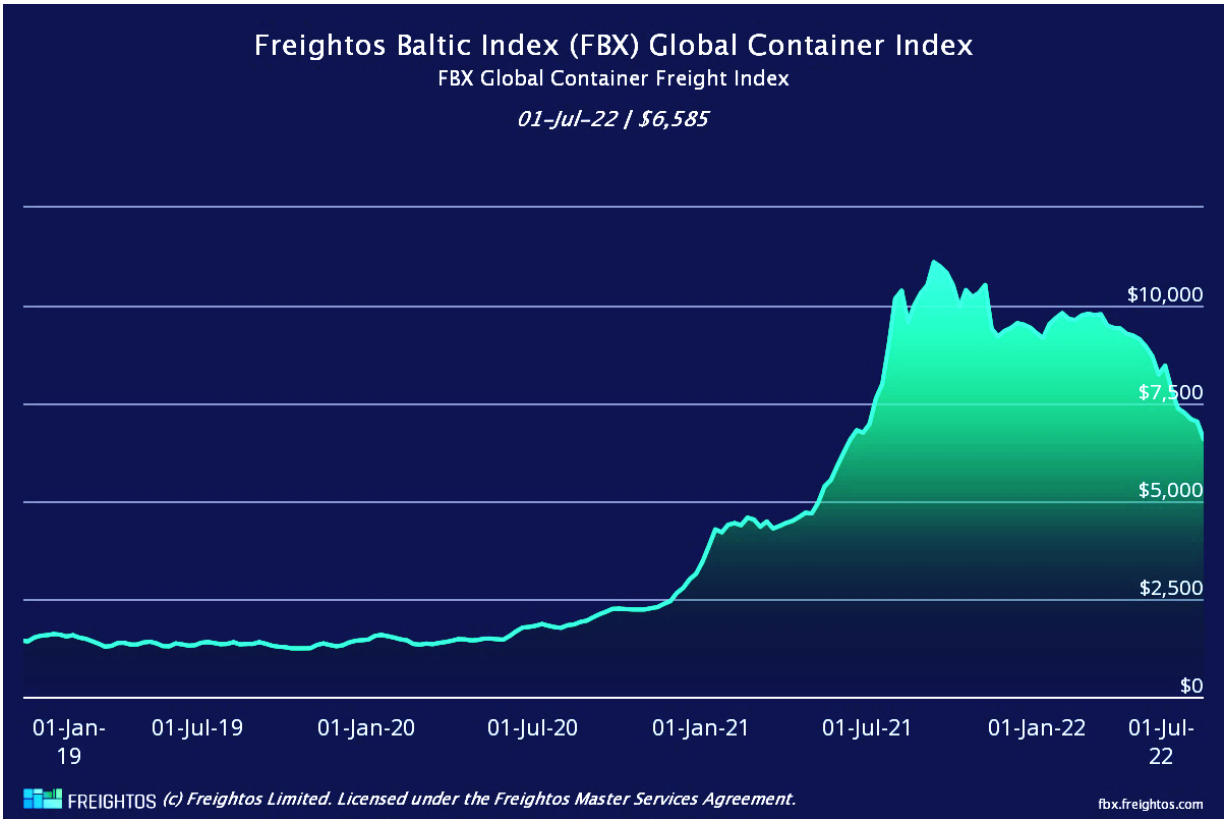


Ocean Container Movement

The Freightos Baltic Index is a daily freight container index that measures global container freight rates by calculating container spot rates on 12 global tradelines. The prices used to calculate the indexes are spot tariffs and related surcharges between carriers, freight forwarders, and high-volume shippers. Index values are calculated by taking the median price for all prices with weighting by the ocean carrier. The weekly freight index is calculated as an average of the five business days from the same week. As shown on **Figure 15**, the pandemic significantly increased maritime freight costs in 2020. Global container shipping rates almost tripled from January 2019 to February 2021 and increased again by 156% from February to September 2021. The weekly index spot price to ship a container from China to the East Coast increased by 86% from $2,900 per container in January 2020 to $5,400 per container in December 2020. Additionally, the weekly index price to ship containers from China to the West Coast increased 178% from $2,676 per container from January to December 2020.

Figure 15. Global Container Freight Index

Source: Freightos Baltic Index (FBX): Global Container Freight Index
Note: The index does not include bulk shipping rates.



Fishing and Seafood Industry

In 2019, **Massachusetts ranked second,** behind Alaska, for the **state with the most value of seafood landings—approximately $679 million**.[32] New Bedford was the leading US port in terms of the value of seafood landings. New Bedford processed roughly $451 million and 116 million pounds of seafood in 2019, as shown on **Figure 16** and **Figure 17**.[33] A third of New Bedford's seafood is fished locally; the remaining seafood supply comes from Canadian, Scandinavian, and other international waters. The processed seafood is then distributed globally via Boston and New York City.[35] New Bedford's commercial seafood value is driven by high-value sea scallop landings. Massachusetts ranks second in the US in lobster landings, behind Maine.[34] Other top fishing ports in Massachusetts include Gloucester, Boston, and Fairhaven.

Figure 16. Value of Commercial Fishing Landings in Massachusetts by Port, 2010 to 2021

Source: NOAA Fisheries - Foreign Fishery Trade Data
Note: The dollar value of landings is reported as nominal (current at the time of reporting) values and not adjusted for inflation.

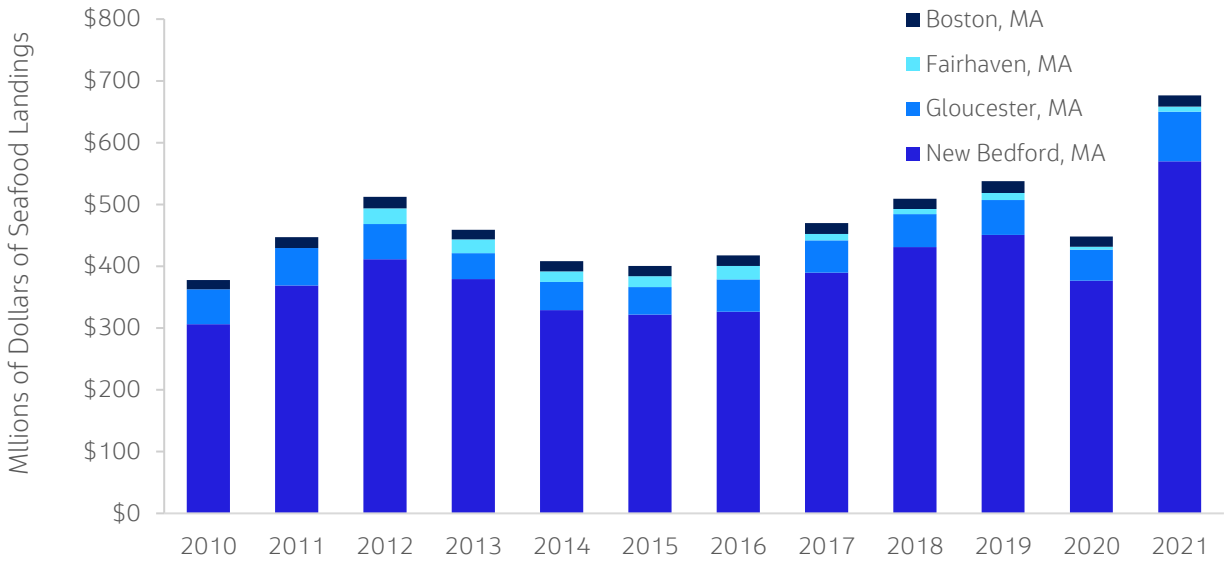
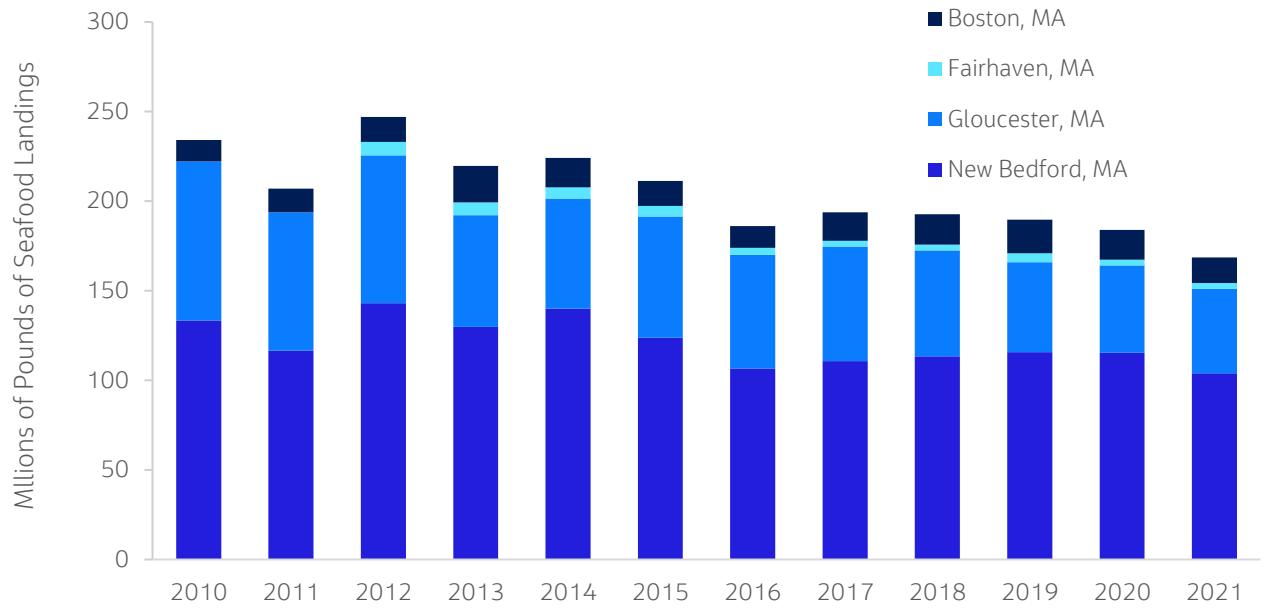


Figure 17. Pounds of Commercial Fishing Landings in Massachusetts by Port, 2010 to 2021

Source: NOAA Fisheries - Foreign Fishery Trade Data
Note: The dollar value of landings is reported as nominal (current at the time of reporting) values, and not adjusted for inflation.



Approximately 13,500 commercial fishing vessels operated in the Northeast region (including the coasts of Massachusetts, Connecticut, Maine, New Jersey, and Rhode Island) from 2015 to 2019, accounting for an annual average of $1.82 billion in gross landed value.[35] At the pandemic's peak, commercial harvesters in the Northeast region were instructed by seafood dealers/processors not to fish.

With the closure of restaurants, demand for much of the domestically consumed fresh seafood from the Northeast region's declined considerably. This decline greatly affected seafood dealers as they lost revenue from the seafood sold to these restaurants. Furthermore, seafood consumption habits shifted to frozen shelf-stable products to meet increased demand for at-home consumption, a change that greatly affected the industry.[35]

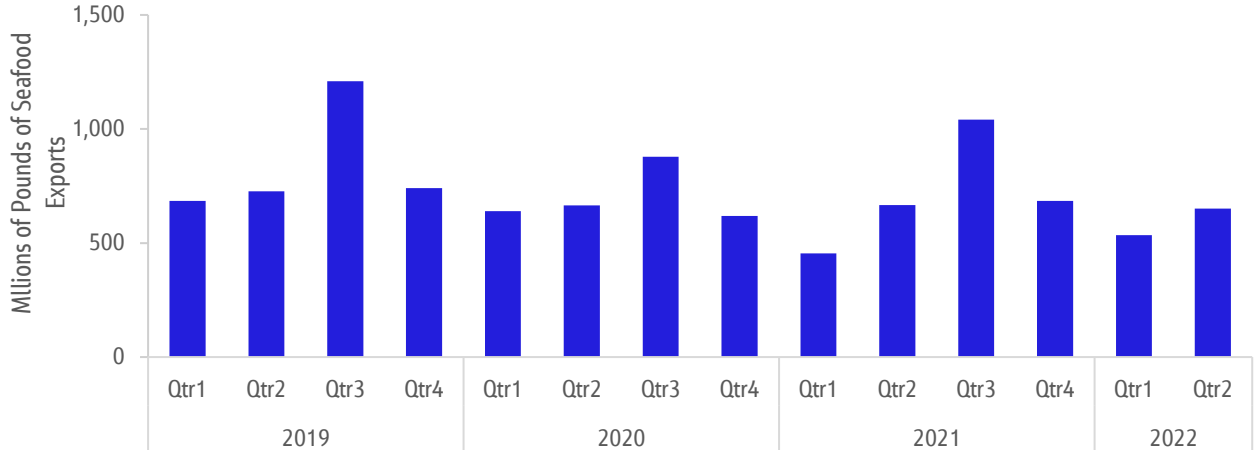
Fishing was the primary source of income for 63% of commercial harvesters surveyed in the Northeast. During the pandemic, compared to business operations from January to June of 2019, 17% reduced their number of trips, 60% experienced a lack of markets and low prices, 78% stopped fishing for some period, and 91% of commercial harvester operators had reduced revenue.[35] Among seafood dealers and processors, 85% reported reduced sales in January 2020, with revenues decreasing by 44%.[35]

US seafood exports also declined in value and volume during the pandemic's peak, reflecting limited seafood exports and a big downturn in restaurant sales. During the recovery, changes in seafood wholesale and retail markets resulted in a decline in the number of federally permitted dealers that purchased seafood. Additionally, climate change has caused vast shifts in aquatic populations, and threats such as overfishing have yielded increasingly strict regulations.[36]

As shown on **Figure 18**, the volume of fish exports from the US declined in 2020 and 2021 compared to 2019. Third-quarter peak volumes in 2020 and 2021 were 27 and 14% less than in 2019, respectively.

Figure 18. Quarterly Volumes of US Exports from January 2019

Source: NOAA Fisheries - Foreign Fishery Trade Data



Biomedical Industry

In 2019, Massachusetts led all US states in medical product exports as a percentage of total exports, with a value of $6.1 billion. Hospitals, nursing, and residential care were the largest contributors to the state's GDP, with about 500 medical-device manufacturing companies and a 25,000-person statewide workforce.

Before 2019, Massachusetts' medical device manufacturing industry struggled financially, with revenue falling in 2018 due to companies leaving the state. Average industry growth decreased by 1.2% between 2015 and 2020, according to IBISWorld's October 2020 report.

At the pandemic's peak, PPE supply shortages strained the medical equipment industry amid growing commercial demand. Numerous medical equipment companies experienced dramatic positive or negative shifts in product demand and investment as market priorities shifted during the early stages of the pandemic, favoring early diagnostic and preventative care services, particularly in the spreading and symptom mitigation of infectious diseases.

In March 2020, the Manufacturing Emergency Response Term (MERT) was formed to support Massachusetts manufacturers in producing materials in response to the COVID-19 pandemic. About $16.1 million in MERT grants were distributed to manufacturers. MERT focused on producing PPE such as N95 masks, surgical masks, face shields, test kits, and sanitizers. [37]

By April 2021, Massachusetts produced more than 15 million items through MERT support, including 10,000 ventilators, more than 9 million isolation gowns, more than 3 million N95 masks, and 5 million face shields, amongst other items.[38]

Cambridge-based biotech firm Moderna became one of the first companies in the world to gain regulatory approval for a COVID-19 vaccine. Telemedicine, video conferencing, and remote patient monitoring gained popularity during the recovery. In addition, widespread COVID-19 test deliveries were produced, and the testing equipment supply met demand in most areas.

In 2021 Massachusetts exported $2.7 billion worth of vaccines for human use, $1.14 billion worth of medical instruments and appliances, and $1.03 billion worth of filtering/purifying machinery for liquids.

Chemicals and Materials Industry

In 2019, there were 317 chemical establishments in Massachusetts employing 14,725 employees. Middlesex, Suffolk, Worcester, and Essex counties have the most employees and establishments in the chemicals sector.[19]

Before the pandemic, globalization led to raw materials being shipped from long distances, making the impact of regional issues on world trade more pronounced.[39] Disruptions from hurricanes, industrial

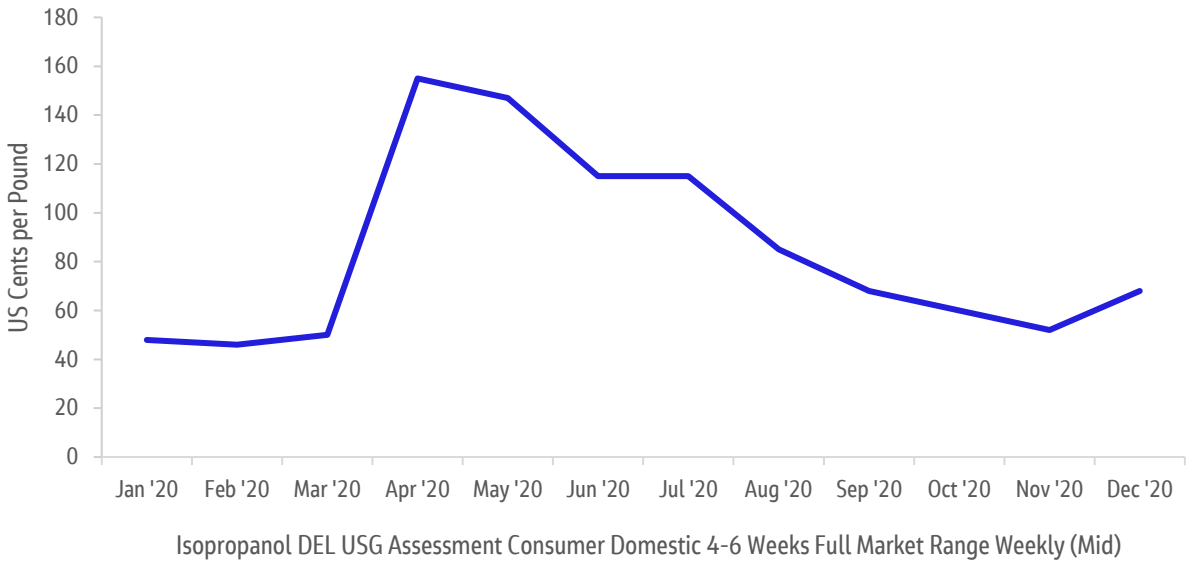
incidents, port closures, and regulatory changes are more frequent, with a greater impact on global supply chains. Lean manufacturing, focusing on minimizing waste while simultaneously maximizing productivity within manufacturing systems, became the preferred method of operation.[39]

Furthermore, growing consumer awareness of sustainability practices led energy and chemical companies to explore decarbonization technologies, reexamine their assets, and diversify away from hydrocarbons.

Isopropyl alcohol (IPA) is a commonly used disinfectant within pharmaceutics, hospitals, and electronics or medical device manufacturing settings.[40] US IPA suppliers include ExxonMobil, Dow Chemical, LyondellBasell, Monument Chemical, and Shell Chemical. The pandemic created a high demand for products such as hand sanitizer, which created shortages and drove the price of IPA to all-time highs in April 2020, as shown on **Figure 19**. IPA prices more than tripled in the US from 50 cents per pound ($1,103 per metric ton) in March 2020 to 150 cents per pound ($3,308 per metric ton) by April 2020.[41]

Figure 19. Isopropanol (IPA) Spot Prices

Source: Independent Commodity Intelligent Services

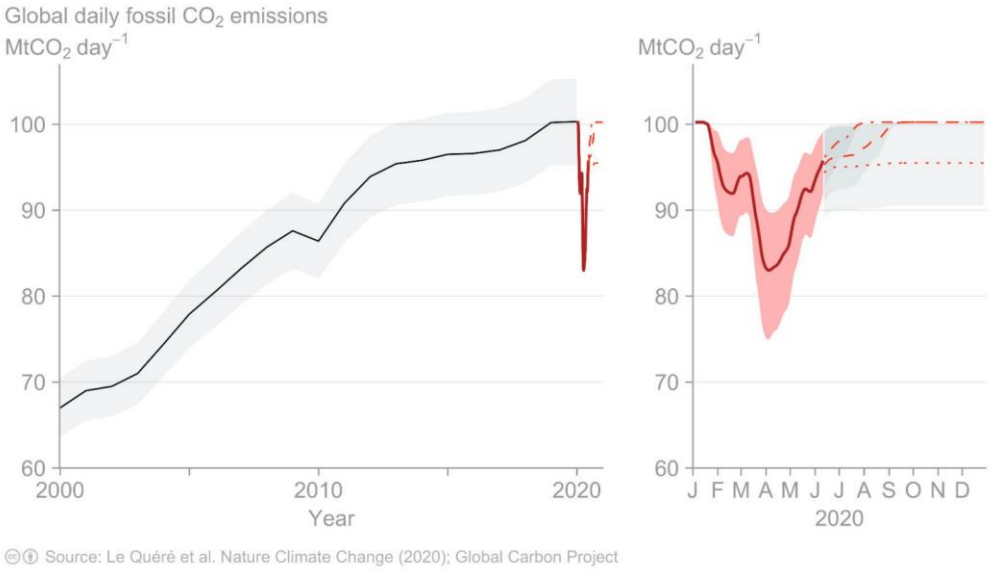


Decarbonization

Stay-at-home policies also significantly reduced carbon emissions and pollution globally, providing a glimpse of stringent decarbonization policies. **Figure 20** illustrates the global change in carbon dioxide emissions during the pandemic's peak. In the US, carbon dioxide levels were estimated to have dropped by about one-third for a week in April.[42] Though short-lived, lessons learned during this period can advise climate change policies.[43]

Figure 20. Global Daily Carbon Dioxide Emissions Plunged During the COVID-19 Pandemic as Countries Worldwide Issued Stay-at-Home Orders

Source: LeQuere et al., Nature Climate Change (2020), Global Carbon Project



Crude Oil Demand

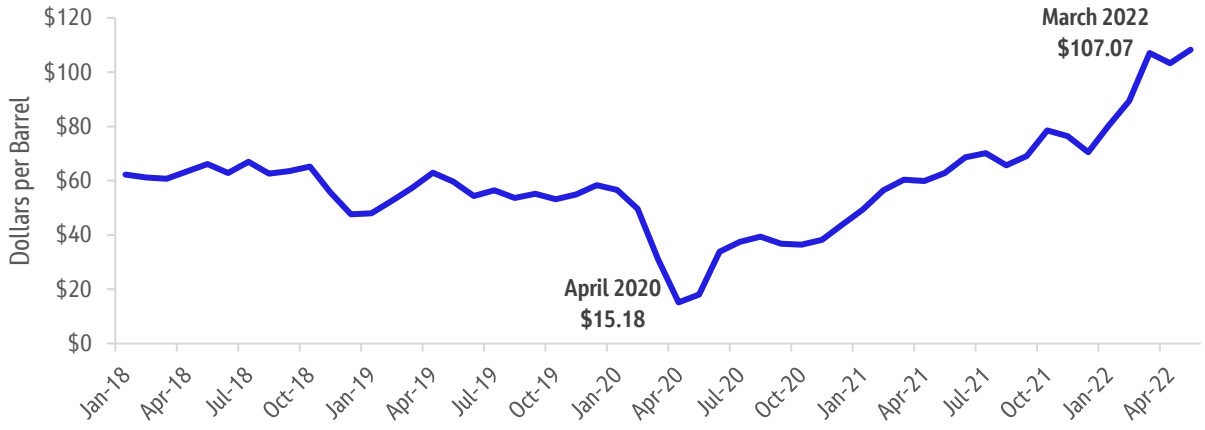
As shown on **Figure 21**, demand for crude oil dropped also significantly in March 2020 because of travel restrictions, resulting in a substantial price drop.

The collapse of oil prices exacerbated the oversupply situation faced by US chemical producers as it narrowed their feedstock cost advantage, making products less competitive in the global market. [44]

In the pharmaceutical industry, international export restrictions were instituted on active ingredients, posing a threat to vulnerable business models and presenting significant opportunities for growth and transformations.[45]

Figure 21. US Crude Oil First Purchase Price (Dollars per Barrel)

Source: US Energy Information Administration



Redundancy and Resiliency of Supply Chains During the Pandemic

Before the pandemic, companies focused on efficiency and reduced costs at the expense of building sufficient redundancy and flexibility in their supply chains. Just-in-time sourcing, for example, led to reduced inventory costs but also yielded insufficient inventory buffers. At the pandemic's peak, companies with insufficient redundancy and contractual obligations faced supplier delays because of labor shortages or insufficient resources.[46]

President Biden signed Executive Order 14017 on February 24, 2021, to assess critical supply chain vulnerabilities and strengthen resiliency in response to the supply chain crisis. Some areas of supply chain vulnerability examined by the administration include vaccine manufacturing, semiconductor chips, large-capacity batteries, critical minerals, cyber security, pharmaceuticals, and active pharmaceutical ingredients.[47]

Table 1 summarizes some of the strategies developed to address the identified vulnerable supply chains. These strategies benefit Massachusetts because of the state's investments in the high-tech, chemical, materials, and pharmaceutical industries.[48]

Table 1. Response Strategies for Vulnerable Supply Chains[48]

Product	Vulnerabilities	Response Strategy
Semiconductors	Reliance on imports because of lack of production capability in the US	▪ Proactively invest in domestic production, research, and development. ▪ Develop an ecosystem of innovative small, medium, and disadvantaged businesses. ▪ Workforce development. ▪ Engagement with partners and promoting global resilience.
Large capacity batteries	Reliance on importing the inputs for fabricated advanced battery packs	Increase domestic battery manufacturing while investing to scale the full lithium battery supply chain, including sourcing and processing the critical minerals used in battery production, end-of-life battery collection, and recycling.
Pharmaceuticals and active pharmaceutical ingredients	Dependence on imports for a range of key pharmaceutical products and active pharmaceutical ingredients.	Improve transparency, build emergency capacity, and invest in domestic production.

Critical minerals and materials	Reliance on China for critical minerals and materials necessary for national and economic security.	▪ Work with allies and partners to diversify supply chains away from adversarial nations and sources with unacceptable environmental and labor standards. ▪ Incentivize environmentally and socially responsible production from abroad. ▪ Investment in sustainable production, refining, and recycling capacity domestically, while ensuring strong environmental, environmental justice, and labor standards and meaningful community consultation, including with Tribal Nations through government-to-government collaboration.

China Caixin Manufacturing Purchasing Manager's Index

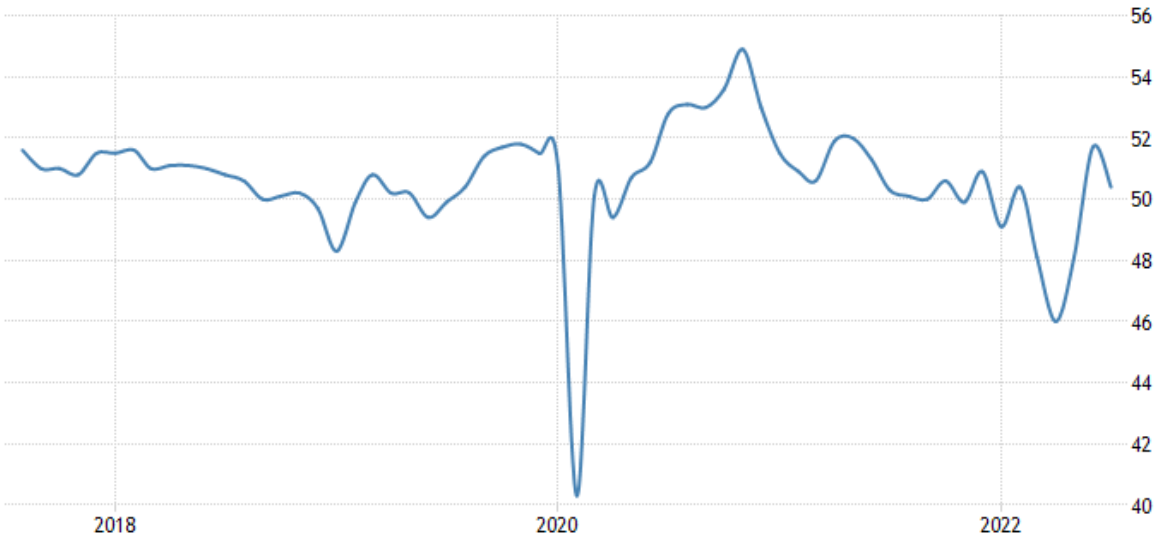
In China, the Caixin Manufacturing Purchasing Managers' Index (PMI) is a composite indicator that measures the overall performance of the manufacturing sector and is a leading indicator for the entirety of China's economy.[49] The Caixin PMI is computed from a survey of 430 private industrial companies. The PMI is derived from five various indexes, each with its weight contributing towards the overall numerical value. The indexes are as follows: new orders (30%), output (25%), employment (20%), suppliers' delivery times (15%)[50], and stock of items purchased (10%).

If the overall PMI reading is above 50, this indicates an expansion of the manufacturing economy compared to the previous month. A reading of 50 indicates no change, and a reading below 50 indicates a declining economy compared to the previous month.

As shown on **Figure 22**, when the pandemic initially hit in February 2020, the Caixin PMI dropped to 40.3, the lowest it had been in almost two decades. During this time, output, new orders, and employment reached all-time lows. In April 2022, the PMI dropped again, reflecting shutdowns of industrial plants across China because of its zero-tolerance policy for COVID-19 and concerns over supply disruptions from the Russia-Ukraine war. [51, 52]

Figure 22. China Caixin PMI Affected by Pandemic

Source: Trading Economics



Trucking Employment

Both local (short haul) and long-distance trucking have surpassed pre-pandemic levels. The strong growth in the trucking industry can be attributed to trucker wage increases. As shown on **Figure 23**, nationally, local trucking increased by 12% from 263,700 employees in June 2020 to 295,800 employees by June 2022 because of the strong demand for e-commerce transportation. In comparison, recovery for long-haul trucking took much longer since the pandemic's peak. However, in June 2022, long-haul trucking employment had increased by 11% from 741,100 to 823,600, surpassing pre-pandemic levels.

Figure 24 shows truck driver hourly wages have grown significantly since 2018. Wages for long-distance trucking saw a steep jump during the pandemic's peak because of the high demand for truckers amid a labor shortage. This strong growth continued through 2021 and 2022, with another steep jump in early 2022, likely because of rising inflation.

Figure 23. General Freight Employment, Local (NAICS 48412) and Long Distance (NAICS 48411) Trucking (Seasonally Adjusted)

Source: US Bureau of Labor Statistics

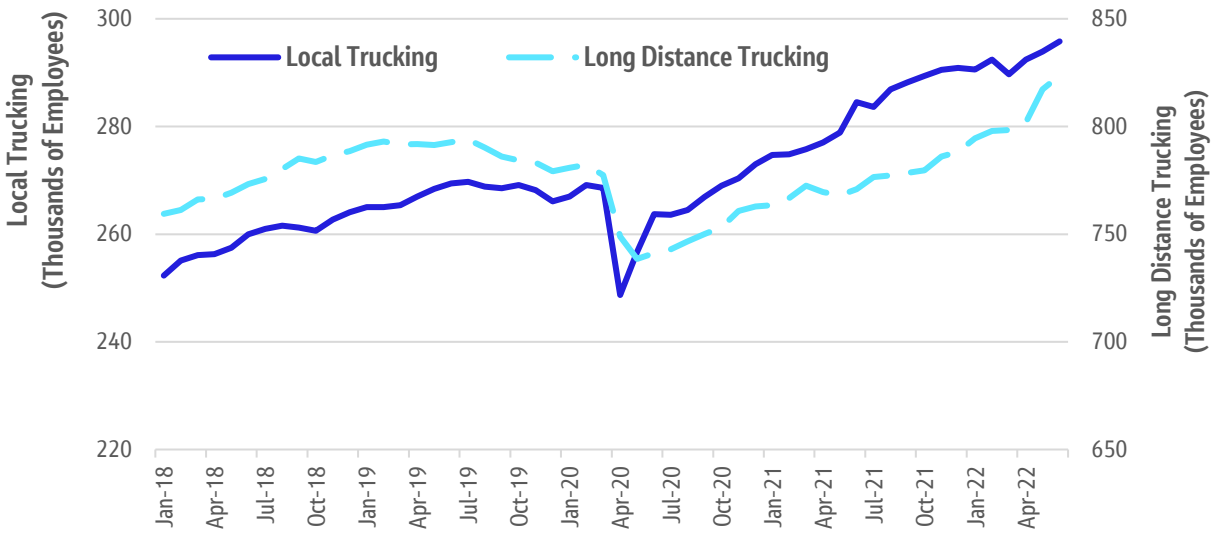
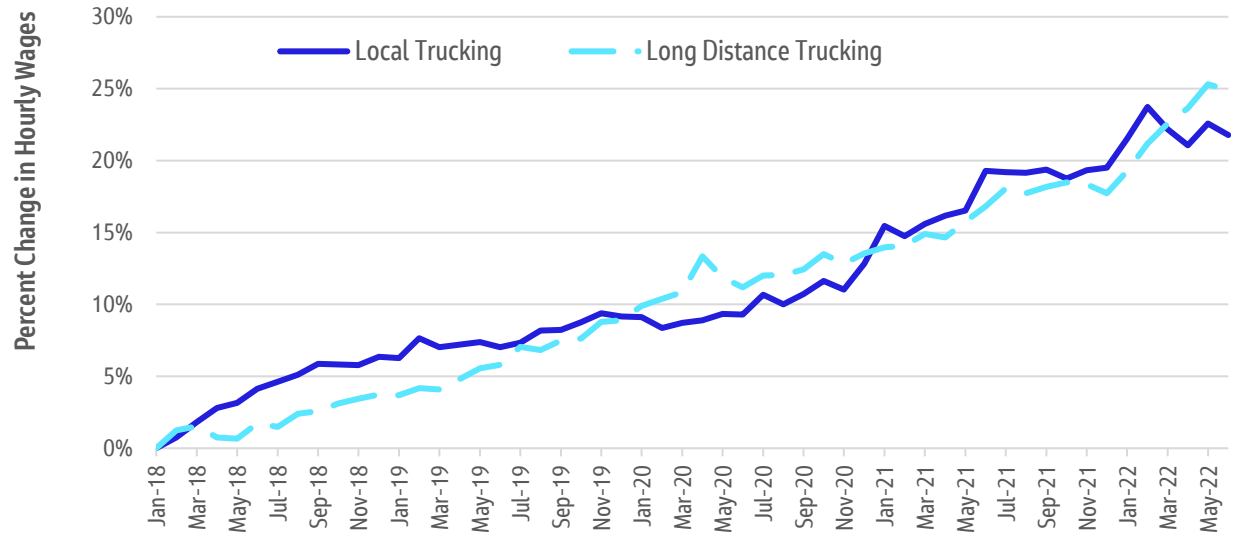


Figure 24. Percent Change in Hourly Wages, Local (NAICS 48412), and Long Distance (NAICS 48411) Trucking (Seasonally Adjusted)

Source: US Bureau of Labor Statistics

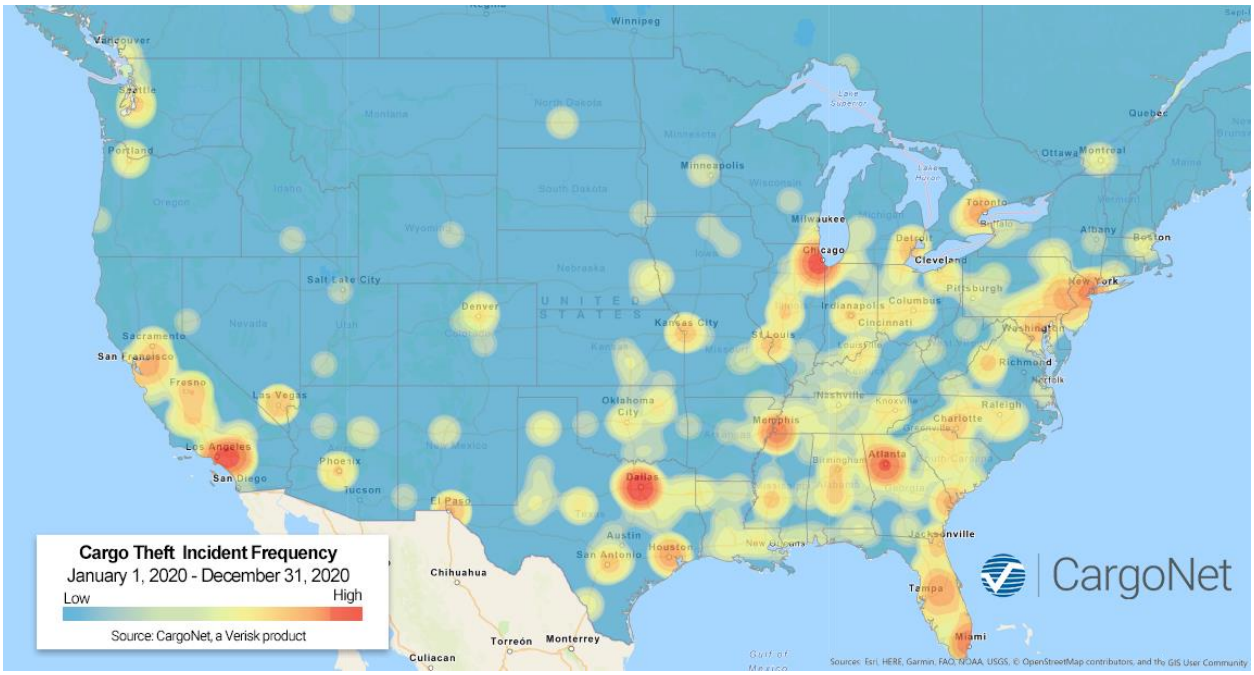


In response to the pandemic, the Federal Motor Carrier Safety Administration (FMCSA) issued an emergency declaration, including extensions of the initial declaration, that suspended the hours-of-service regulation for motor carriers and drivers. This declaration provided regulatory relief for drivers providing direct assistance in support of emergency relief efforts related to COVID-19 and was limited to the transportation of specific goods.[53]

Supply Chain Thefts and Fraud During the Pandemic

Supply chain fraud covers many topics, including intellectual property theft, kickbacks on raw material purchases, free trade zone fraud, inventory fraud, sanction violations, and fake business listings.[54] Supply chains are inherently vulnerable to fraud because of companies' geographical reach, the operation environment's complexity, and the volume of daily transactions.[55] The pandemic created challenges for supply chain managers as the opportunities for fraud were fraught because of resource scarcity, panic buying, and the overall volatility in supply and demand during the pandemic's peak. For example, in the early stages of the pandemic, demand for face masks, hand sanitizer, and disinfectants outpaced supply, creating a market shortage. This resulted in higher prices and an increase in counterfeit products.[56] Growth in online sales also created opportunities for hackers to impersonate and steal customer data. **Figure 25** depicts the nationwide supply chain risk incident frequency for 2020.

Figure 25. Supply Chain Risk Incident Frequency, 2020
Source: CargoNet



In 2020, CargoNet reported 1,676 supply chain risk events across the US and Canada. These events represented a 16% increase in activity in comparison to 2019. 48% of events involved the theft of at least one heavy commercial motor vehicles such as a semi-tractor, semi-trailer, or intermodal chassis or container. 61% of events involved the theft of cargo or attempted theft of cargo. The average cargo theft was worth $166,334 in 2020 and increased by $27,045 from 2019 in part due to increased theft of expensive shipments of pharmaceuticals and medical supplies related to the COVID-19 pandemic. Truck stops and retailer parking lots were the most common locations for theft to occur. Most stolen items included household goods such as major

appliances, cleaning supplies, and furniture. Food, alcoholic beverages, pharmaceutical, and medical supplies were some of the items with increased theft in comparison to 2019.

In 2021, theft incidents decreased to 1,285; the top targeted commodities were electronics and household goods. The top targeted locations were truck stops, warehouses, and distribution centers. The estimated total loss of items due to incidents in the US was $57.9 million.
- 2020 and 2021 Supply Chain Risk Trends Analysis, by Verisk.

Key Takeaways from the Literature Review

When examined as an isolated event, the COVID-19 pandemic disrupted "normal" life and created global, national, and regional challenges for various freight-intensive industries. Other global events, such as the Russia-Ukraine war, prolong the recovery from the pandemic. Variants of the virus also continue to play a central role in intensifying supply chain pressures as countries like China implement a zero-COVID policy. Business closures, unemployment, hybrid workplaces, labor shortages, disrupted supply chains, increased cost of living, and record inflation are some of the few short to long-term effects of the pandemic.

Tables 2, **3**, **4,** and **5** summarize key takeaways from the literature review. The summaries are rated by severity, the anticipated period of impact, and observations from the recovery as it pertains to the anticipated impact period. Short-term is 1 to 3 years, medium-term is 3 to 5 years, and long-term is more than 5 years.

Table 2. Infrastructure

Infrastructure Impacts	Severity of Impact	Anticipated Period of Impact	Observation from the Recovery
Physical retail decline	High	Short term	Stores are reopening their doors to shoppers.
Increased demand for warehousing facilities for e-commerce	High	Short to medium term	Record inflation is slowing down consumer purchasing behavior
Demand for dedicated truck parking	High	Medium to long term	Provisions continue to be made to expand truck parking facilities

Table 3. Operations

Operational Impacts	Severity of Impact	Anticipated Period of Impact	Observation from the Recovery
Demand for air cargo deliveries	Medium	Short to medium term	Labor shortages continue to be of concern during the recovery
24-hour port operations	High	Short to medium term	Diversion of ships to less congested ports
Canceled ocean carrier calls to the Port of Boston	High	Short to medium term	Container volumes continue to decline as of 2021 despite the infrastructure improvements
Decreased demand for seafood	High	Short to medium term	Seafood landings are yet to recover to pre-pandemic levels
Delays in order fulfillment due to chip shortage	High	Medium to long term	The CHIPS Act and private-sector investments would help curb the chip shortage

Table 4. Federal and State Policies

Policy Impacts	Severity of Impact	Anticipated Period of Impact	Observation from the Recovery
Vaccinations, testing, and mask requirements	High	Short to medium term	Effective in curbing the spread of the coronavirus.
Hours of service emergency declarations by FMCSA	Medium	Short term	Hours of service regulations would be reintroduced for road safety reasons

Table 5. Workforce

Workforce Impacts	Severity of Impact	Anticipated Period of Impact	Observation from the Recovery
Unemployment	High	Short to medium term	Recent legislation such as CHIPS Act and IIJA provides opportunities for job creation.
Labor shortages	High	Medium to long term	Area of concern for the long-term

IIJA = Infrastructure Investment and Jobs Act

Quantitative Analysis

A deep dive into some of the literature review findings was conducted through a quantitative analysis of the pandemic's impact on Massachusetts. The quantitative analysis examined socio-economic, infrastructure, and operational indicators that determine the short- to medium-term effects of the pandemic on the Commonwealth. Indicators examined include changes in population, GDP, employment, and traffic patterns. Demand for warehouses, port operations, air cargo, and bottleneck locations are also examined.

Population Changes

The population of Massachusetts increased by approximately 482,300 residents (7%) between the 2010 census and the 2020 census, as shown in **Figure 26**. Counties projected to have the greatest increase were Suffolk (32%), Dukes (20%), Nantucket (20%), Norfolk (19%), and Middlesex (16%). **Figure 27** shows a breakdown of the census and projection data by county between 2010 and 2040.

Pre-pandemic population trends illustrated increasing urbanization within the state, whether by natural or migratory growth. ***During the pandemic, this trend was abruptly reversed.***

Between 2010 and 2020, population growth was highest in urban areas with already high population densities, such as Boston and Worcester. Simultaneously, rural population growth was low overall, especially in the more sparsely populated regions of Western Massachusetts (see **Figure 28**). Overall, pre-pandemic population trends illustrated increasing urbanization within the state, whether by natural or migratory growth. During the pandemic, this trend was abruptly reversed.

Figure 26. Population Growth from 2010 to 2040

Source: US Census Bureau, UMass Donahue Institute

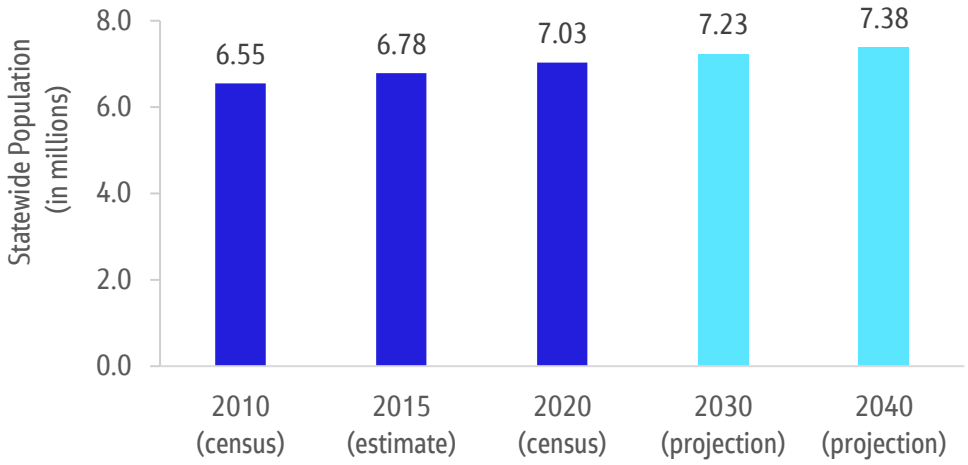


Figure 27. Population Change by County from 2010 to 2020

Source: US Census Bureau, UMass Donahue Institute

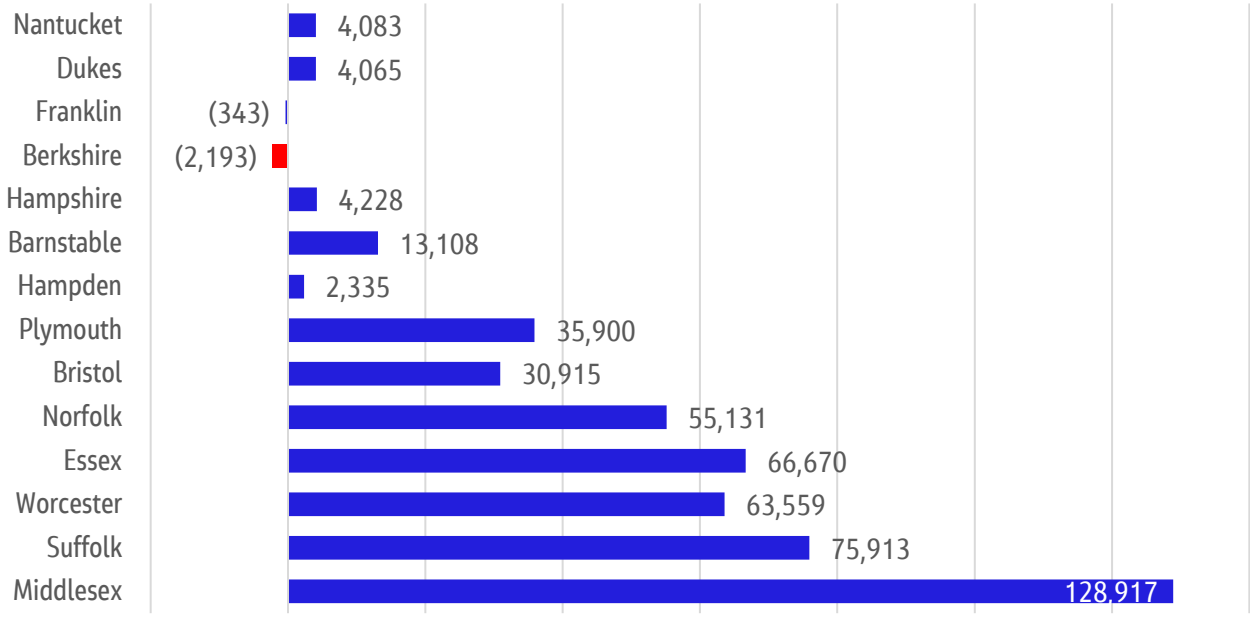
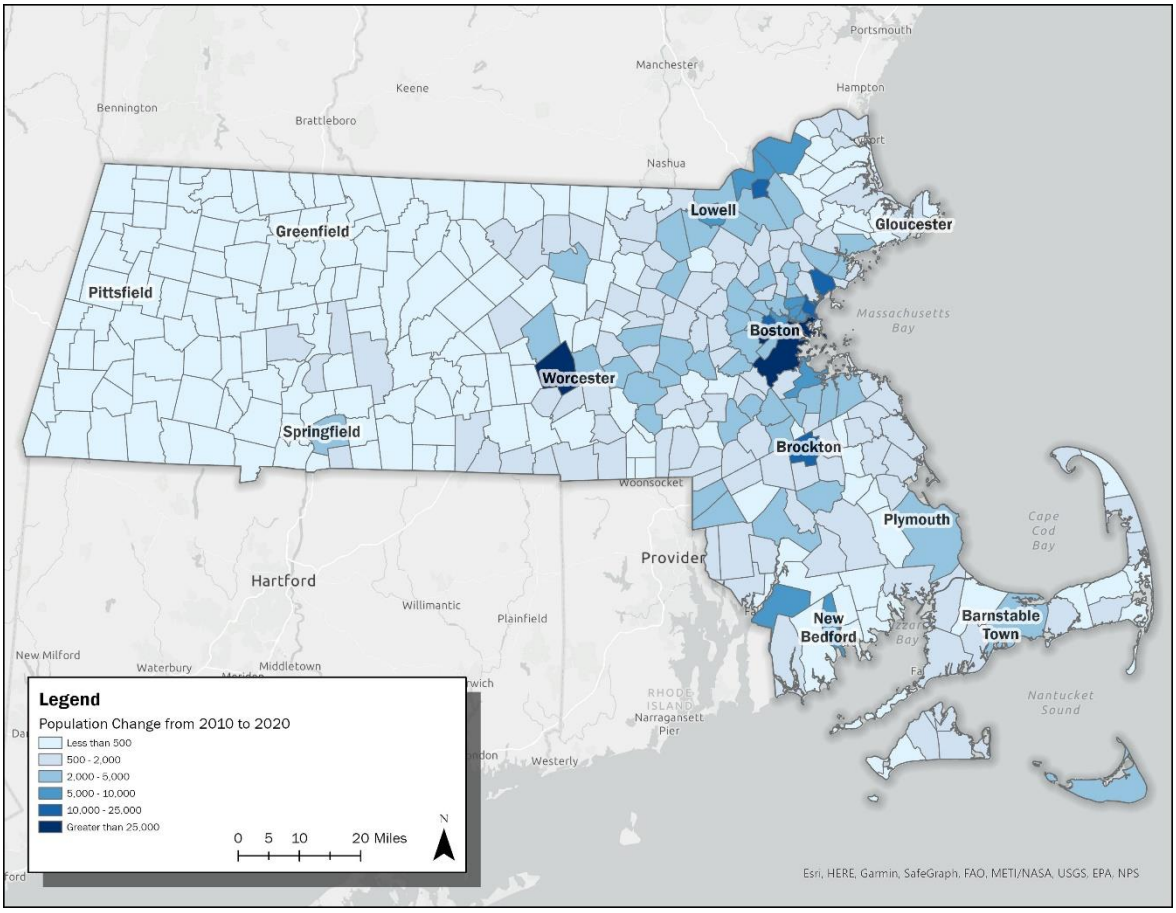


Figure 28. Change in Population in Cities and Towns in Massachusetts, 2010 to 2020

Source: US Census Bureau



From July 2020 to July 2021, Boston led all cities in Massachusetts in population decrease (2.9%), followed by Newton (-1.3%), Somerville (-1.3%), Framingham (-1.2%), and Lowell (-1.1%), as shown in **Table 6**. Compared nationally, Boston ranked 8th numerically in declining US city populations from July 2020 to July 2021.

Table 6. Change in Population in the Largest Cities in Massachusetts, July 2020 to July 2021
Source: US Census Bureau

Name	1-Jul-20	1-Jul-21	Difference	Percent difference
Boston	674,272	654,776	-19,496	-2.9
Newton	88,624	87,453	-1,171	-1.3
Somerville	80,842	79,815	-1,027	-1.3
Framingham	72,162	71,265	-897	-1.2
Lowell	115,264	113,994	-1,270	-1.1
Lawrence	89,024	88,508	-516	-0.6
Springfield	155,556	154,789	-767	-0.5
Cambridge	117,699	117,090	-609	-0.5
Quincy	101,606	101,119	-487	-0.5
Haverhill	67,690	67,361	-329	-0.5
Lynn	101,118	100,843	-275	-0.3
Worcester	206,242	205,918	-324	-0.2
Brockton	105,579	105,446	-133	-0.1

Nationally, growth slowed in some of the biggest cities in the US except in some states that experienced an uptick in population due to migration.[57] The exodus from large cities to smaller cities and towns was widely attributed to policies and lifestyle changes initiated by the COVID-19 pandemic. It is unknown, however, whether these changes will continue in the long term.

Gross Domestic Production Impacts

Before the COVID-19 pandemic, statewide GDP in Massachusetts was increasing at an annual computed rate of 2.55%. In 2019, the largest contributor to GDP by county was Middlesex, followed by Suffolk, Norfolk, Essex, and Worcester. At the peak of the pandemic, Massachusetts experienced a decrease in real GDP from 2019 to 2020. As shown on **Figure 29**, the percent change from 2019 to 2020 ranged from -1.75% to -9.99%. Counties across Massachusetts experienced varying changes in real GDP—Middlesex County declined the least of all counties with a percent change of -1.75%. Following Middlesex County, real GDP in Worcester County declined by -2.8% and in Suffolk County by -3.7%. Nantucket County had the highest change in real GDP from 2019 to 2020, declining by -9.9%.

Figure 29. Percent Change in Real GDP (in 2012 US dollars) from 2019 to 2020

Source: Bureau of Economic Analysis, GDP by County, Metro, and Other Areas, May 2022

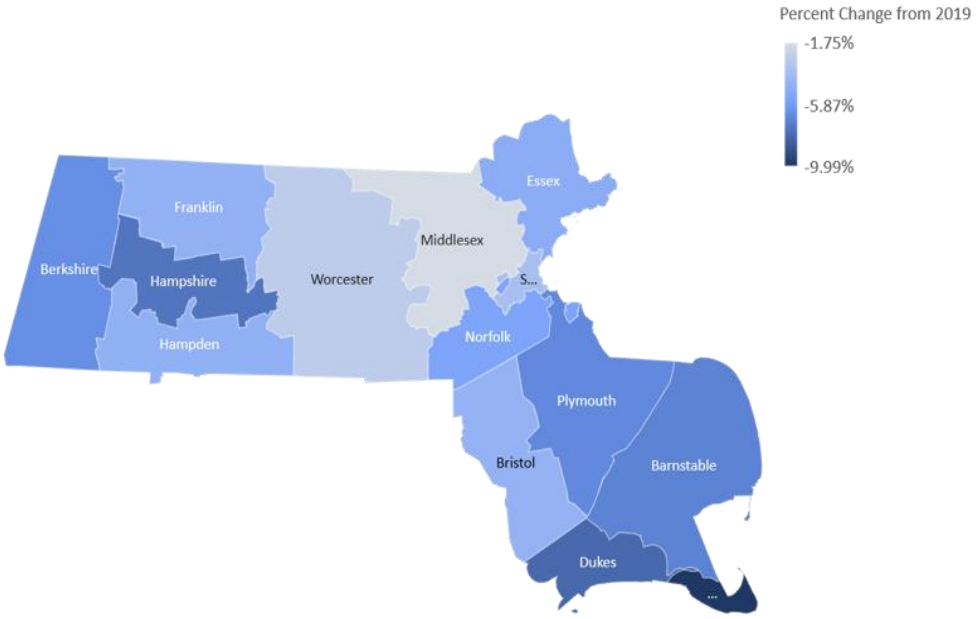
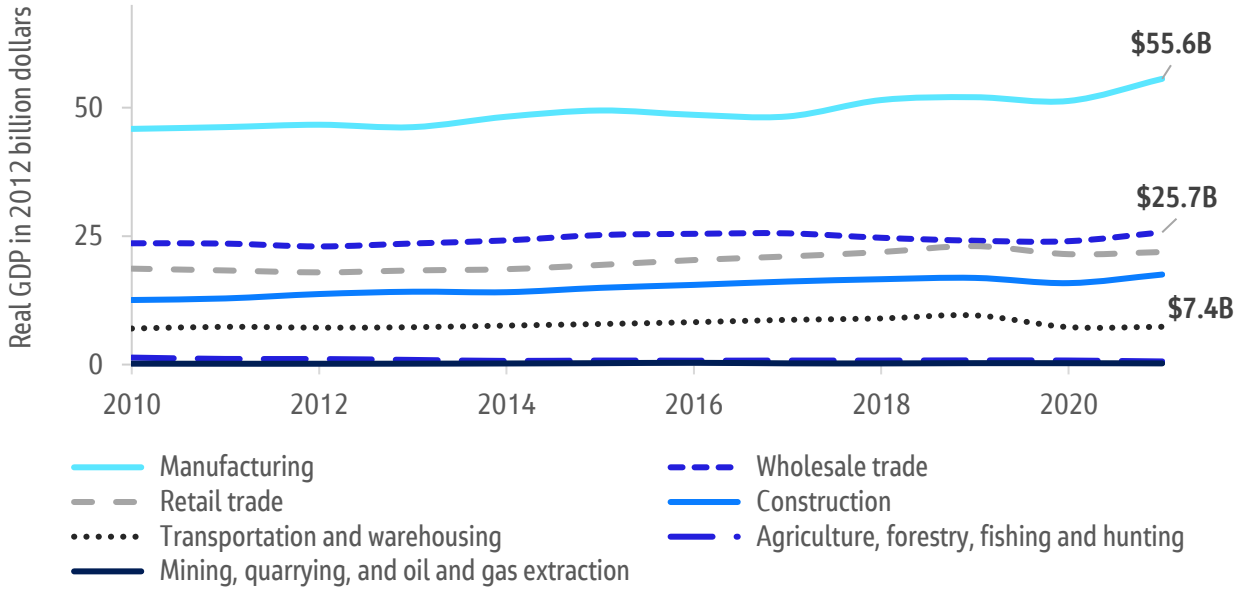


Figure 30 demonstrates how varying freight-intensive industries contribute to statewide GDP Manufacturing is the leading freight-intensive industry for GDP, contributing over 10% of the state's GDP from 2012 to 2020. From 2019 to 2020 every industry except for manufacturing and wholesale trade experienced a decline in percent contribution to GDP. Retail trade and construction GDP declined by -0.1% and transportation and warehousing declined by -0.4%.

Figure 30. GDP Contribution by Freight Intensive Industries (2010-2021)

Source: Bureau of Economic Analysis, GDP by Industry



Retail trade's decline in 2020 could be attributed to brick-and-mortar store closures. Transportation and warehousing's decline could be attributed to labor shortages in the transit, aviation, and support activities for transportation sectors because of travel restrictions. Overall, the total GDP of freight-intensive industries' contribution to Massachusetts declined by -0.2%.

Manufacturing

Manufacturing and wholesale trade's resilience during the pandemic can be attributed to computer and electronic product manufacturing, chemical manufacturing, and growth in e-commerce during the pandemic's peak (see **Figure 31**). When looking at the top 10 locations in Massachusetts for manufacturing, as shown in **Table 7**, Andover has the highest number of employees followed by Boston, Marlborough, and Billerica. Manufacturing in Andover is dominated by 'blue chip' science and technology employers such as Pfizer and Raytheon.

Table 7. Change in Number of Employees for Top 10 Cities for Manufacturing
Source: Mass.gov Labor Market Information (LMI)

City	2019	2020	Percent Change from 2019 to 2020	2021	Percent Change from 2019 to 2021
Andover	9,385	9,217	-2%	9,274	-1%
Boston	7,616	6,729	-12%	6,861	-10%
Marlborough	6,172	6,537	6%	6,538	6%
Billerica	4,908	5,013	2%	4,894	0%
Wilmington	4,974	4,788	-4%	4,762	-4%
Fall River	4,608	4,575	-1%	4,651	1%
New Bedford	5,059	4,263	-16%	4,543	-10%
Worcester	5,393	4,812	-11%	4,533	-16%
Lawrence	4,350	4,021	-8%	4,253	-2%
Chelmsford	3,904	3,936	1%	4,121	6%

Andover, Billerica, and Fall River saw minimal changes in 2020 and 2021 in comparison to 2019. Marlborough and Chelmsford experienced a 6% increase in manufacturing employees from 2019 to 2021. Other places such as Boston, New Bedford, and Worcester saw declines in employment in 2020 and 2021. Overall, the state lost on average 12,777 employees in the manufacturing industry. **Table 8** summarizes the top 10 locations with the highest number of job losses in manufacturing and **Table 9** summarizes the top 10 locations with an increased number of employees in manufacturing from 2019 to 2021. The differences in these trends around Massachusetts could be attributed to the dominant industries in each location.

Figure 31. Change in GDP Contribution for Manufacturing Industries (2019 to 2020)

Source: Bureau of Economic Analysis, GDP by Industry

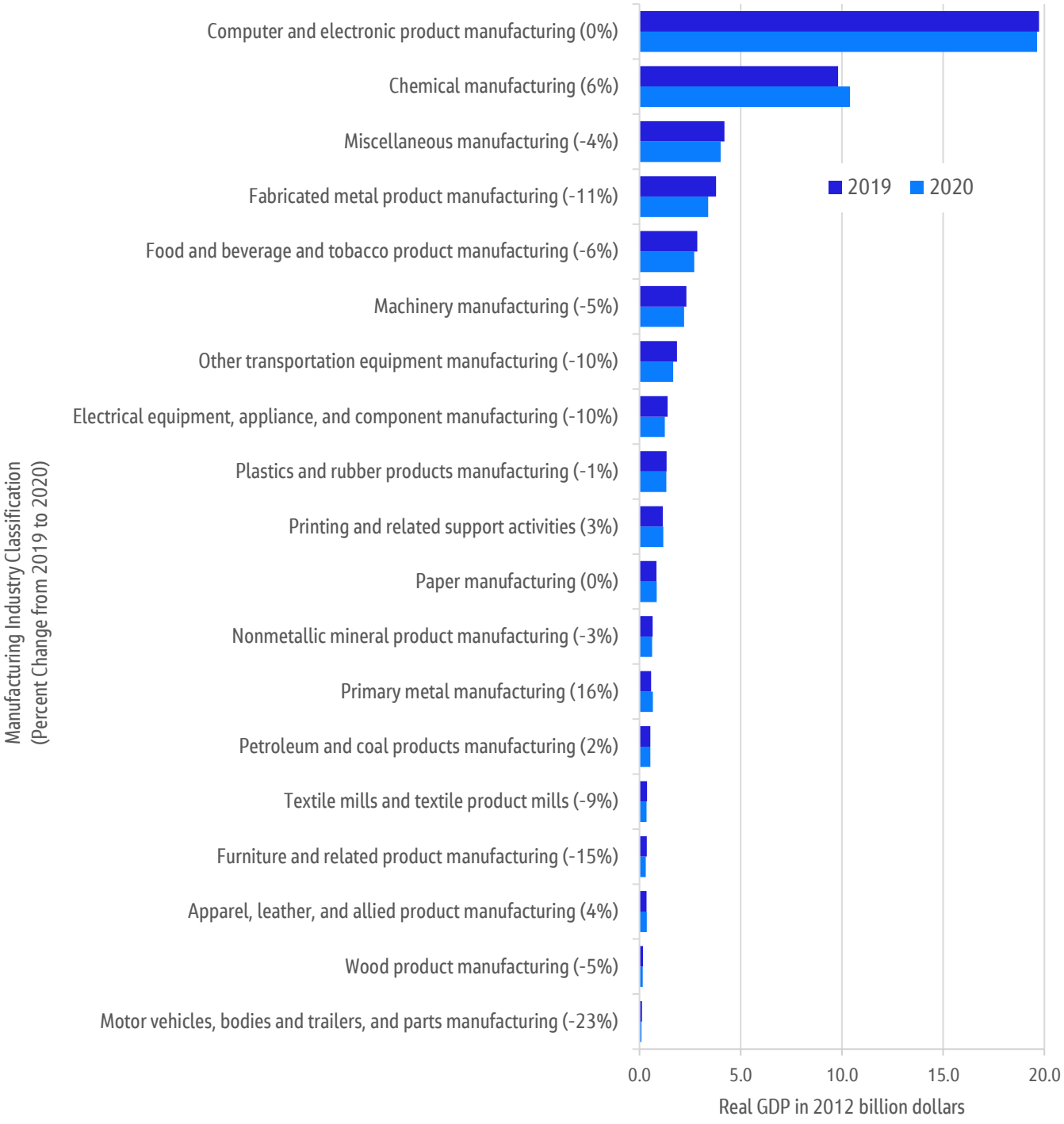


Table 8. Top 10 Locations with Highest Decline in Number of Employees in Manufacturing from 2019 to 2021

Source: Mass.gov Labor Market Information (LMI)

City	2019	2020	Change from 2019 to 2020	2021	**Change from 2019 to 2021**	Percent Change from 2019 to 2021
Worcester	5,393	4,812	-581	4,533	-860	-16%
Boston	7,616	6,729	-886	6,861	-754	-10%
Framingham	3,130	2,769	-361	2,478	-652	-21%
Haverhill	3,537	3,133	-404	3,008	-529	-15%
Canton	1,639	1,166	-473	1,114	-525	-32%
New Bedford	5,059	4,263	-796	4,543	-516	-10%
Raynham	2,011	1,888	-123	1,560	-451	-22%
Franklin	3,724	3,444	-280	3,286	-438	-12%
Lowell	3,301	2,972	-329	2,922	-379	-11%
Pittsfield	1,816	1,533	-283	1,448	-368	-20%

Table 9. Top 10 Locations with Highest Increase in Number of Employees in Manufacturing from 2019 to 2021

Source: Mass.gov Labor Market Information (LMI)

City	2019	2020	Change from 2019 to 2020	2021	**Change from 2019 to 2021**	Percent Change from 2019 to 2021
Springfield	3,412	3,632	220	3,911	499	15%
Marlborough	6,172	6,537	365	6,538	366	6%
Acton	1,801	1,912	111	2,073	272	15%
West Boylston	216	322	105	481	265	122%
Chelmsford	3,904	3,936	32	4,121	218	6%
Beverly	1,903	1,894	(9)	2,075	172	9%
Harvard	1,660	1,690	30	1,819	159	10%
Waltham	3,132	3,206	73	3,272	139	4%
West Bridgewater	799	802	3	932	133	17%
Westborough	1,877	1,887	10	2,004	127	7%

Transportation & Warehousing

The transportation and warehousing industry classification (NAICS 48-19) is comprised of employees working in the air, water, truck, transit, port, rail, pipeline, tourism, courier, and warehousing sectors. As shown on **Figure 32**, transportation and warehousing's decline during the pandemic's peak can be attributed to labor shortages in the transit, aviation, and support

activities for transportation sectors. These sectors were significantly impacted by the pandemic due to travel restrictions. Statewide GDP of air transportation, transit, water, and rail declined by 63%, 32%, 30%, and 22% respectively (see **Figure 33**).

Figure 32. Transportation and Warehousing Industry Employees (2019 to 2021)

Source: Mass.gov Labor Market Information (LMI)

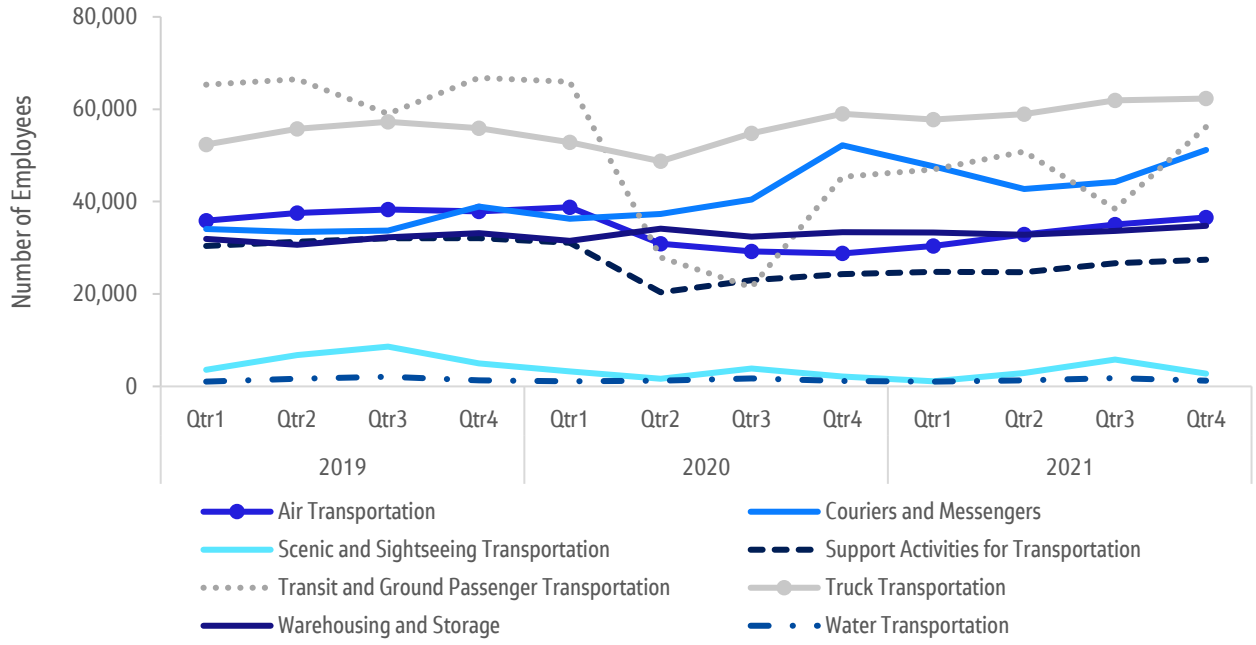


Figure 33. Change in GDP Contribution for Transportation and Warehousing Industries (2019 to 2020)

Source: Bureau of Economic Analysis, GDP by Industry

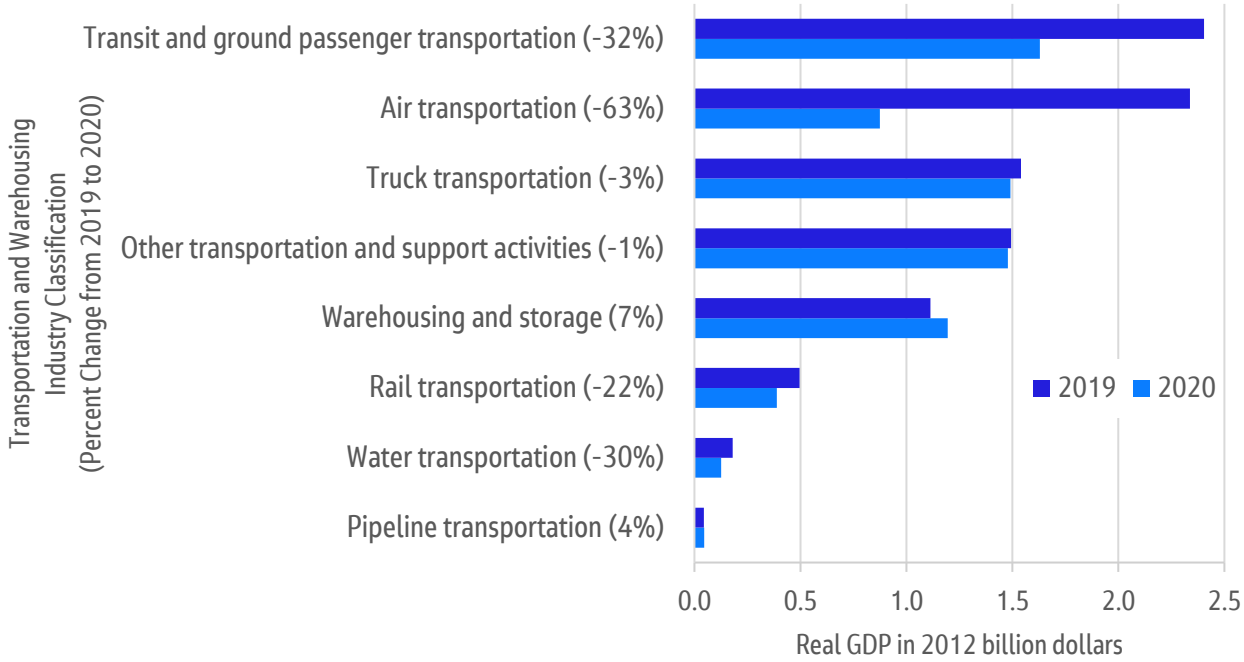


Figure 34 illustrates the transportation and warehousing industry from 2019 to 2021 for the top five cities by the number of employees and compares monthly changes. In 2019, the number of employees in transportation and warehousing in Boston increased from about 27,000 in January to a peak of 29,000 by the summer period, likely due to tourism. From March to July 2020, during the pandemic's peak, there was a decrease in the number of employees. Although the number of employees has been increasing again in Boston, it has yet to meet pre-pandemic levels. In North Reading, the number of employees also decreased in 2020 but recovered in 2021.

Figure 34. Change in Number of Employees Transportation and Warehousing: Top 5 Locations

Source: Mass.gov Labor Market Information (LMI)

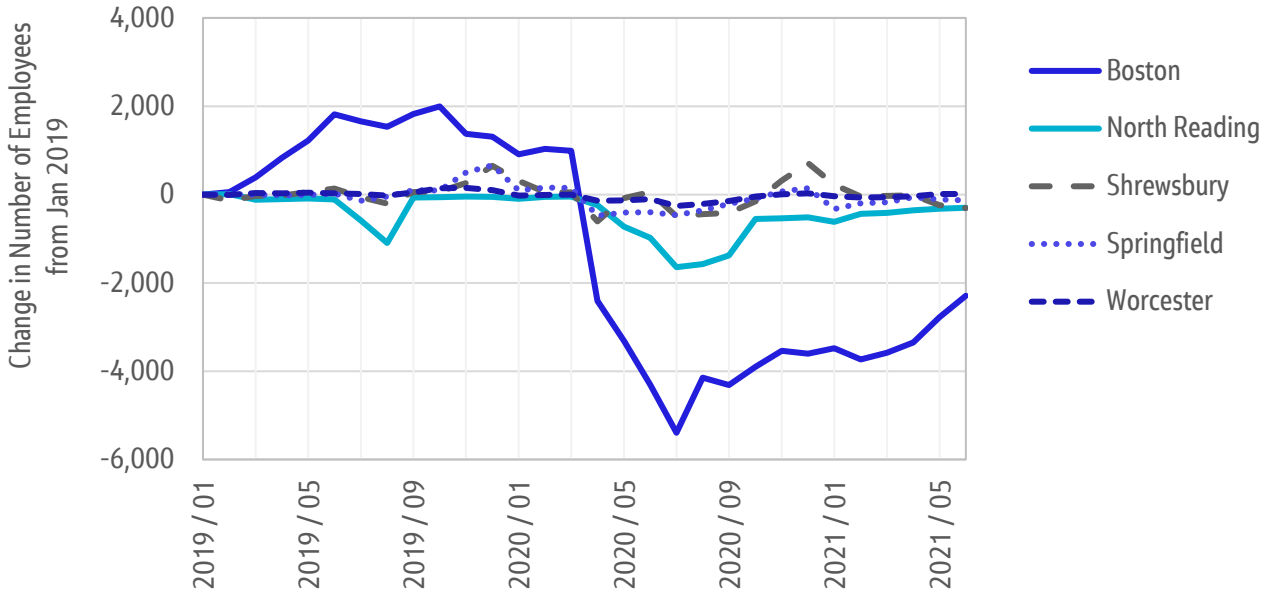


Figure 35 represents the top 5 locations with the highest number of employees per establishment for transportation and warehousing. As shown all locations experienced a decline from 2019 to 2021 and subsequently in the first 6 months of 2021. Despite the decline in the number of employees, there was an increase in average weekly wages from 2019 to 2021, as shown in **Figure 36.**

Figure 35. Transportation and Warehousing Employees per Establishment: Top 5 Locations

Source: Mass.gov Labor Market Information (LMI). ***Note:*** *2021 data represents Q1 and Q2*

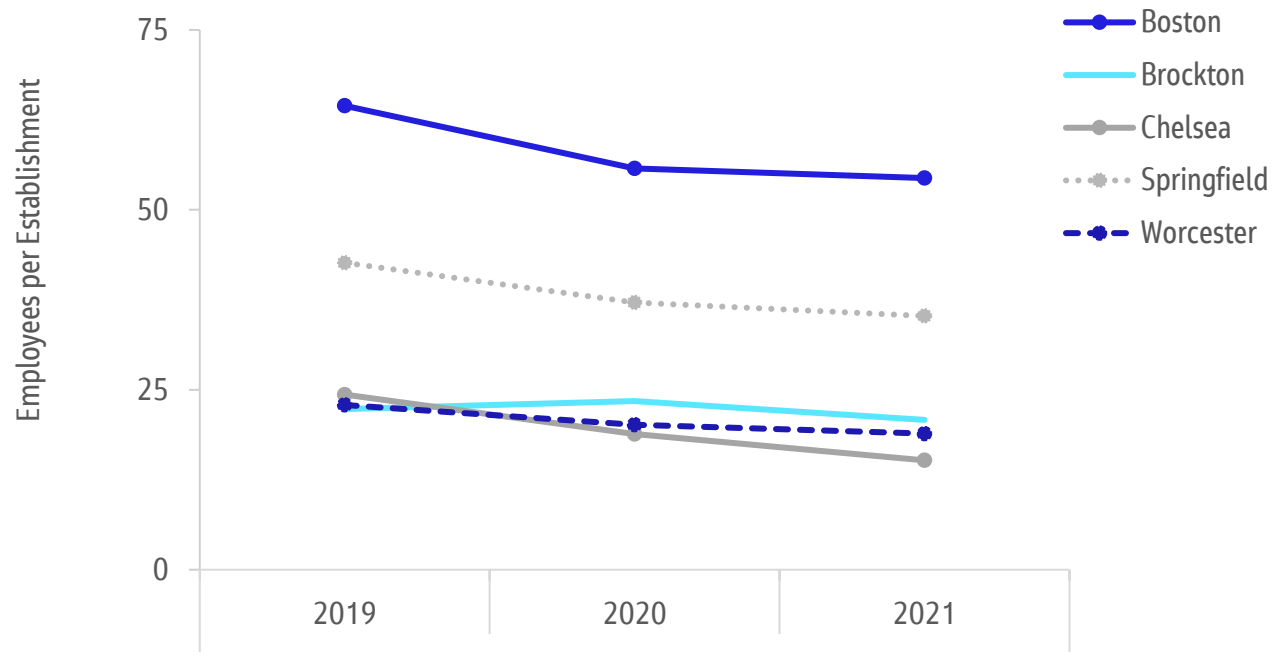
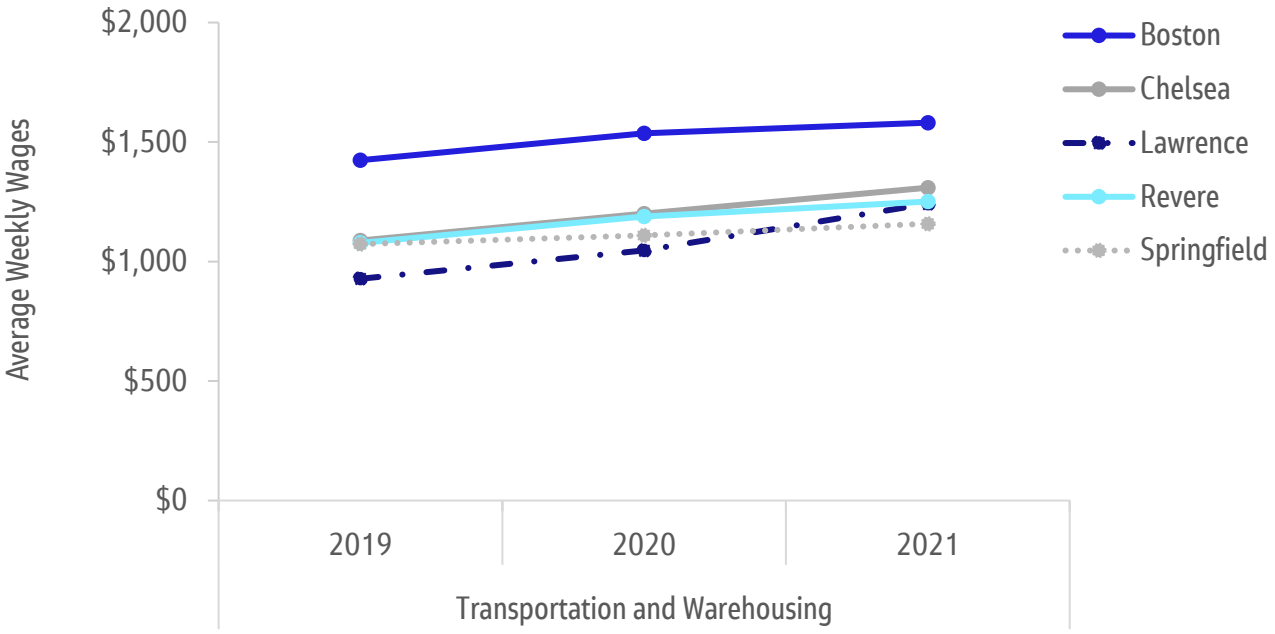


Figure 36. Transportation and Warehousing Average Weekly Wages: Top 5 Locations

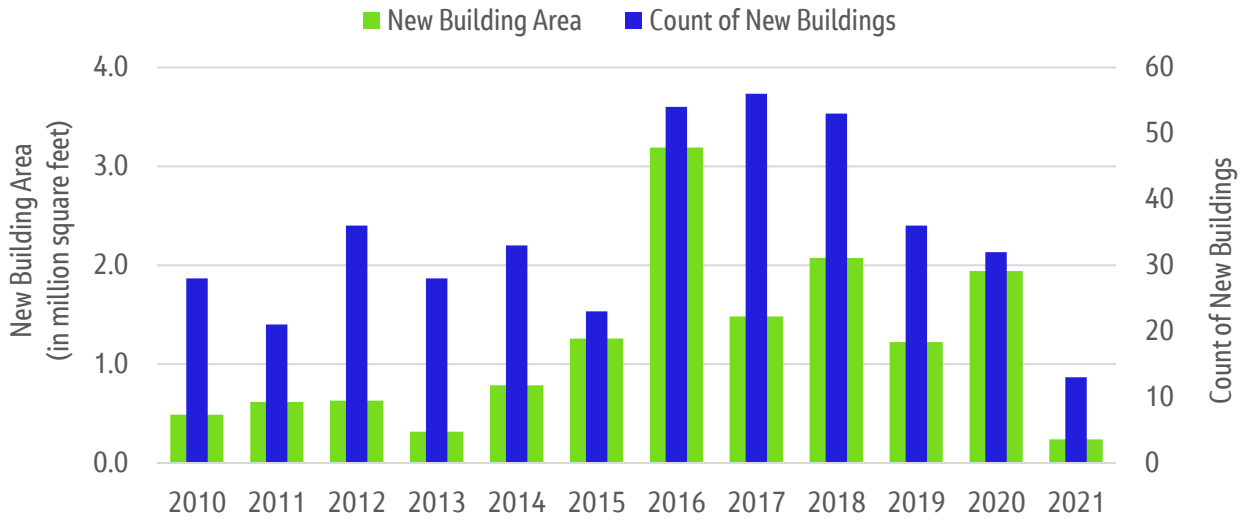
Source: Mass.gov Labor Market Information (LMI) ***Note:*** *2021 data represents Q1 and Q2*



E-Commerce

E-commerce's popularity grew amongst consumers as many retail shops closed their doors during the pandemic's peak. **Figure 37** represents new buildings and building areas in Massachusetts from 2010 to 2021. From 2016 to 2018 there was a significant increase in the number of warehouses compared to prior years and likely due to growth in e-commerce.[58] The trend slowed down in 2019 and 2020 though the sum of new building area was the third highest since 2010. The highest number of new warehouses in 2020 was three each in Norton, Northborough, Bridgewater, Worcester. and Marlborough as summarized in **Table 10.** Some of the new facilities built in 2020 include a new Amazon distribution center in Northborough and the Blue Star Business Park in Norton.

Figure 37. New Warehouse Building Area and Count by Year – 2010 to 2021
Source: Property Tax Parcels, Bureau of Geographic Information (MassGIS)



In August 2022, Amazon announced that it is closing five of its delivery warehouses in Dedham, Everett, Mansfield, Milford, and Randolph to consolidate its operations in the state and cope with overgrowth during the COVID-19 pandemic. It also mentioned that consumer demand patterns have stabilized. However, Amazon recently opened a new location in Bridgewater focused on same-day deliveries and plans on opening additional grocery stores in Saugus and Braintree.

A major area of concern for warehouse and distribution centers is residential complaints regarding increased traffic, noise, and crashes from delivery vehicles accessing these facilities. Parking by third-party contractors, for example, became an issue of contention in Milford as they parked in locations that disrupted traffic flows and caused accidents. In response, cities like Milford passed zoning bylaws that closed loopholes and restricted commercial vehicle parking.[59]

Table 10. Communities with New Warehouses, 2020

Source: Property Tax Parcels, Bureau of Geographic Information (MassGIS)

Top 5 Number of New Warehouses		Top 5 New Warehouses by Square Area	
Community	**Number of New Warehouses**	**Community**	**New Building Area (thousand square feet)**
Norton	3	Northborough	768
Northborough	3	Norton	355
Bridgewater	3	Bellingham	345
Worcester	3	Bridgewater	132
Uxbridge	2	Worcester	77
Walpole	2	Canton	76
Lawrence	2	W. Bridgewater	40

Overall, the greatest concentration of warehouse and distribution facilities is in the Boston area, Worcester, New Bedford, Fall River, and Plymouth as shown in **Figure 38**. Warehousing land use is concentrated at locations with major roadway intersections such as Springfield, Worcester, and Boston. There were 7,940 total warehouses and distribution centers built for all years; of those, 4,806, or 60.5% are located within one mile of a major roadway. As of 2020, there were 326 warehouses and distribution centers within 1 mile of a major route, with approximately 43%within an environmental justice area. **Figure 39**, **Table 11**, and **Table 12** summarize statistics on the location of warehouse and distribution centers around environmental justice areas.

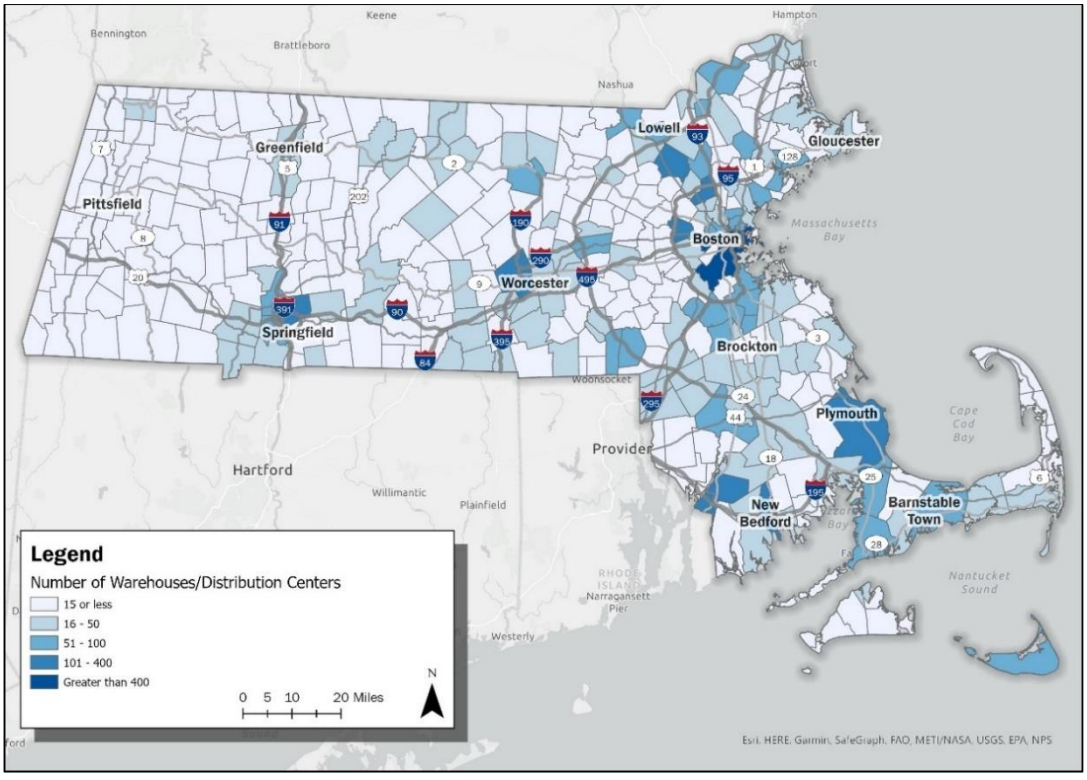


Figure 38. Warehousing - Land Use

Source: Bureau of Geographic Information (MassGIS)

Figure 39. Warehousing - Land Use and Median Household Income

Source: Bureau of Geographic Information (MassGIS)

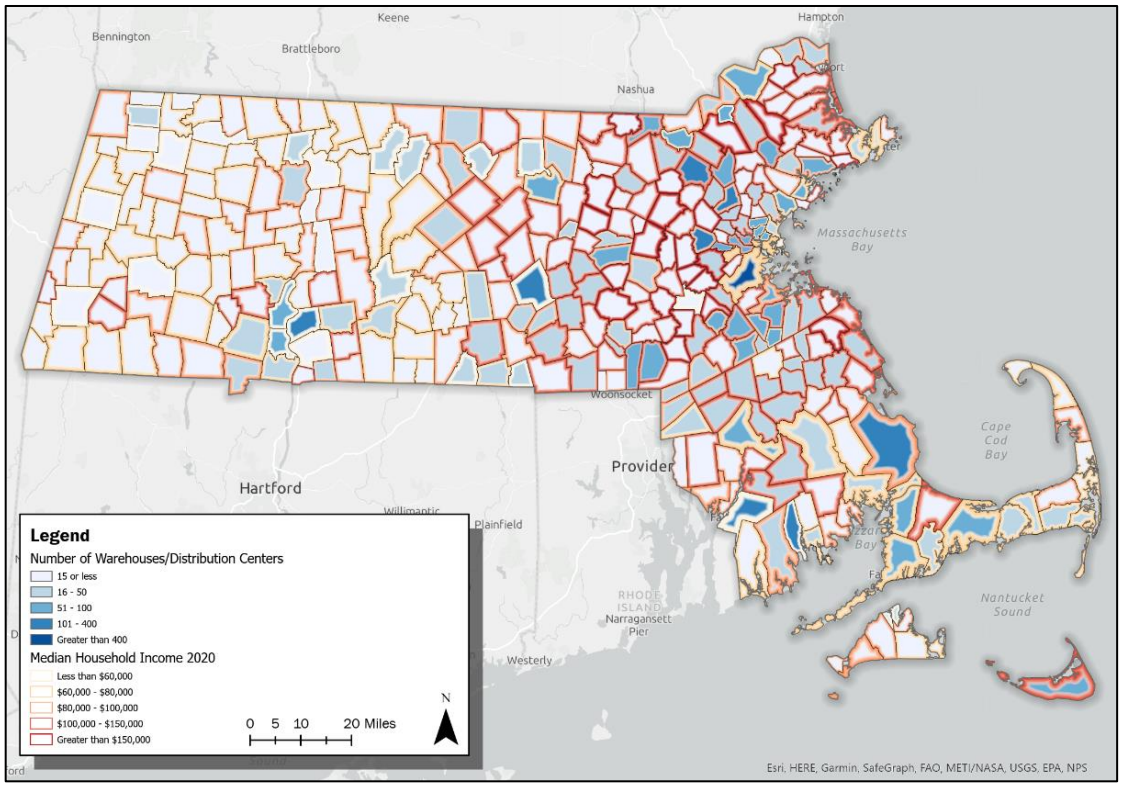


Table 11. Warehouses and Distribution Centers within One Mile from Major Route – All Years

Source: Bureau of Geographic Information (MassGIS)

Category	Count	Percent
Within a Low-Income Area	343	7.1%
Within a Minority Area	1,175	24.4%
Within a Low Income and Minority Area	914	19.0%
Not within an Environmental Justice Area	2,374	49.4%
Total	**4,806**	**100%**

Table 12. Warehouses and Distribution Centers within One Mile from Major Route – 2020

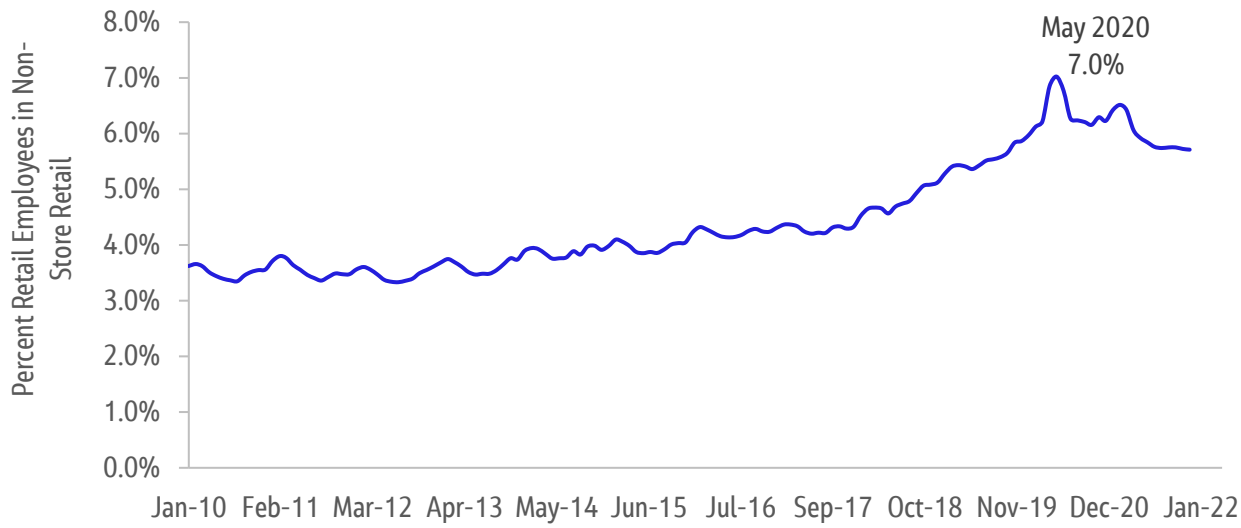
Source: Bureau of Geographic Information (MassGIS)

Category	Count	Percent
Within a Low-Income Area	22	6.7%
Within a Minority Area	67	20.6%
Within a Low Income and Minority Area	50	15.3%
Not within an Environmental Justice Area	187	57.4%
Total	**326**	**100%**

With the increased adoption of e-commerce, the percentage of retail employees in Massachusetts working in non-store retail trade reached its peak in May 2020 at 7%, as shown in **Figure 40**.

Figure 40. Percent Retail Employees Working in Non-Store Retail Trade (E-commerce) from 2010 to 2021

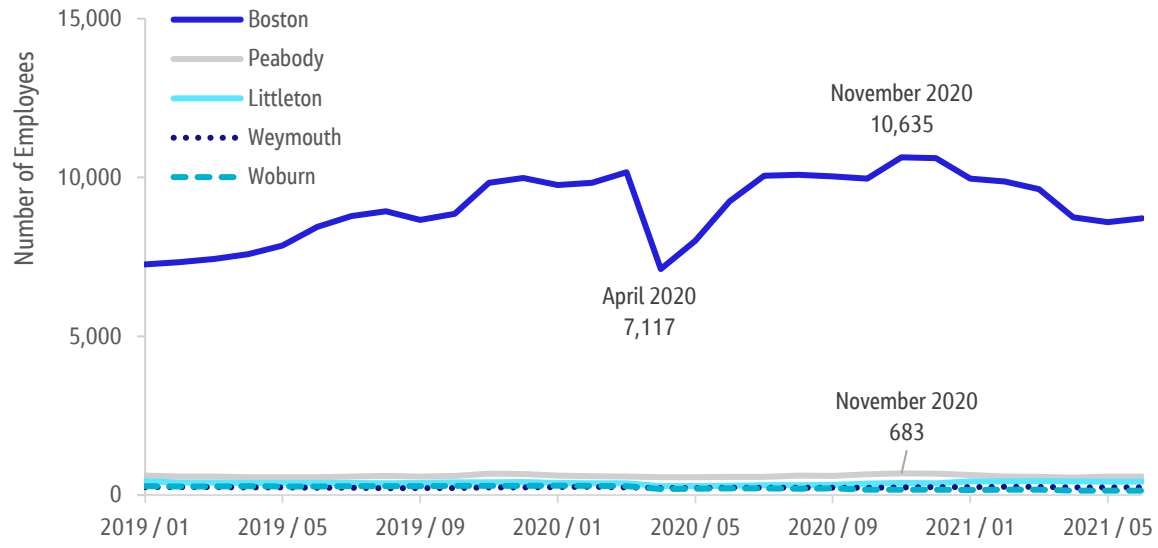
Source: Mass.gov Labor Market Information (LMI), Bureau of Labor Statistics



Boston leads all cities in Massachusetts for e-commerce-related employment. In 2019, the number of employees working in the city's e-commerce industry steadily increased from about 7,200 employees in January to 10,000 by December 2019. In April 2020, at the pandemic's peak, there was a sharp decline in employment with about 3,000 employees departing the workforce; however, by July 2020 the number of employees working in the e-commerce sector recovered and peaked at 10,635 employees by November 2020, as shown in **Figure 41**.

Figure 41. Number of Employees in Non-Store Retail Trade (E-commerce): Top 5 Locations

Source: Mass.gov Labor Market Information (LMI)



Other indicators such as the number of employees per establishment in Boston decreased from its peak of 85.6 employees in 2020 to 75.5 employees in 2021, as shown in **Figure 42**. This change corresponded with an increase in weekly wages from $2,400 in 2020 to $3,100 in 2021, as shown in **Figure 43**. Although Boston was the city with the largest increase in the number of establishments and employees per establishment, Newton had the highest average weekly wages from 2019 to 2020. However, Newton experienced a decline in weekly wages from about $3,000 in 2020 to $2,400 in 2021. The remaining eight top cities for e-commerce experienced a common trend of seeing a slight decrease in average weekly wages for non-store retailer employees. Depending on the location, these changes indicate a return to e-commerce employment patterns similar to 2019 by the end of 2021, with possible increases in average wages as a result of a reduced workforce.

Figure 42. Change in Employees per Establishment in Non-Store Retail Trade (E-commerce): Locations with the Highest Number of Establishments

Source: Mass.gov Labor Market Information (LMI)

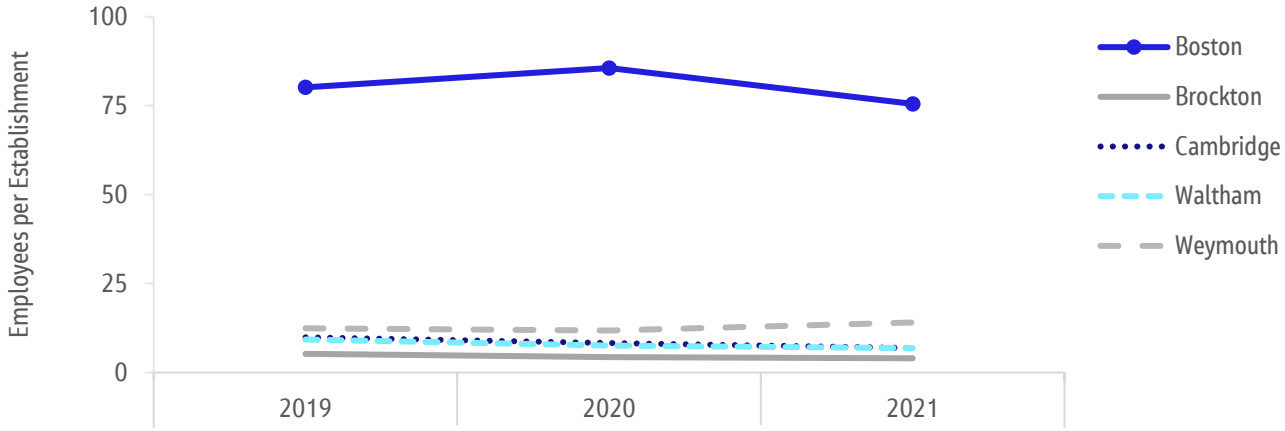
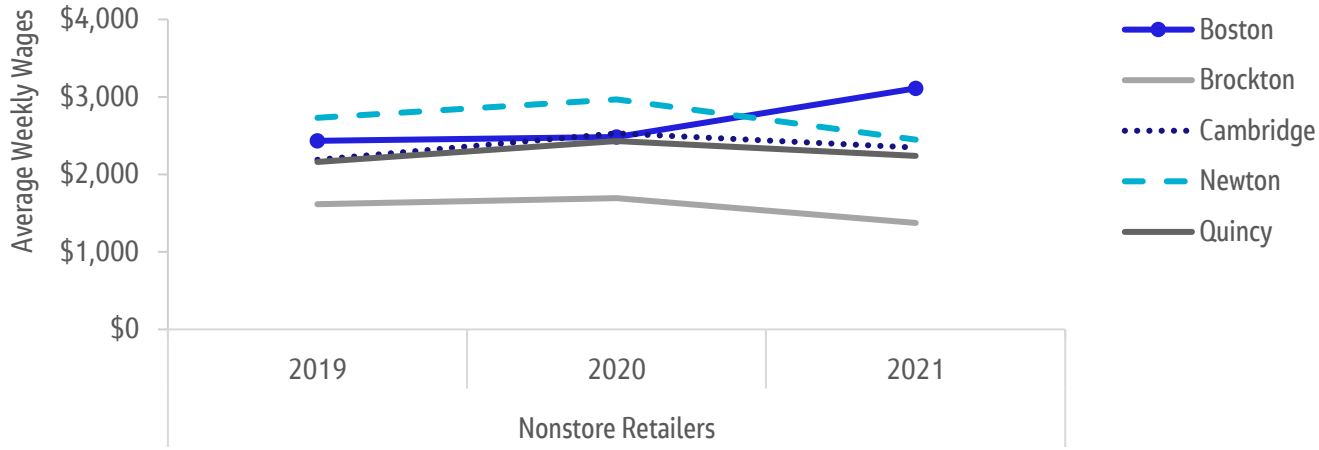


Figure 43. Change in Average Weekly Wages in Non-Store Retail Trade (E-commerce): Top 5 Locations

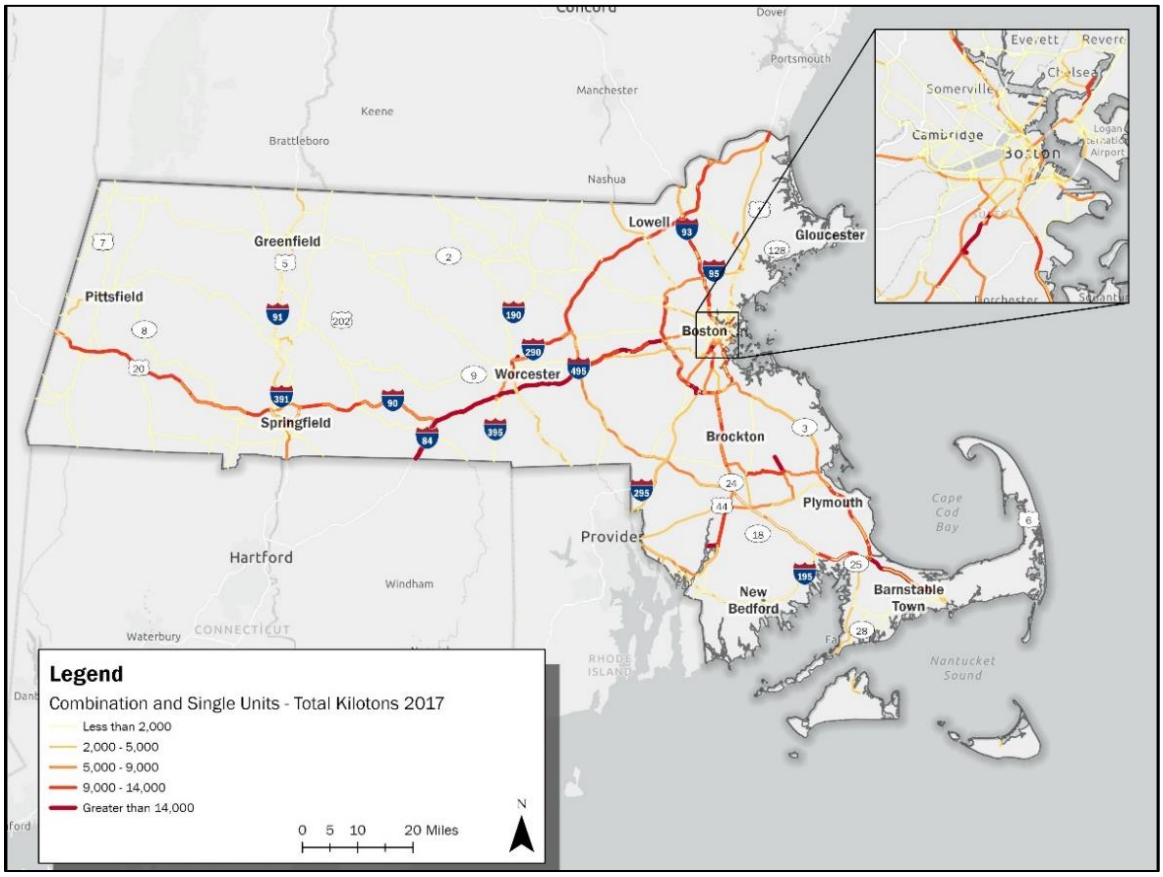
Source: Mass.gov Labor Market Information (LMI)



Trucking Industry

As shown on **Figure 44,** Interstate 84 (I-84) from Connecticut through I-90 (Massachusetts Turnpike) to Boston moved more freight than any other corridor in 2017. Other major freight routes by tonnage include I-90 west from I-84 to New York, I-495 from I-290 to New Hampshire, and I-95 in the Boston Metro Area.

Figure 44. 2017 Truck Tonnage by Route
Source: Freight Analysis Framework, version 5.5



The highest truck volumes were recorded on I-90 in Charlton and Hopkinton and I-93 in Wilmington (16,908, 12,111, and 9,161 trucks per day, respectively). Other high-volume truck locations include the Wilbur Cross Highway at Sturbridge and I-90 in Ludlow and Westfield, as shown in **Figure 45.**

Changes in truck trips along major corridors in Massachusetts are shown on **Figure 46** and **Table 13**. Changes in truck volumes were observed along major highways such as I-90 which recorded some of the highest increases in truck volumes – likely due to truck flows from Port of New York and New Jersey (PNYNJ) to Boston and from the capital region of New York through Springfield. Interstate Highway 93 (I-93) at Stoneham, I-95 at Foxborough, and I-290 at Auburn are some of the other highways with increased truck traffic of more than 500 from 2019 to 2021.

Figure 45. 2019 Average Daily Truck Volumes
Source: Derived from MassDOT Permanent Traffic Counts, 2019

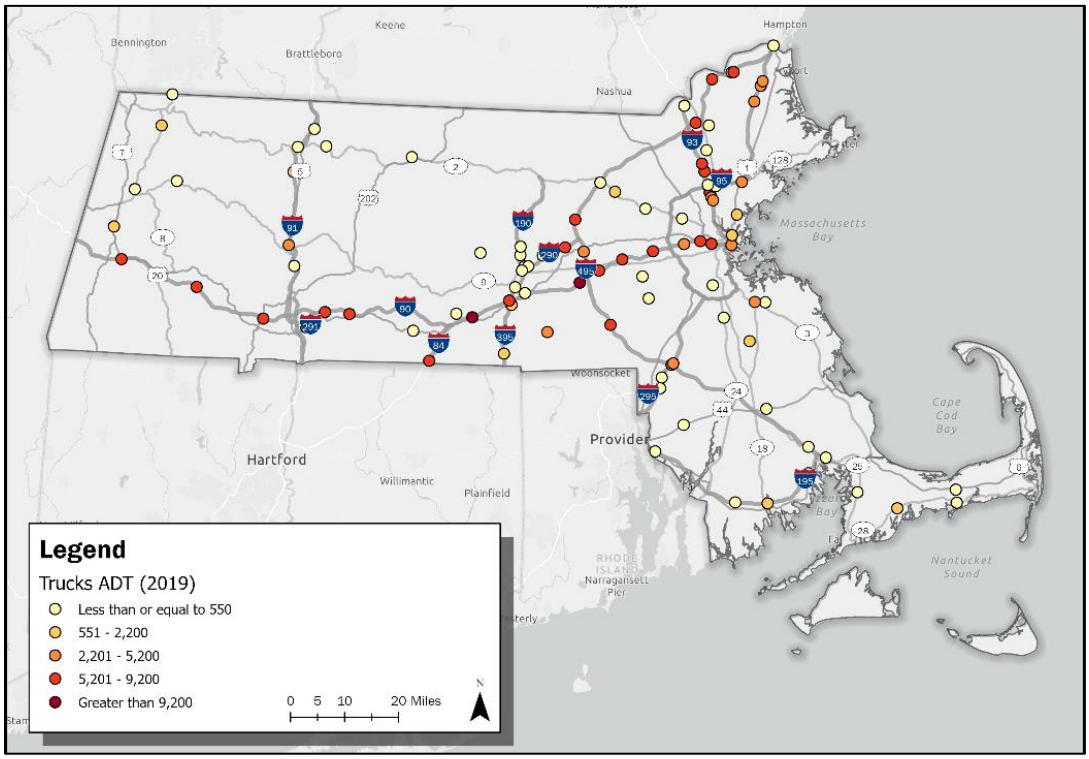


Figure 46. Percent Change in Average Daily Truck Volumes from 2019 to 2021
Source: MassDOT Traffic Count Data

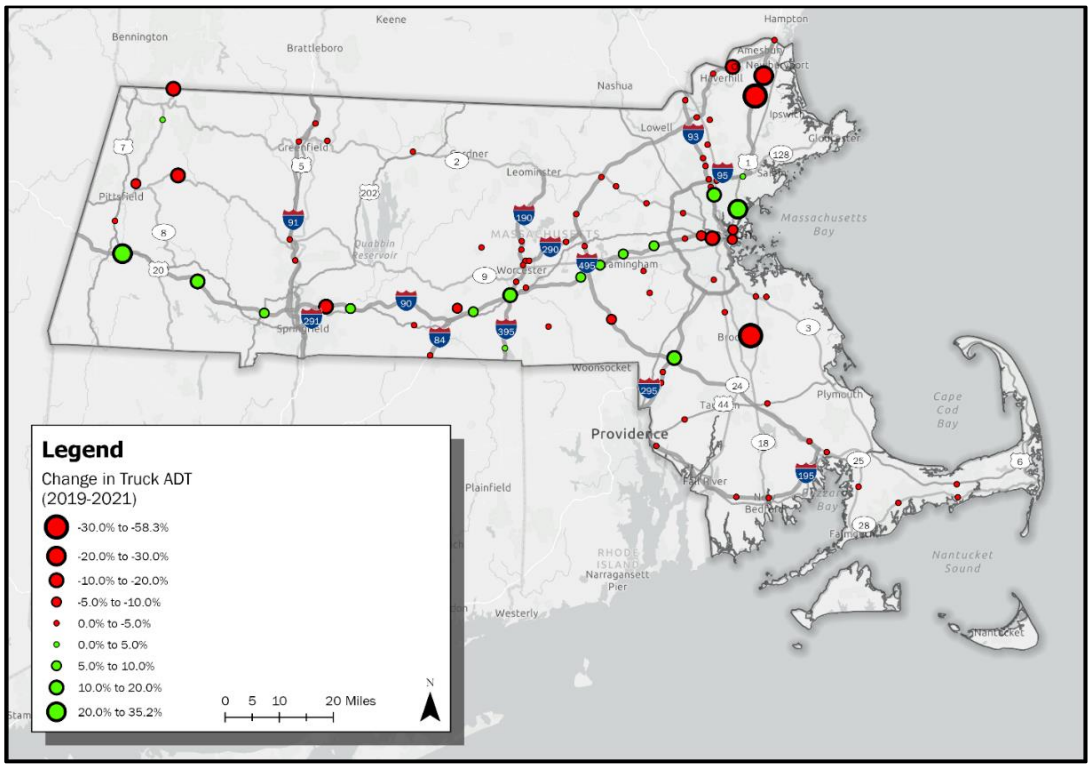
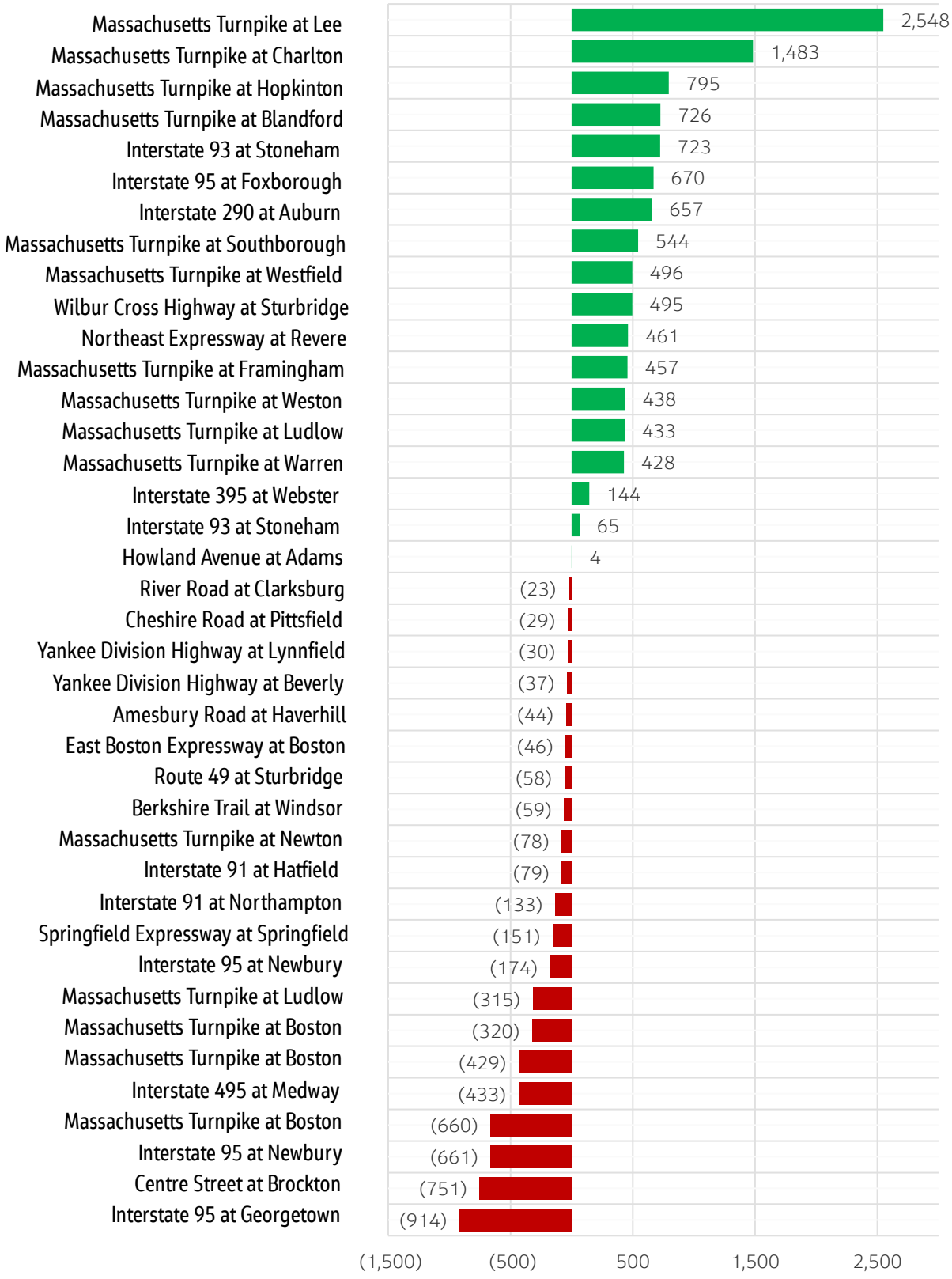


Table 13. Change in Average Daily Truck Traffic Volumes from 2019 and 2021

Source: MassDOT Traffic Counts



Top Trucking Routes

When observing the top routes used by heavy trucks (greater than 26,000 pounds) in Spring 2019 compared to Fall 2021 in **Figure 47** and **Figure 48**, they remained relatively similar. One observation, however, shows more heavy trucks leaving Conley Terminal heading to the FedEx warehouses west of Billerica. These may be a result of operational changes by FedEx or its partners during the pandemic's recovery period.

Figure 47. Spring 2019 Top Routes - Average Daily Origin-Destination Heavy Truck Traffic

Source: StreetLight Data - Top Routes, May 2022

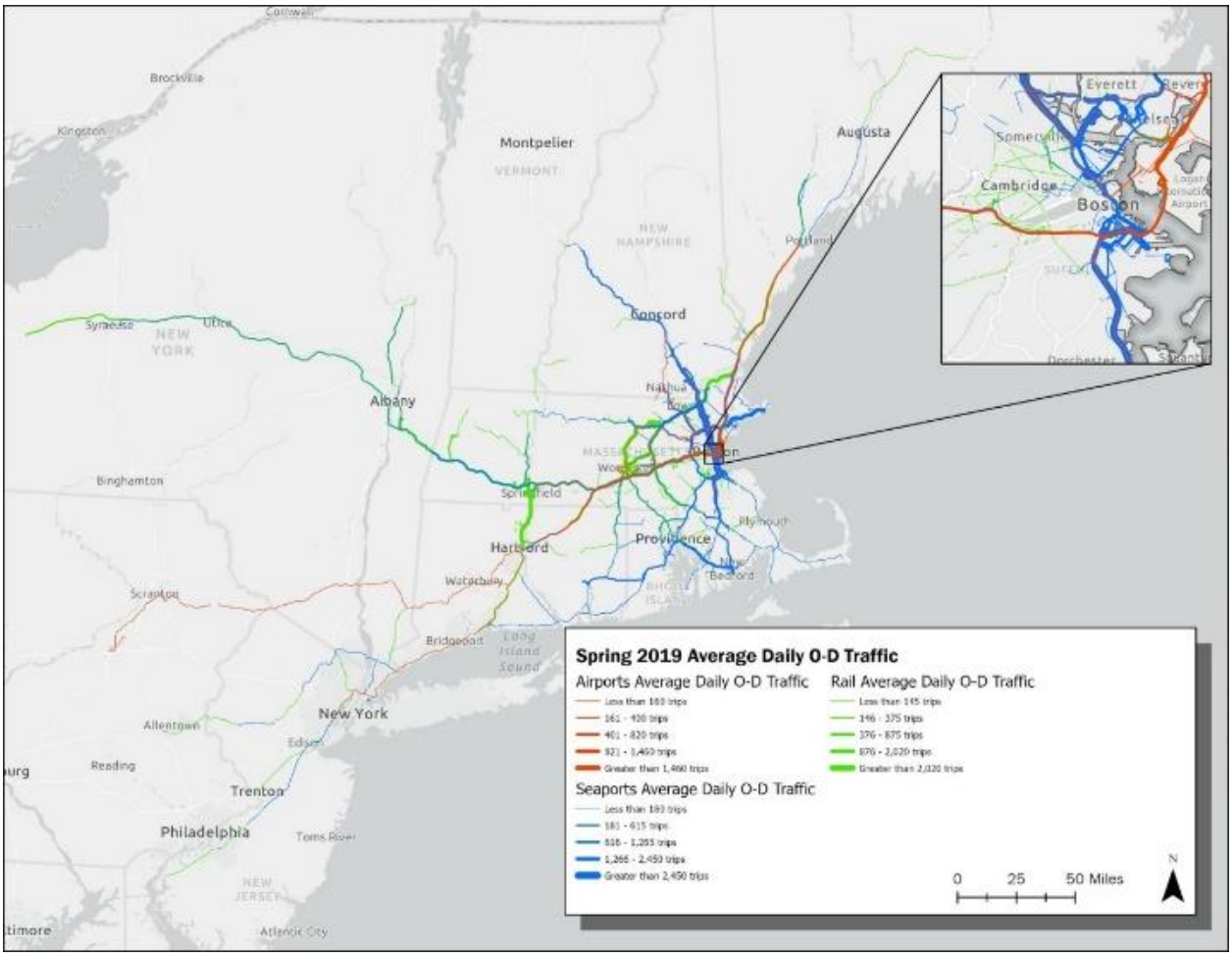
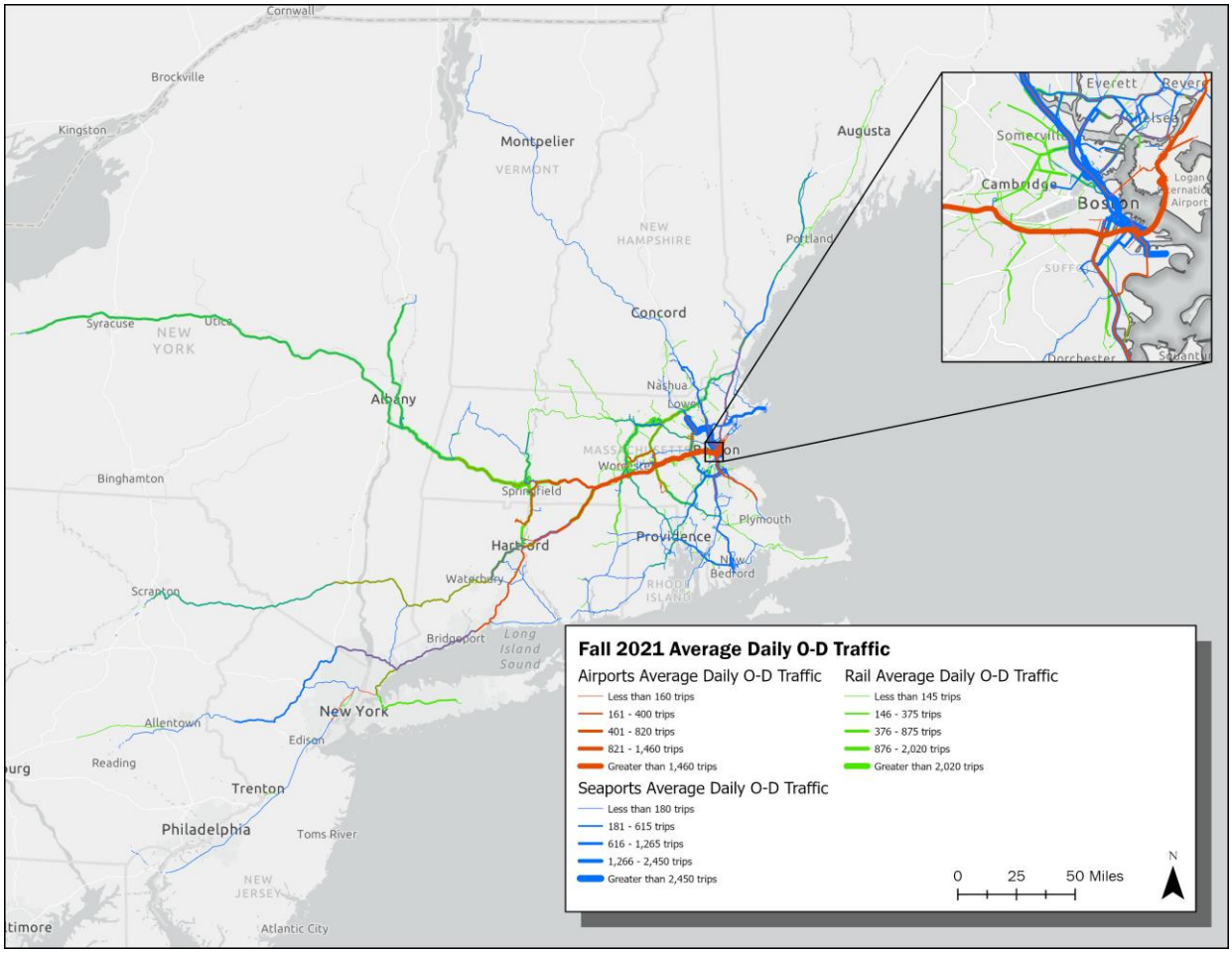


Figure 48. Fall 2021 Top Routes - Average Daily Origin-Destination Heavy Truck Traffic

Source: StreetLight Data - Top Routes, May 2022

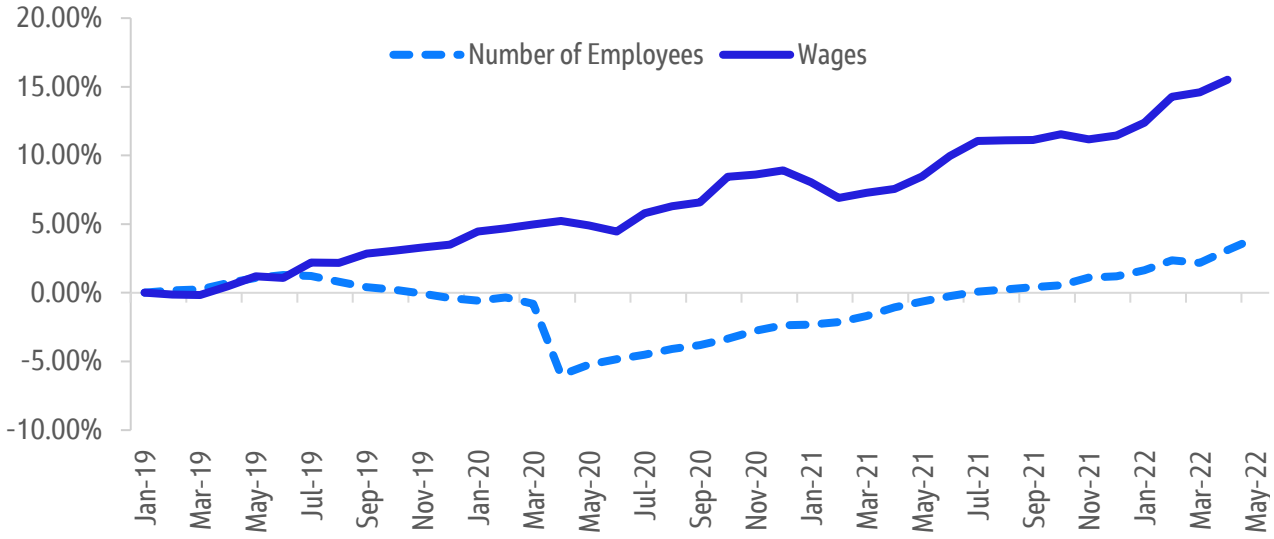


Trends in Trucking Employment and Wages

In the beginning months of 2019, the national trucking industry's employment and hourly wages simultaneously and steadily rose until July 2019, when wages increased while the number of employees declined, as shown in **Figure 49**. In March 2020, at the peak of the COVID-19 pandemic, there was a steep decline in the number of employees as lockdowns and restrictions began. In the months following March 2020, the number of employees did not increase as significantly as in March. From May 2020 to May 2022, the number of employees increased; inversely, wages in the trucking industry have constantly increased since 2019. From March 2020 to May 2020, during the peak of the pandemic, wages declined but not as sharply as the number of employees. In September 2020, there was a sharp increase in wages, which can be attributed to incentives for new employees as there was a drastic shortage of workers. Wages did not increase as steadily as the number of employees, but overall, there was an increase in wages. Trucking companies are searching in hopes to find longer-term commitments as employee retention rates are an issue.

Figure 49. National Trucking Industry Employment and Hourly Wages (2019 to 2022)

Source: US Bureau of Labor Statistics, May 2022



Road Safety

Road safety in Massachusetts remained a major concern during the pandemic's peak period and recovery. As shown on **Figure 50,** during the pandemic's peak in 2020, there were fewer vehicles on the road, with total daily vehicle miles traveled of 148 million in comparison to 178 million in 2019. From 2019 to 2021, the number of crashes decreased by 29% from about 141 thousand to 101 thousand, but the number of fatal injury crashes increased from 324 to 327. The increase in fatal injury crashes is attributed to over speeding and reckless driving due to fewer vehicles on the road. In 2021, as vehicle miles traveled increased by 12% to 165 million, the total number of crashes and fatal injury crashes increased by 22%. As shown in **Table 14**, the top contributing factors did not change considerably from 2019 to 2021, except for *failure to yield right of way* and *followed too closely* which decreased by 2% and 3%, respectively, in 2020.

Figure 50. All Crashes in Massachusetts from 2019 to 2021

Source: MassDOT Crash Data

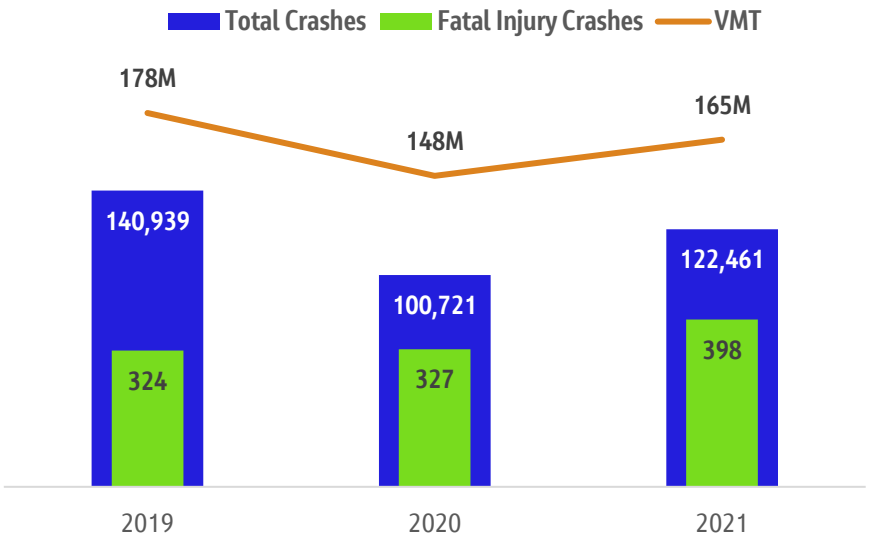


Table 14. Top Crash Contributing Factors for All Vehicles from 2019 to 2021
Source: MassDOT Crash Data

TOP 5 Crash Contributing Factors	Percent of all Contributing Factors for All Crashes [a]		
	2019	2020	2021
Inattention	23%	23%	22%
Failure to yield right of way	16%	14%	15%
Followed too closely	14%	11%	13%
Failure to keep in the proper lane or running off the road	7%	8%	8%
Operating a vehicle in an erratic, reckless, careless, negligent, or aggressive manner	5%	6%	6%
Other (including unknown)	35%	38%	36%

[a] *Crashes with contributing factors coded as* No improper driving *or* Unknown *were excluded from this analysis*

As shown on **Figure 51**, commercial motor vehicle (CMV) crashes followed a similar trend as all vehicles with the number of crashes decreasing by 31% from 50,010 in 2019 to 34,484 in 2020. Fatal CMV crashes decreased from 109 to 90, which was a contrast to all vehicle fatal injury crashes. In 2021, despite a 21% increase in CMV-involved crashes, fatal injury crashes increased by 7%. This marginal change could be attributed to more stringent commercial vehicle driver training in comparison to passenger vehicle drivers. As shown in **Table 15**, the top contributing factors for CMV crashes did not vary significantly from 2019 to 2021, except for *failure to yield right of way* which decreased by 3% in 2020.

Figure 51. Crashes involving CMVs in Massachusetts from 2019 to 2021
Source: MassDOT Crash Data

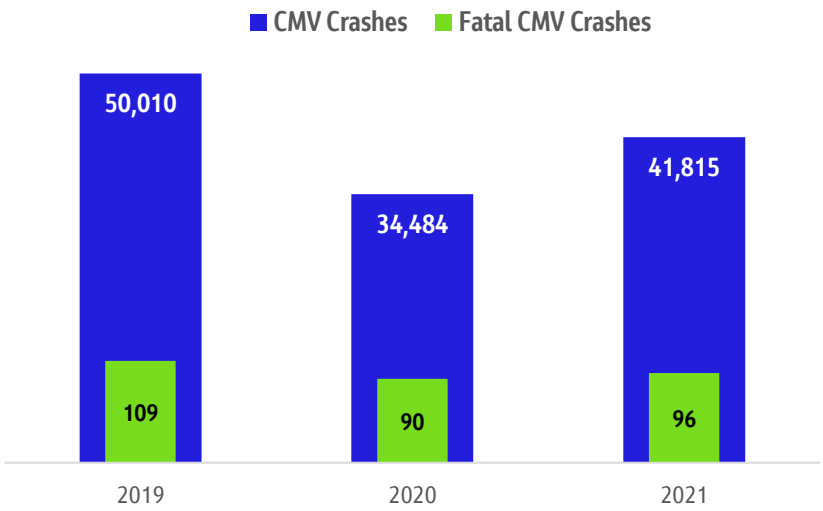


Table 15. Top Crash Contributing Factors for CMV involved Crashes from 2019 to 2021

Source: MassDOT Crash Data

TOP 5 Crash Contributing Factors	Percent of all Contributing Factors for All Crashes [a]		
	2019	2020	2021
Inattention	22%	23%	22%
Failure to yield right of way	19%	16%	18%
Followed too closely	17%	18%	18%
Failure to keep in the proper lane or running off the road	8%	7%	8%
Operating a vehicle in an erratic, reckless, careless, negligent, or aggressive manner	7%	8%	6%
Other (including unknown)	27%	28%	28%

[a] *Crashes with contributing factors coded as No improper driving or Unknown were excluded from this analysis*

With regards to the location of crashes, 90% of CMV crashes occurred in a large, urbanized area as shown on **Table 16** and **Figure 52**. Boston led all urbanized areas, followed by Worcester, Springfield, and Providence. Furthermore, fatal injury crashes involving CMVs were concentrated within these urban areas and on major routes, as shown on **Figure 53**. Single-vehicle crashes accounted for 17% of all commercial motor vehicle crashes and 83% of commercial motor vehicle crashes involving two or more vehicles.

Table 16. CMV involved Crashes in Urbanized Areas from 2019 to 2021.

Source: MassDOT Crash Data

Urbanized Areas	2019	2020	2021
Boston	66%	64%	64%
Worcester	11%	10%	11%
Springfield	5%	6%	7%
Providence	5%	5%	5%
Barnstable Town/New Bedford	3%	4%	3%
All others	10%	11%	10%

Figure 52. Location of CMV-involved Crashes from 2019 to 2021

Source: MassDOT Crash Data

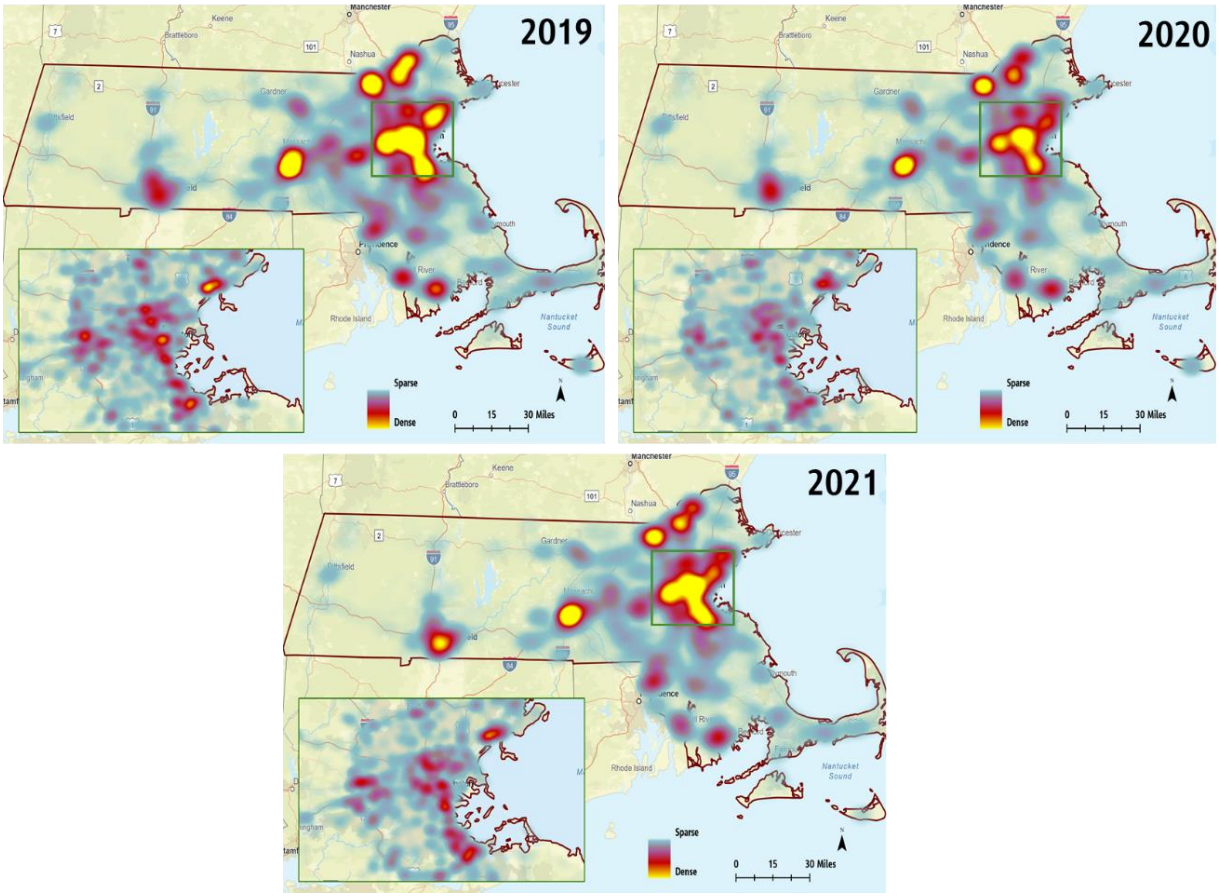
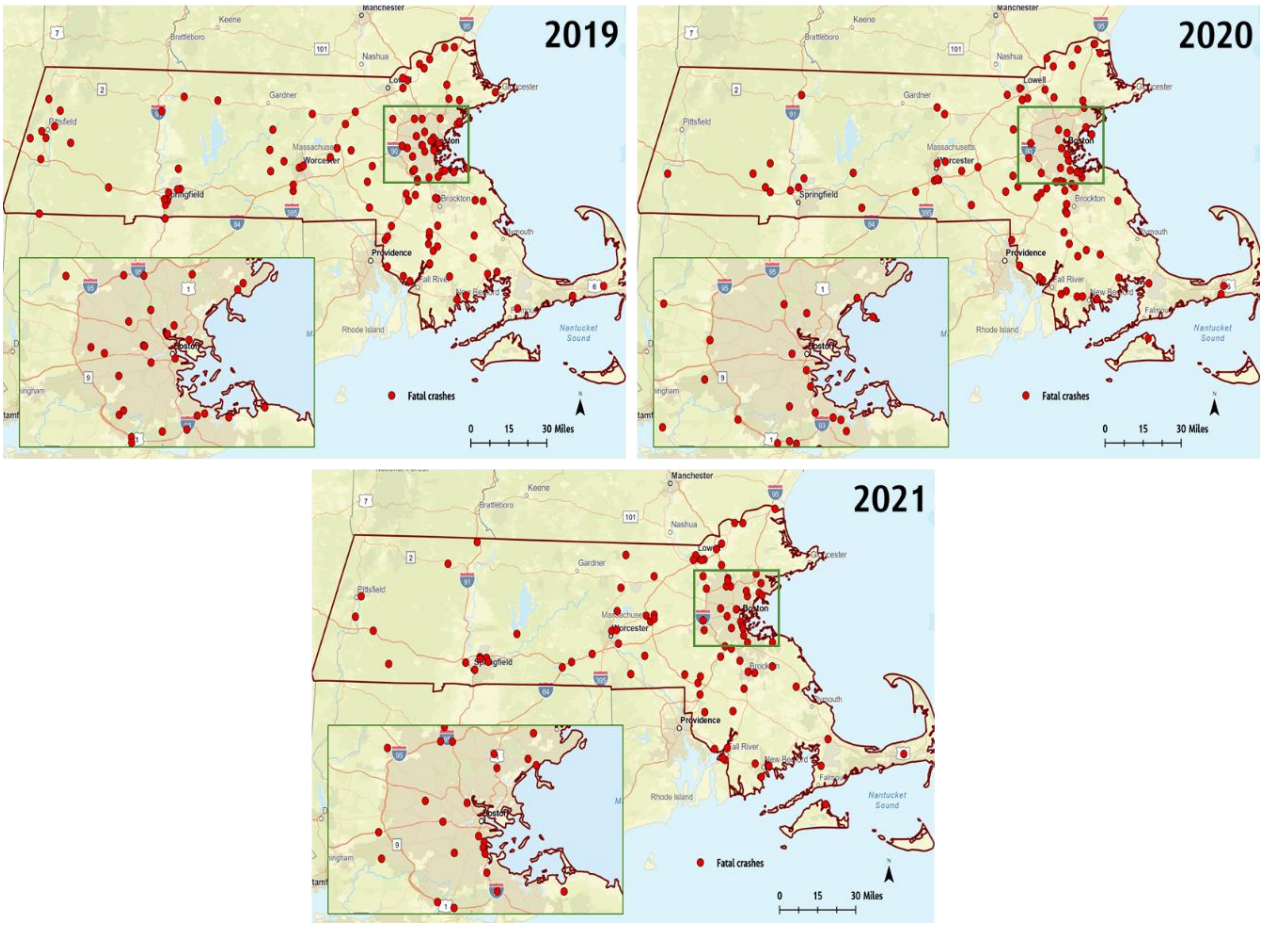


Figure 53. Location of CMV-involved Fatal Injury Crashes from 2019 to 2021

Source: MassDOT Crash Data



Air Cargo

Figure 54 shows the 3-month moving average of air cargo shipments to and from Logan International Airport. Top cargo origins are from Memphis, Indianapolis, London, Louisville, and Cincinnati. Top cargo destinations are Memphis, Indianapolis, Louisville, Cincinnati, and Newark (see **Figure 55**).

Memphis International Airport is the top origin and destination airport with the largest amount of annual cargo to and from Logan International Airport, followed by Indianapolis. Both of these airports are major FedEx hubs and serve as transit locations to and from other national or international airports. Louisville Muhammad Ali and Cincinnati International are UPS and DHL hubs, respectively.

Overall, the amount of all cargo movements to Logan Airport decreased by 14% from 2019 to 2020 which the largest decline of 59% being airports classified in the *All Others* category. Memphis, Indianapolis, and Cincinnati saw an increase of 22%, 28%, and 26%, respectively (see **Figure 54)**.

During the pandemic's recovery period from 2020 to 2021, London, Indianapolis, and all other airports saw an increase of 22%, 6%, and 14%, respectively in air cargo movements destined for Logan International. Air cargo movements from Memphis, Louisville, and Cincinnati, however, declined likely due to operational changes by air carriers after the pandemic's peak.

Boston Logan is ranked 6th in air cargo received from London-Heathrow in the US behind Dallas-Fort Worth, Miami, Orlando, Los Angeles, and John F. Kennedy airports. Top commodities shipped from Europe to Boston by air include precision instruments, machinery, plastics/rubber, and electronics.

Figure 54. Logan International Inbound Air Cargo: Top 5 Origins

Source: Air Carrier Statistics Database, 2022

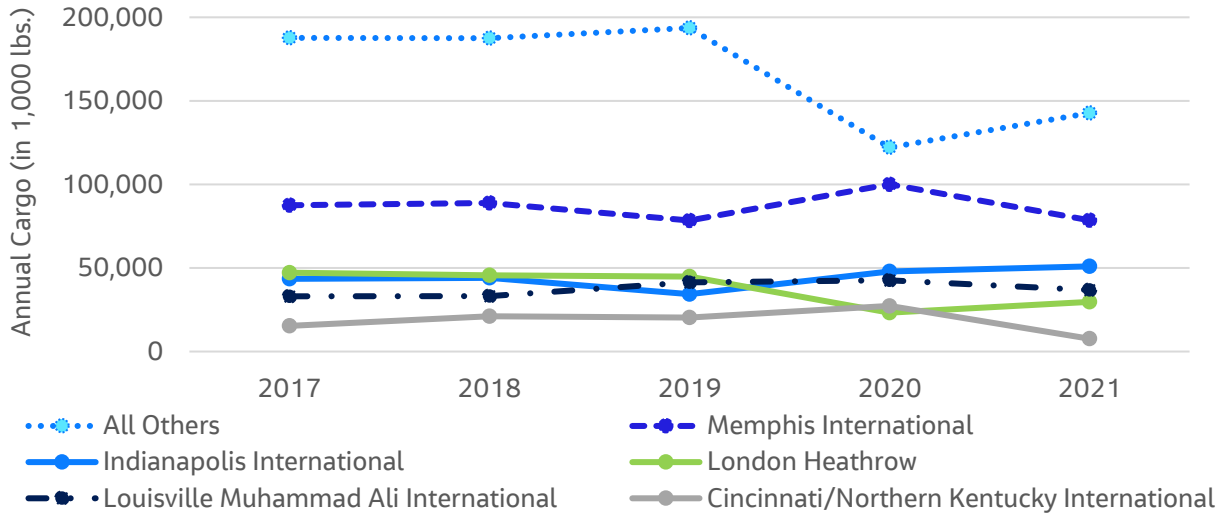
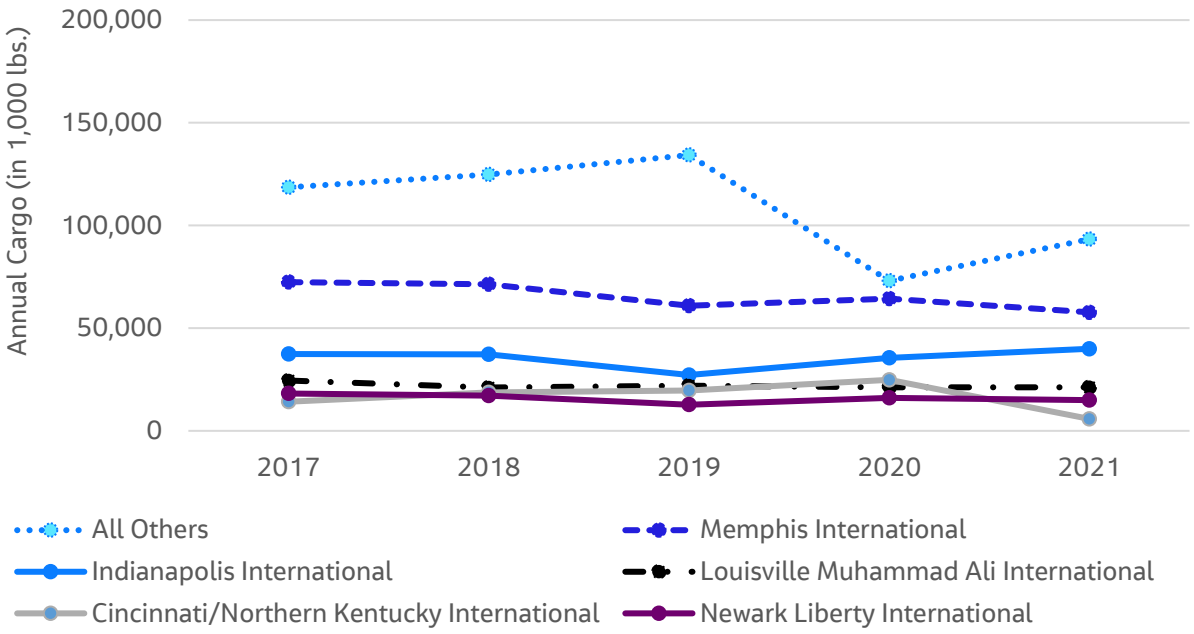


Figure 55. Logan International Outbound Air Cargo: Top 5 Destination

Source: Air Carrier Statistics Database, 2022

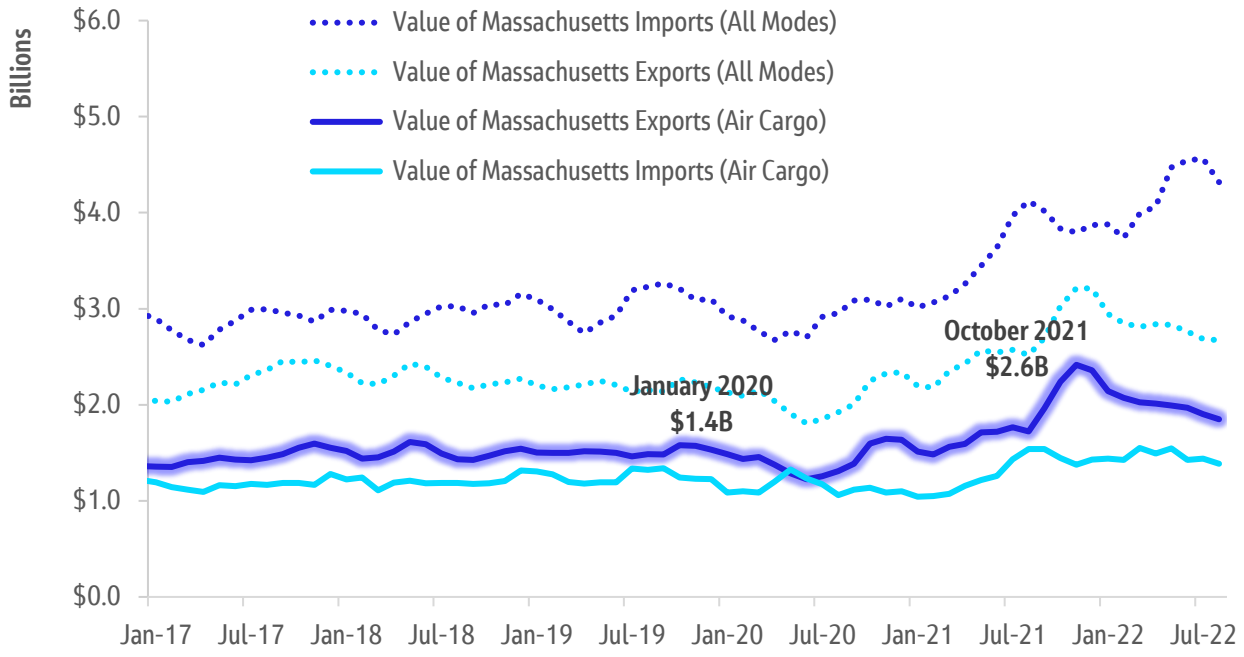


Overall, the amount of all cargo movements from Logan Airport decreased by 18% from 2019 to 2020 which the largest decline of 84% being airports classified in the *All Others* category. Memphis and Indianapolis saw an increase of 5% and 24%, respectively. Cincinnati and Newark saw an increase of 21% in air cargo movements. During the recovery in 2021, Memphis and Cincinnati experienced a decline in air cargo while Indianapolis and *All Others* experienced increases of 11% and 22%, respectively.

During the recovery in 2021, the value of air cargo exports from Massachusetts peaked in October 2021 at 2.6 billion dollars ***increasing by 82%*** *from 1.4 billion dollars in January 2020. Top exports from Massachusetts in 2021 were vaccines for human use, machines for semiconductor manufacturing, electronic integrated circuits, instruments, medical appliances, and filtering/purifying machinery for liquids. In 2021, air cargo made up about 70% of the total value of exports from Massachusetts and 36% of imports into Massachusetts (see* ***Figure 56****).*

Figure 56. Value of Air Cargo Imports and Exports

Source: Foreign Trade Statistics, 2022



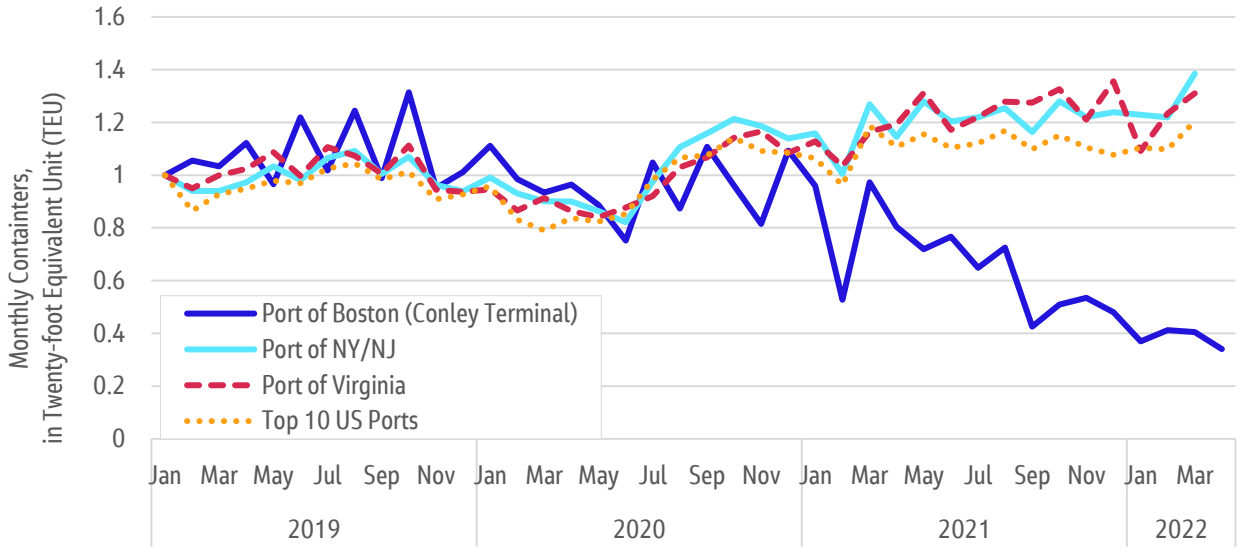
Maritime

Port of Boston ranks 23rd in the US for container movement. Conley Terminal handles approximately 40% of containerized goods coming into the Boston market, with the remainder coming through the Port of New York and New Jersey.[60] From March to June 2020, there was a 20% decline in the monthly reported TEU of containers across all major ports compared to 2019 (see **Figure 57**). From July 2020, container shipments for the top 10 US ports, Port of New York and New Jersey, and Port of Virginia saw a recovery and subsequent increase in container movements. Despite improvements to the port (including the installation of three new post-Panamax ship-to-shore cranes at Conley Terminal), container shipments through the Port of Boston declined from January 2021 and reached as low as 40% of 2019 volumes in March 2022. Ocean Alliance, the only direct Asia-US East Coast shipping carrier calling at Boston, stopped its service to Conley in November 2021 due to congestion and severe delays at the Port of Savannah. The stoppage of service by Ocean Alliance resulted in more containers being moved by truck from the Port of New York and New Jersey. For example, dry van loads from Elizabeth, New Jersey, to Boston rose by 18% from September to October 2021.[61] As of September 2022, the Port of Boston is served biweekly by the Ocean Alliance.[62]

On January 16, 2022, the supersized Ever Fortune vessel called Conley Terminal. With the ability to carry up to 12,000 twenty-foot container units, the Ever Fortune and other ocean carriers connect Boston to East Asia ports via the Panama Canal. Conley Terminal is expected to increase its shipping routes to six by Fall 2022 and connect shippers to 25 ports around the world.

Figure 57. Total Monthly TEUs – indexed from January 2019

Sources: BTS - Container Port Activity Dashboard; Conley Terminal Port Statistics



With hospitals overrun with COVID-19 cases, safety protocols were set in place globally, resulting in a surge in demand for masks and other personal protection equipment (PPE). Because of the urgent demand, PPE production became a priority in most factories in China. These factories relied on air cargo and marine containers to deliver PPE gear around the globe. In March 2020, ocean carriers increased blank sailings in response to the spread of the pandemic to cut costs. Empty containers began to pile up at United States (US) and European Union (EU) ports. Limited exports from the US and EU created an unexpected shift in the direction of trade, further exacerbating the disproportionate distribution of shipping containers. ***Figure 58*** *and* ***Figure 59*** *illustrate the growing container cargo deficit for Massachusetts and the US since the peak of the pandemic.*

Figure 58. Massachusetts Containerized Cargo Imports and Exports from 2017 to 2022 (in million pounds)

Source: Foreign Trade Statistics, 2022

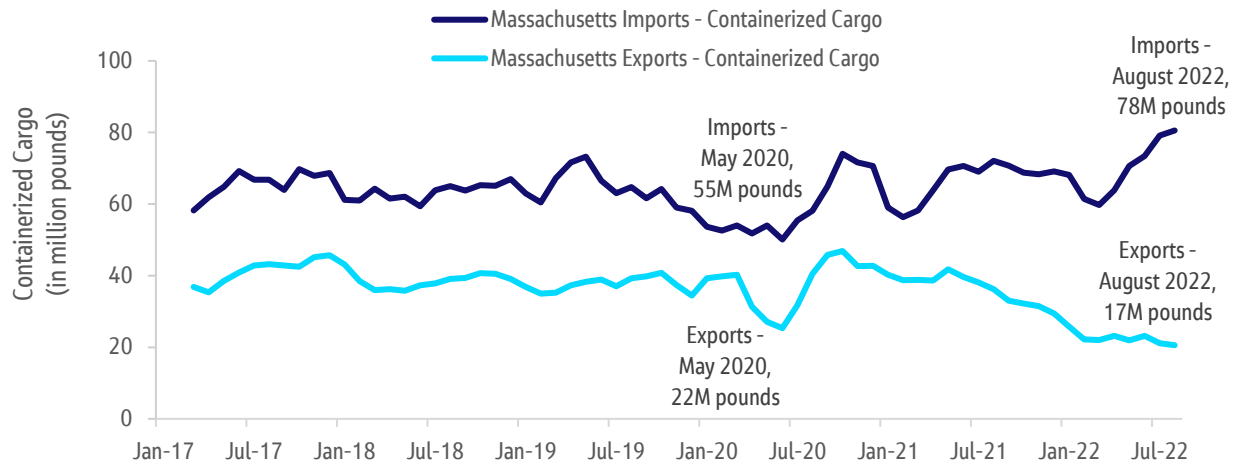
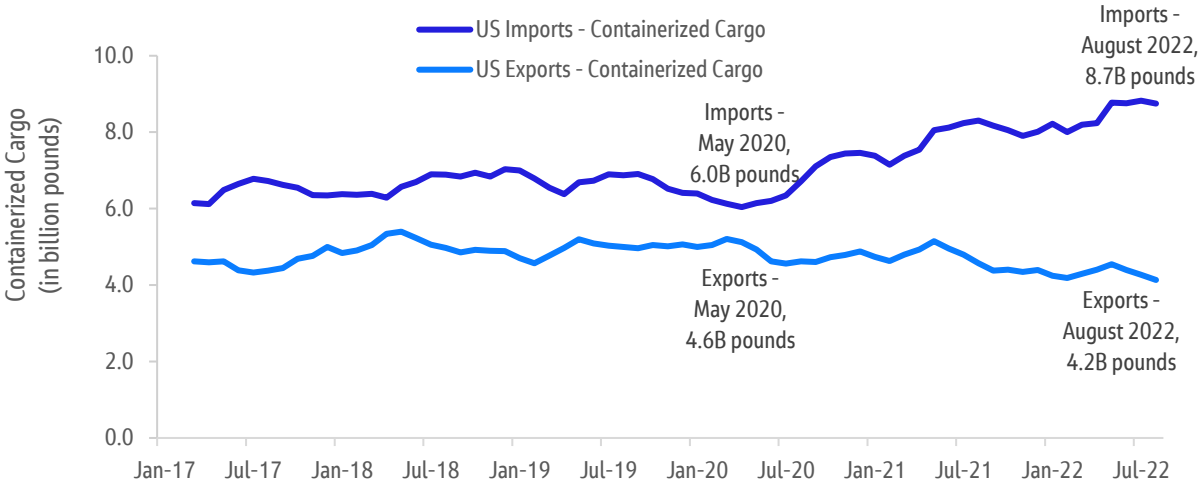


Figure 59. US Containerized Cargo Imports and Exports from 2017 to 2022 (in billion pounds)

Source: Foreign Trade Statistics, 2022



Rail

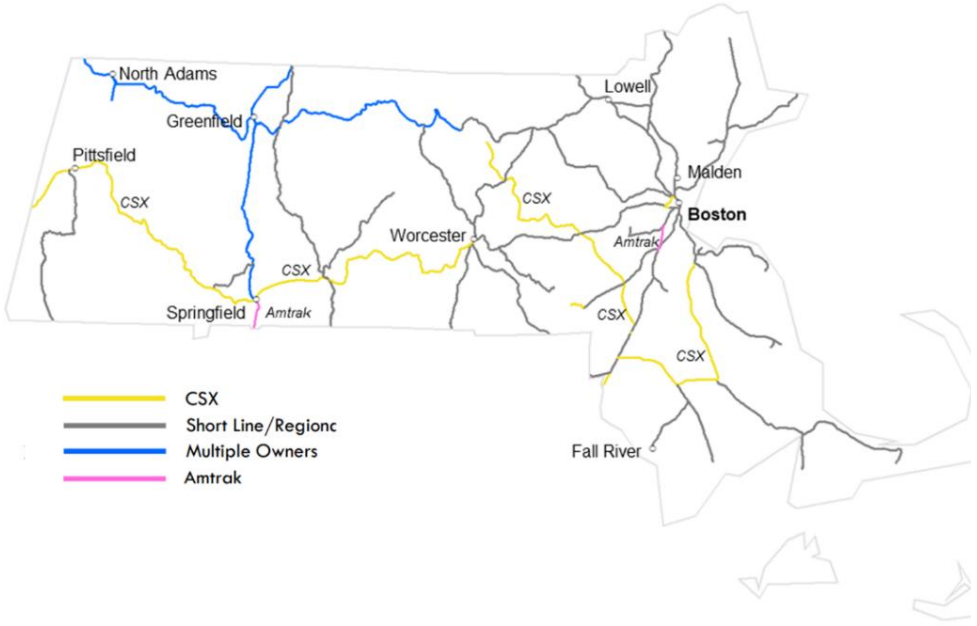
As of 2019, there were 14 freight railroads operating in Massachusetts with CSX being the only Class I railroad. Pan Am Systems serves its customers at Ayer Intermodal Yard through shared ownership with other railroads**. Figure 60** summarizes the rail industry infrastructure and operations in Massachusetts as of 2019. The CSX serves the majority of freight rail into southern New England and connects two New Jersey marine terminals to the railroad's Worcester terminal about 50 miles west of the Conley terminal. The other rail route is into Pan Am System's Ayer intermodal terminal, which takes international containers from Norfolk Southern's Chicago terminals through Greenfield in northwest Massachusetts.

During the supply chain crisis in 2021, there was limited cargo space for rail service to Massachusetts. Due to high container volumes into Ayer, Norfolk Southern issued an embargo on accepting new shipments in October 2021.[61]

Figure 60. Massachusetts Rail Facts for 2019

Sources: Association of American Railroads 2019 State Rankings and U.S. DOT - Bureau of Transportation Statistics

14 freight railroads **1,000** freight rail miles **604** freight rail employees



1 Class 1 railroad (CSX)

4 regional railroads

9 short-line railroads

3.5 million originating rail tons

8.7 million terminating rail tons

93,322 originating rail carloads

235,831 terminating rail carloads

On a national level, the rail industry was more resilient than most industries though changes in carload shipments differed by commodity. Grain shipments changed marginally during the pandemic's peak, and increased by as much as 20% from spring to fall of 2020, as shown on

Figure 61. The shipment of chemicals saw a marginal decrease in carloads during the pandemic's peak but recovered by end of 2020, as shown on **Figure 62.**

Figure 61. Grain Shipments: US Average Weekly Rail Carloads Originated, January 2020 to September 2022

Source: Association of American Railroads

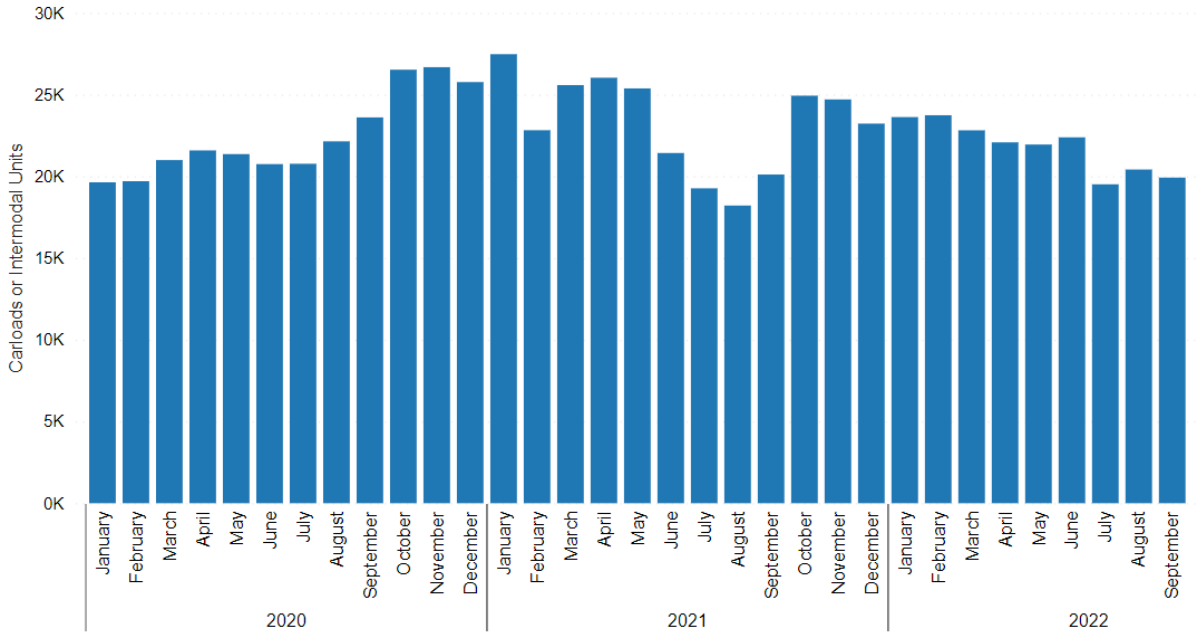
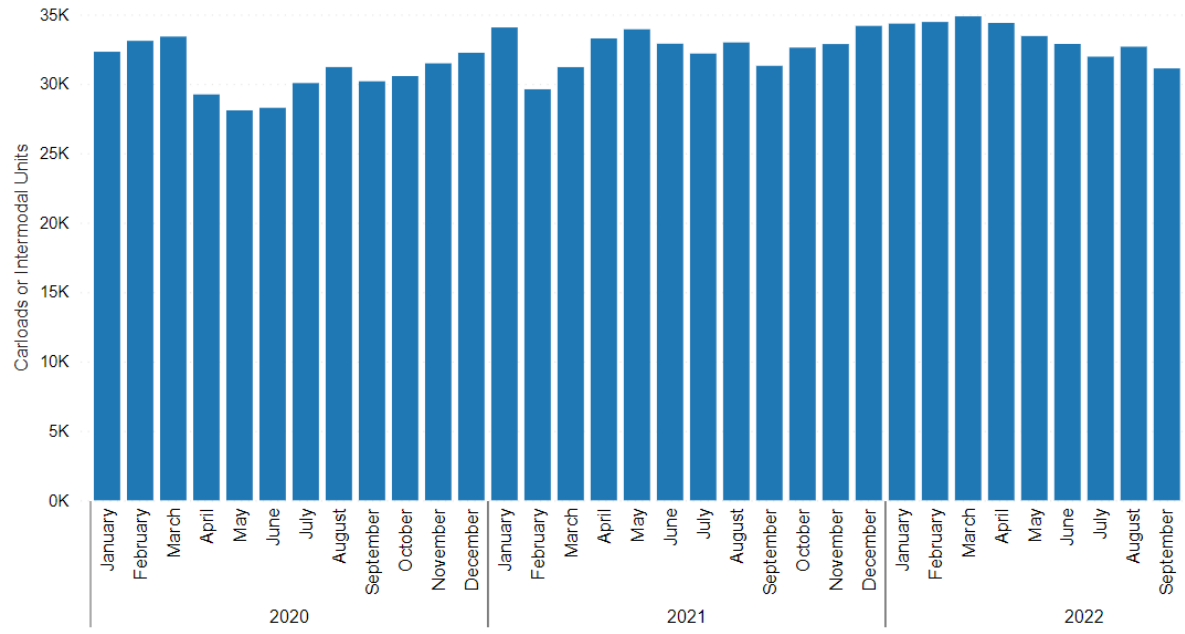


Figure 62. Chemicals Shipments: US Average Weekly Rail Carloads Originated, January 2020 to September 2022

Source: Association of American Railroads



Other commodities such as petroleum (including petroleum products) and autos saw substantial decreases in the average weekly rail carloads during the pandemic's peak (see **Figure 63** and **Figure 64**). Auto shipments recovered to pre-pandemic levels by August 2020 but dipped again in 2021, likely as a result of the supply chain crisis.

Figure 63. Petroleum and Petroleum Products Shipments: US Average Weekly Rail Carloads Originated, January 2020 to September 2022

Source: Association of American Railroads

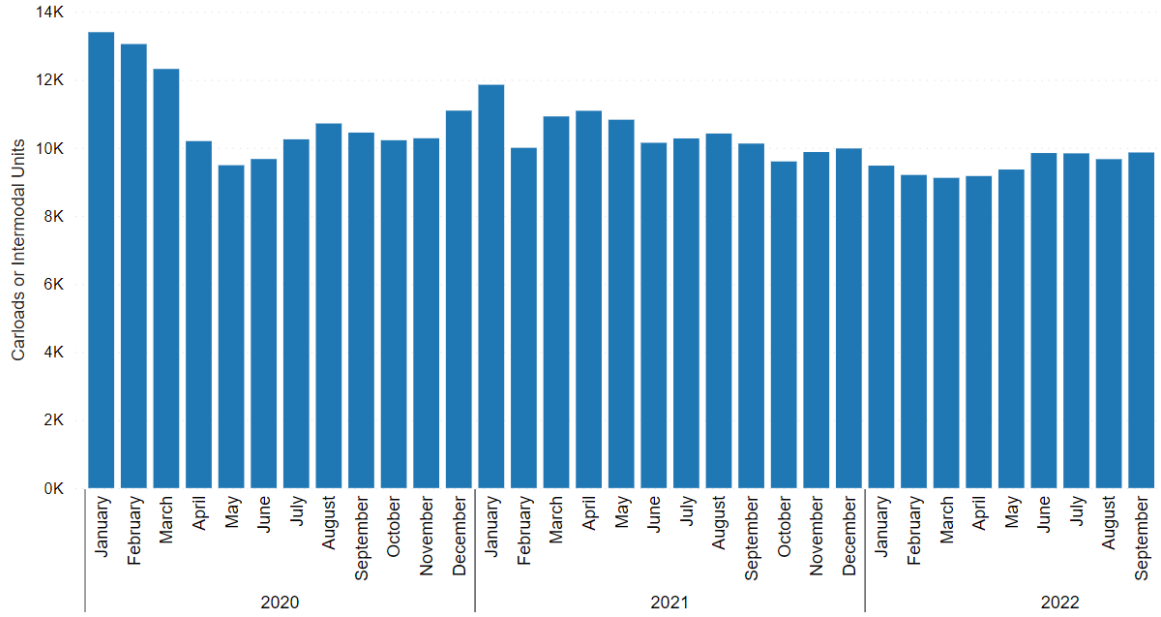
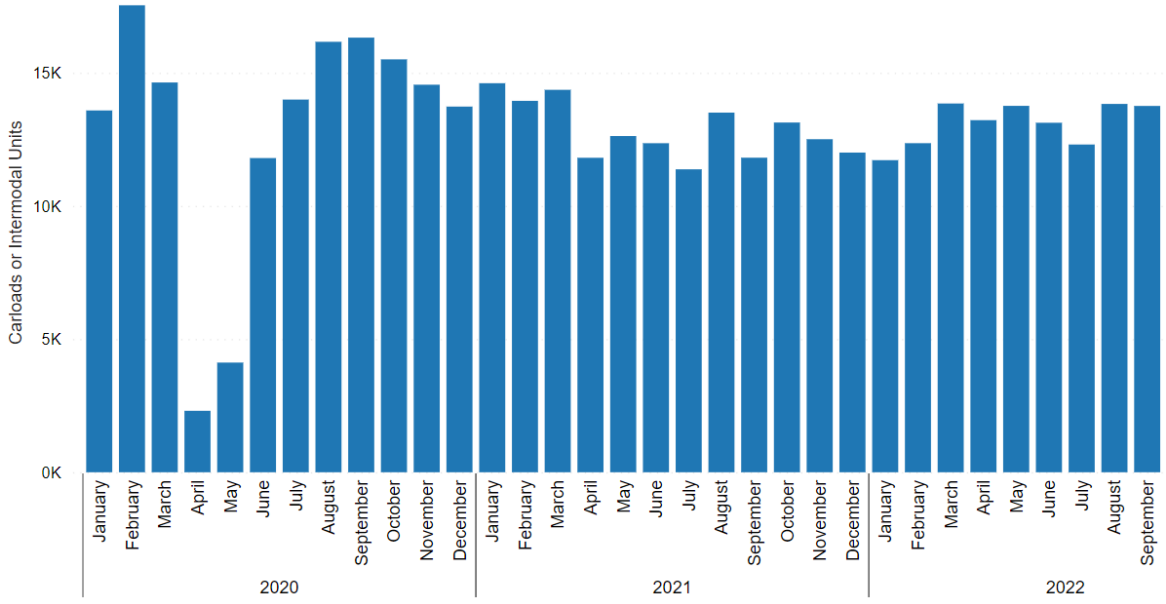


Figure 64. Autos Shipments: US Average Weekly Rail Carloads Originated, January 2020 to September 2022

Source: Association of American Railroads



In April 2022, the Surface Transportation Board approved, subject to conditions, the application by CSX to acquire control of seven rail carriers owned by Pan Am Systems, Inc., and Pan Am Railways, Inc., and to merge six of those railroads into CSX. The Board also approved six related transactions, allowing Norfolk Southern (NS) Railway Company to acquire trackage rights over certain lines of four other railroads [CSX, Providence & Worcester Railroad Company (a subsidiary of Genesee & Wyoming), Boston & Maine, and Pan Am Southern; these trackage rights agreements would create a new route for NS to move intermodal and automobile trains from Voorheesville in eastern New York State to Ayer]; allowing Pittsburg & Shawmut Railroad, LLC, doing business as Berkshire & Eastern Railroad [a subsidiary of Genesee & Wyoming], to replace Springfield Terminal [an affiliate of Pan Am Railways] as the operator of Pan Am Southern LLC; and allowing SMS Rail Lines of New York, LLC, to discontinue service and terminate its lease of a rail line between Delanson, N.Y., and Voorheesville, N.Y.[63]

Summary of Quantitative Analysis

The quantitative analysis revealed insights regarding the short- to long-term impacts of the pandemic on the Massachusetts economy.

Between 2010 and 2020, population growth was highest in urban areas with already high population densities, such as Boston and Worcester; however, from July 2020 to July 2021, Boston led all cities in Massachusetts in population decline, followed by Newton, Somerville, Framingham, and Lowell. While the actual reasons for the sharp decline in population in urban areas are unknown but they could potentially be attributed to domestic migration and other factors such as COVID-19-related health concerns, flexible work-from-home options, and higher cost of living in urbanized areas. The shifts also occurred during a period when the country recorded the lowest population growth (0.1%) in the last 120 years. Reduced immigration, a higher mortality rate, and lower birth rates are some of the reasons given for the population decline.

Different industries experienced varying impacts due to the pandemic. Overall, the total GDP of freight-intensive industries' contribution to Massachusetts declined by -0.2% with manufacturing and wholesale remaining relatively stable. Manufacturing and wholesale trade's resilience during the pandemic can be attributed to computer and electronic product manufacturing, chemical manufacturing, and growth in e-commerce during the pandemic's peak. Transportation and warehousing's decline can be attributed to labor shortages in the transit, aviation, and support activities for transportation sectors because of travel restrictions. Retail trade's decline in 2020 can be attributed to brick-and-mortar store closures.

The increase in e-commerce led to a surge in the number of new warehouses and distribution centers. A major area of concern for warehouse and distribution centers is residential complaints regarding increased traffic, noise, and accidents from delivery

vehicles accessing these facilities. In response, cities like Milford passed zoning bylaws that closed loopholes and restricted commercial vehicle parking.

Changes in truck volumes were observed along major highways such as I-90 which recorded some of the highest increases in truck volumes – likely due to truck flows from PNYNJ to Boston and from the capital region of New York through Springfield. Despite an overall decline in the amount of air cargo, its value increased by 84% from 1.4 billion dollars in January 2020 to 2.6 billion dollars in October 2021. Top exports from Massachusetts in 2021 were vaccines for human use, machines for semiconductor manufacturing, electronic integrated circuits, instruments, medical appliances, and filtering/purifying machinery for liquids.

Container shipments through the Port of Boston declined from January 2021 and reached as low as 40% of 2019 volumes in March 2022. The $850 million upgrades to the Port of Boston's Conley Terminal led to the supersized *Ever Fortune* vessel calling at Conley Terminal on January 16, 2022. With the ability to carry up to 12,000 twenty-foot container units, the *Ever Fortune* and other ocean carriers connect Boston to East Asia ports via the Panama Canal. Conley Terminal is expected to increase its shipping routes to six by Fall 2022 and connect shippers to 25 ports around the world.

Intermodal rail's resilience was demonstrated during the pandemic when it rebounded from a steep drop in March and April 2020, achieving a near-full recovery by July 2020. However, during the supply chain crisis in 2021, there was little to no available cargo space for rail service to Massachusetts.

In summary, Massachusetts' diverse economy facilitated its resilience to the pandemic with manufacturing jobs in the science and technology industry remaining steady during 2020.

Qualitative Analysis - Stakeholder Outreach

To supplement the quantitative data analysis efforts, interviews with industry leaders and practitioners were conducted. The interviews helped validate and gain additional local and national insights on the impacts of the pandemic on freight movement and freight planning in Massachusetts. Outreach activities were structured to reflect Massachusetts' demographic and commercial diversity. Interviewees included members of the Massachusetts Freight Advisory Committee, State, and regional planning agencies. **Table 17** summarizes stakeholder responses from the interviews and highlights the recurring themes.

Table 17. Summary of Stakeholder Interviews and Responses

Question	Stakeholder Responses
Most significant impact of the pandemic on operations, workforce, and infrastructure	• Many employees were out of work due to early exposure to the virus and there was an early scramble to procure PPE. • There were observed changes in travel patterns including reduced congestion along major routes though these may be returning to pre-pandemic levels. • In the railroad industry, it was a challenge to move critical personnel from one area to another. • In the maritime industry, it was a challenge ensuring employees were available at container ship terminals. • Truckers were also reluctant to get vaccinated. • Reduced traffic made commercial vehicle operations easier in terms of time on the road and fuel consumption; however, there was more reckless driving and higher passenger vehicle speeds. • The ability to show up on sites to assess compliance was impacted by restricted travel. • Hampered growth, lost revenue. • There was already a national shortage of truck drivers before the pandemic hit, and it seemed to get a lot worse. • Increased operating costs due to higher wages when hiring new truckers Recurring Themes: **workforce challenges; hampered growth; lost revenue; increased wages reduced congestion; road safety concerns; resistance to vaccinations**

Question	Stakeholder Responses
Observations regarding the impact of the pandemic on the Massachusetts transportation network	• Adding COVID-19 compliance measures in addition to existing safety procedures in the rail industry made things more complicated. • Truckers were happy moving cargo because they were not competing with passenger vehicles. • There were fewer cars on the road and less law enforcement, but often the cars that were on the road were speeding. • COVID-19 helped with truck parking as rest areas were not as busy • Observed growth in last-mile deliveries. Competing demand for curb space parking. • Preference for home deliveries, • There has been some consolidation of delivery services to achieve greater efficiency, rather than having a larger number of separate vehicles. • Straight across the board, nobody has been immune to the impact of the staffing and supply changes. There is a domino effect–locally, the trucking community has been significantly impacted. • There is competition amongst commercial driver's license-licensed operators (Amazon, UPS) as they are giving more attractive benefits • More air freight than there used to be. More things are being shipped by air. • There's a proliferation of citing projects or last-mile distribution centers in Massachusetts (Amazon warehouses) • Though rail is preferred, it is tough to use rail for small companies. **Recurring Themes: increased regulations; road safety concerns; demand for curb space parking; consolidation of delivery services; observed growth in last-mile deliveries; staff and supply impacts; companies with benefits attract more workers; increase in air freight**

Question	Stakeholder Responses
Operational changes made by your organization due to the COVID-19 pandemic	• Remote learning and virtual meetings became common practice • Shifts had to be spaced out to keep people separate • Created pods of workers to mitigate the spread of infection • Increased cost to get trucks to come out to western Massachusetts • Restrictions were in place for driving out of state. There was some confusion if you had to go into states that required testing • In collaboration with its unions and the Office of Personnel Management, state agencies had to establish a uniform approach to bringing people back to the office. • It is much more challenging to deliver in Boston because deliveries are limited to the daytime. In some NYC communities, only night deliveries are permitted which is preferred as there is less stress on drivers and less fuel consumption. • It's tricky getting onto job sites due to the number of delivery vehicles, especially Amazon. • Accommodating a more flexible work environment for staff **Recurring Themes: virtual meeting adoption; social distancing; fewer recreational drivers on the road; more delivery vehicles at job sites**
Steps to establish reliability and consistency in the organization's supply chain network	• The rail industry has not seen a large rebounding of supply chain correction–very long lead times–larger railroads—having a hard time getting employees to operate trains • Ensured that vendors were following protocols to make sure fuel supply and PPE were received at the ports **Recurring Themes: increased regulations; road safety concerns; demand for curb space parking; consolidation of delivery services**

Question	Stakeholder Responses
Steps to address periodic changes in demand (weekly short-term ups and downs versus long-term changes in demand)	• Forecasting and keeping an open dialogue with customers to ensure MassPort is set up to deliver • Trying to get more commitments from customers to schedule a year out as opposed to 6 months out • Many truck companies are looking for longer-term commitments, which can be hard in this industry. Employee retention is the issue. • The issue may not be a commodity but the availability of drivers to move those commodities • In the Northeast, employee retention may be better (possibly due to better pay/working conditions) but may not be the case in other places (such as Washington) where there is no workforce to bring the products to the customer Recurring Themes: **employee retention issues; driver availability**
Operational changes made to attract and retain employees in the wake of the global pandemic	• Increased presence in job fairs across the region, more advertising and recruiting via social media • Pay raises in certain locations–no layoffs—employees offered better work-life balance • Offering flexibility in ways of working (remotely, hybrid) • Minimal turnover—competitive benefits, especially health insurance and 401K. Benefits seem to be more important than wages to new hires. Being able to spend time at home with family is essential Recurring Themes: **work-life balance; flexible working options**
Role of emerging delivery modes such as cargo bikes, aerial drones, and delivery robots playing in the medium to long term	• It is hard to imagine aerial drones and cargo bikes delivering in the snow. Massachusetts does not do a great job with its sidewalks and corner curb cuts. Modes like delivery robots share the sidewalk with pedestrians, and the street space is cut down during the winter as well Recurring Themes: **snow and climate concerns; street space shared with pedestrians**

Question	Stakeholder Responses
Steps to adopt automation as part of the company's supply chain improvement strategy	• Some elements of the process of movement do involve automated tasks or automated information exchange • Not much room for automation because the nature of the trucking industry is very hands-on • Converted some paper processes to new software platforms. The pandemic has spurred innovation Recurring Themes: **Automation in trucking is difficult to achieve; new software processes; innovation**
Organizational goals relating to decarbonization and emission-free deliveries	• There are ongoing discussions related to transitioning to electric locomotives • However, as hauls are heavy it could take some time before electrification takes off in the trucking industry, especially in the New England region with its harsh climate conditions • Agencies have proposed emission reduction programs and are looking to transition to clean fuel sources such as renewable electricity and renewable natural gas Recurring Themes: **ongoing climate change initiatives; long-term interest in zero-emission vehicles**
How has inflation impacted your organization's ability to meet consumer demand for your products?	• The cost of diesel fuel has affected operations, paying over double that last year • Inflation hasn't directly impacted MassPort yet – capacity on ships and reliance on freight vessels have obstructed the ability to meet consumer demand • Things are more expensive now, making it more challenging for the transportation industry because you can't plan for panic buying (Unistress). Having to include room for price changes in contracts Recurring Themes: **increase in fuel costs; price changes in contracts**

EPA = U.S. Environmental Protection Agency

NYC = New York City

Summary of Qualitative Analysis Findings

Workforce and Operations

Retaining workers has remained a constant hurdle in transportation and logistics. Vaccination mandates impacted the transportation industry already struggling to hire and retain workers in a tight labor market, resulting in hampered growth and decreased revenue across the rail and trucking fields. Labor shortages, a long-standing issue in the transportation industry, were exacerbated by the pandemic. Companies had to pay a higher rate to hire new truckers which significantly impacted operating costs. Transportation leaders increased their presence in job fairs across the region, spending more on advertising, and recruiting via social media. Companies have had to offer competitive benefits, especially health insurance and a 401K. During the pandemic, front offices saw that benefits seem to be more important than wages to new hires. Certain companies and locations have had to offer wage increases to keep employees and offer a better work-life balance.

During the height of the pandemic, to mitigate contagion, work practices across transportation had to be redefined: Where viable, workers were allowed to work from home, and shifts were spread out. Remote learning and virtual meetings have become common practices.

New COVID-19 compliance measures put in place in addition to existing safety procedures made operations more complex and, in some cases, created additional stress on the supply chain. Some companies have created pods of workers to mitigate the spread of infection but suffered the increasing costs of having to house workers in separate accommodations. The trucking industry, for example, saw an increase in the cost to get vital trucks to Western Massachusetts.

Before the COVID-19 pandemic, roadway congestion resulted in many hours of lost productivity for commercial travel across the Commonwealth. However, as shutdowns were implemented and more of the workforce began to work from home, traffic on many of the state's highways eased which in turn allowed truckers to move freight quicker with less fuel consumption. Truckers were happy moving cargo as they were not competing with passenger vehicles cars for space on roadways. Truckers reported that although fewer passenger vehicles were on the roads, there was an uptick in reckless driving leading to less safe driving conditions.

Historically, a considerable challenge for truckers has been finding a safe and comfortable place to rest after many hours on the road. In some cases, the COVID-19 outbreak alleviated drivers' concerns about finding parking at rest stops. These facilities were not as congested leaving more room for truckers to safely park their vehicles and rest.

It was noted that truckers prefer delivering in NYC because deliveries in some communities are only permitted at night

time. During these off-hour delivery times, there are fewer pedestrians and private drivers, resulting in quicker delivery of goods. Interviewees noted that the off-hour program is conducive because there is less stress on drivers and less fuel consumption. In Boston, however, deliveries are limited to the daytime making them more challenging.

COVID-19 reshaped last-mile logistics, causing an increase in last-mile deliveries that is likely to continue. Consumers have adapted to online shopping resulting in more at-home deliveries. There has been increased demand for curb space and in response, companies are consolidating delivery services to achieve greater efficiency rather than having multiple separate vehicles making deliveries.

In the rail and maritime industries, the major challenge was labor shortage during the peak of the pandemic. For railroads, it was a challenge to move personnel from one location to another and employees were out of work due to early exposure to COVID-19. Furthermore, implementing compliance measures in addition to existing safety procedures was reported to make things more complicated in the industry. Long lead times for deliveries continued to plague the industry during the recovery as demand surpassed supply.

Innovation and Automation

Members of the transportation industry in the Commonwealth find it hard to imagine aerial drones and cargo bikes delivering in a Massachusetts winter. There are still many questions regarding how far off the industry is from autonomous trucks on highways, with numerous regulatory hurdles to getting self-driving trucks approved across the country and the hundreds of thousands of jobs that would be at stake. Trucking leaders believe that if it does happen, there will be a slow rollout but acknowledge that it does have the opportunity to cut down on operating costs.

Data Assessment and Summary of Key Findings

Opportunities exist for Massachusetts to strengthen its freight network to be more resilient based on observations and lessons learned from the COVID-19 pandemic. The 2017 Statewide Freight Plan developed strategies for Massachusetts to accommodate future unknowns or the continuation of existing trends. These strategies included:

- *Immediate Strategies* to address a current or near-term need,
- *Robust Strategies* to address issues that are expected to arise in the future but should be appropriate for the Commonwealth no matter what the future holds,
- *Hedging Strategies* that might not be needed, but if they are needed will need to have started implementing,
- *Shaping Strategies* that allow agencies in Massachusetts to influence – and hopefully direct – trends for the future, and
- *Deferred Strategies* that might be necessary, but safe to wait and see what happens.

In response to observations and lessons learned from the pandemic, an "impact-certainty about the future" matrix was proposed to categorize the pandemic's impacts and determine which 2017 Statewide Freight Plan strategies should be modified or updated. As shown on **Figure 65** to **Figure 68** and in **Table 18** to **Table 21**, the suggested recommendations are grouped by infrastructure, operations, policy, and workforce to align with the 2017 Statewide Freight Plan recommendations. Suggested responses to the pandemic's impact using the "impact-certainty about the future" matrix are categorized as follows:

- **Address Immediately** – These are medium-to-high COVID-19 impacts that require immediate attention as the impacts are long-term and there is enough information available to start addressing them.
- **Investigate Triggers** - These are medium-to-high COVID-19 disruptors that were observed for a short period for which further studies are required to determine triggers and possible scenarios.
- **Test System Resiliency** – These are low-to-medium COVID-19 impacts that are expected to continue into the long term based on lessons learned and require the system's resilience to be able to withstand these impacts.
- **Possible Noise** – These are low-to-medium COVID-19 impacts that were observed for a short period with no immediate action to be taken.

Figure 65. Operations: Impact-Certainty about the Future Matrix

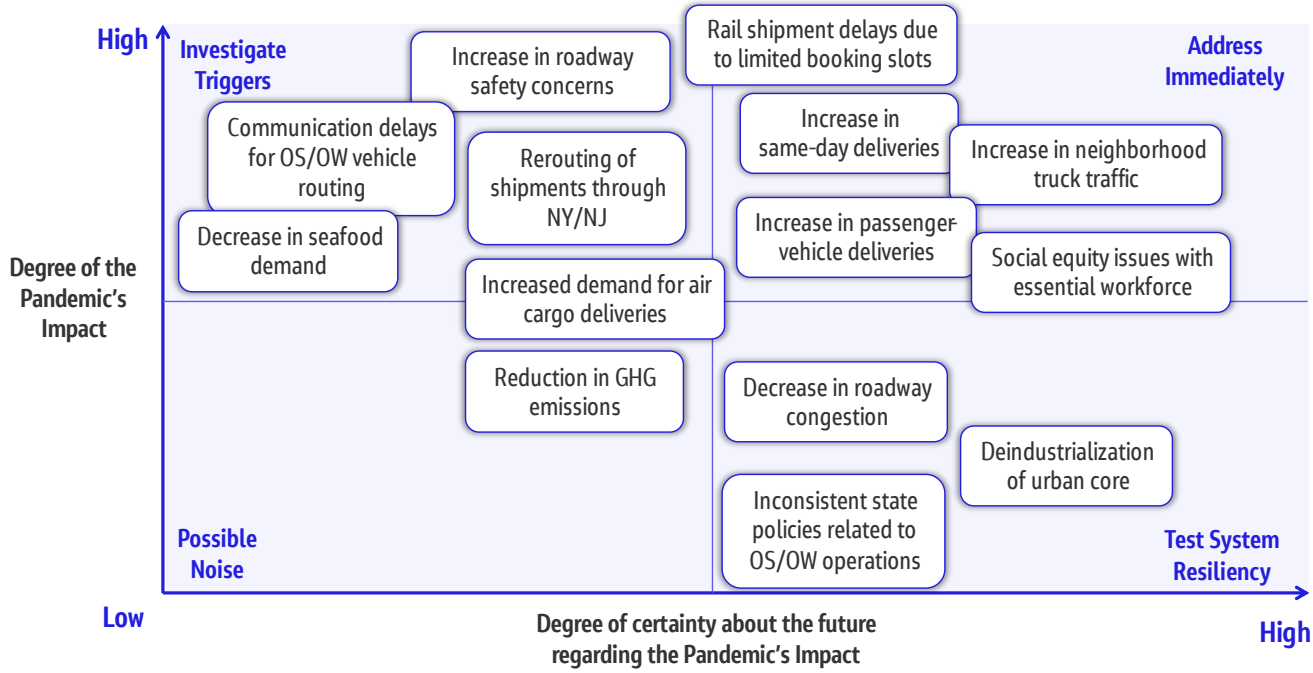


Figure 66. Infrastructure: Impact-Certainty about the Future Matrix

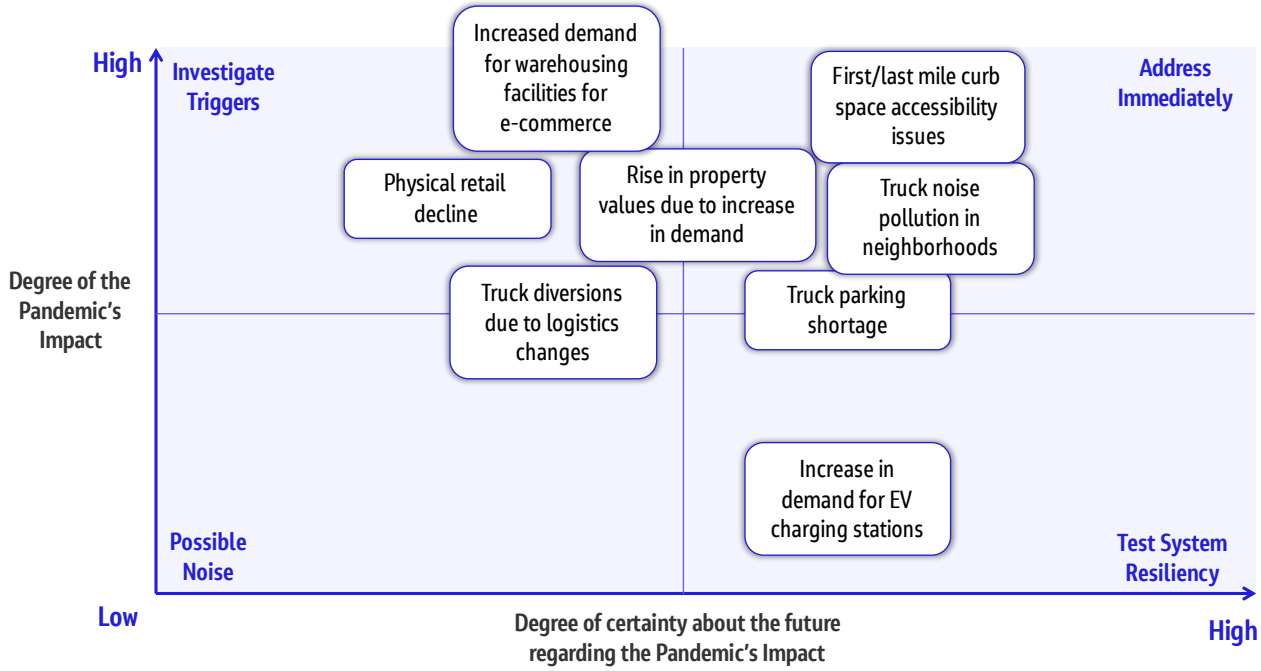


Figure 67. Policies: Impact-Certainty about the Future Matrix

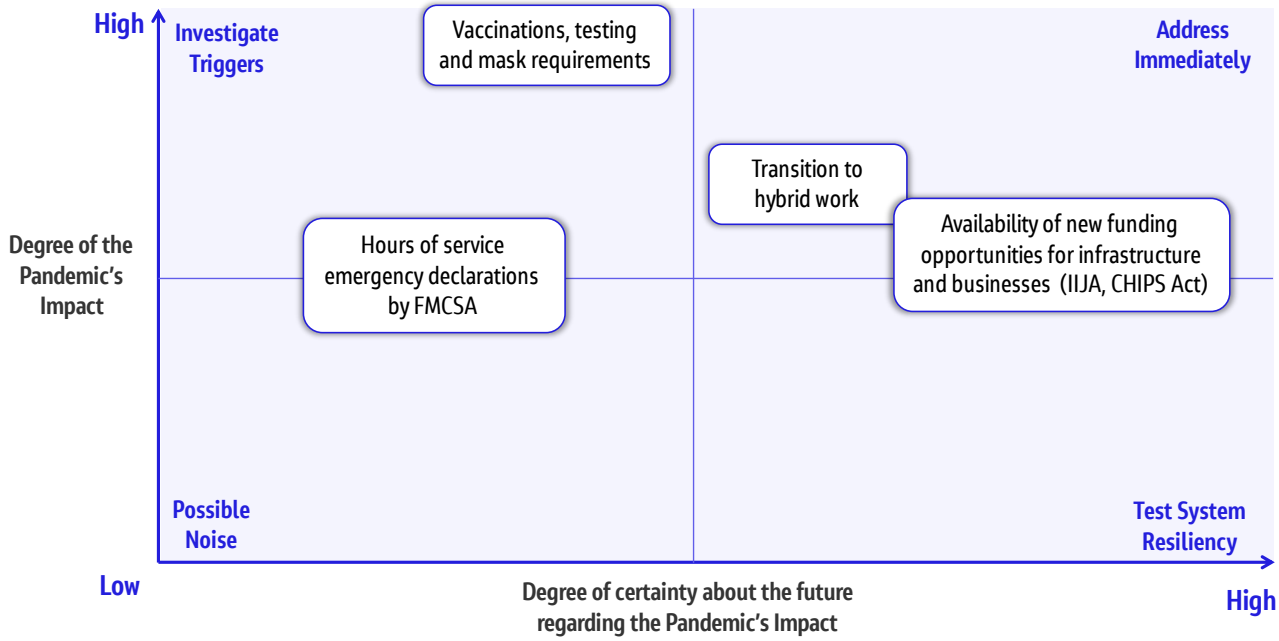


Figure 68. Workforce: Impact-Certainty about the Future Matrix

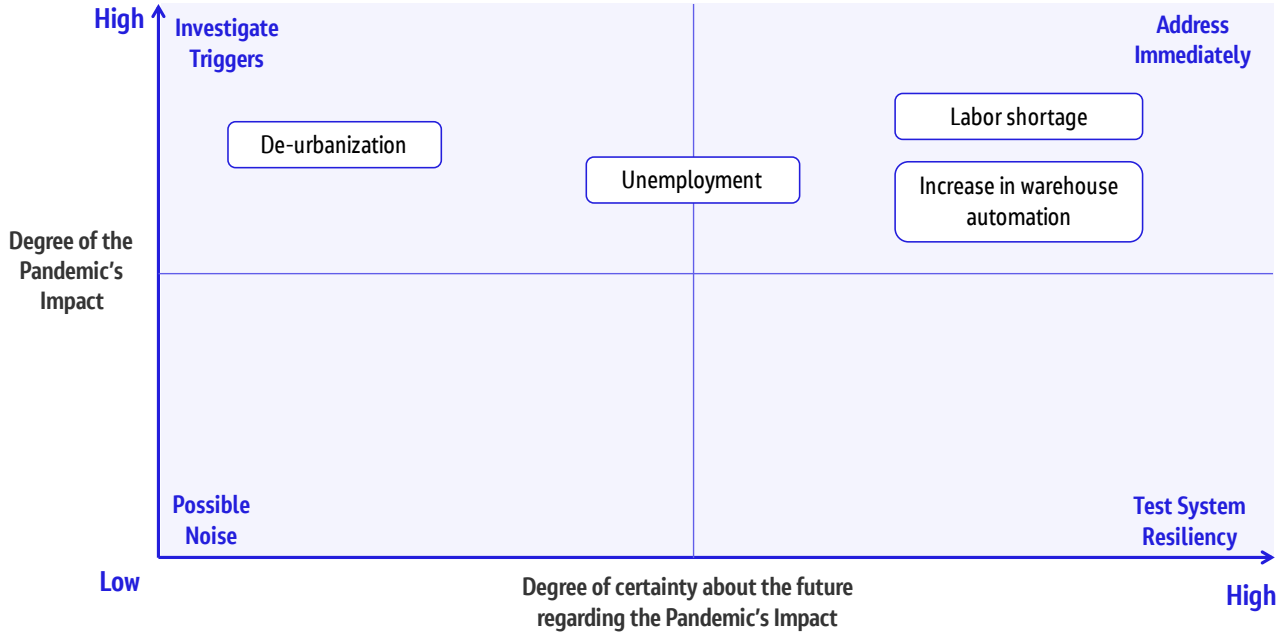


Table 18. Operations: Summary of the Pandemic's Impacts and Suggested Response

No.	Pandemic Impact	Suggested Response	Applicable 2017 Strategy	Modification to Strategy	Additional Considerations
1	**Increase in same-day deliveries**	Address Immediately	Build right-sized distribution centers inside Route 128	Move from *Hedging and Shaping* to *Immediate*	Expand strategy to address efficient land use and monitor locations with increased e-commerce demand; consider applicable strategies developed in NCHRP Research Report 998: Planning Freight-Efficient Land Uses: Methodology, Strategies, and Tools
2	**Social equity issues with essential workforce**	Address Immediately	Develop a workforce strategy for freight professions	No change	Incorporate equity considerations into workforce development, transport access, and environmental impacts; consider applicable strategies developed in Evaluating Transportation Equity - Guidance For Incorporating Distributional Impacts in Transportation Planning
3	**Increase in neighborhood truck traffic**	Address Immediately	Develop delivery areas in urban districts and town centers	Move from *Hedging and Shaping* to *Immediate*	Conduct studies to determine appropriate locations for delivery areas that minimize truck traffic in residential neighborhoods; consider applicable strategies developed in NCHRP Research Report 998: Planning Freight-Efficient Land Uses: Methodology, Strategies, and Tools
4	**Increase in passenger-vehicle deliveries**	Address Immediately	Build standardized small package drops	Move from *Deferred* to *Robust*	Conduct studies to determine the impact of passenger-vehicle deliveries and best practices to mitigate negative impacts
5	**Rail shipment delays due to limited booking slots**	Investigate Triggers/ Address Immediately	Upgrade rail lines to the 286k standard	No change	Upgrading rail lines will provide additional capacity and improve the efficiency of the rail system; prioritize freight rail improvements based on lessons learned from How America's Freight Railroads Responded

No.	Pandemic Impact	Suggested Response	Applicable 2017 Strategy	Modification to Strategy	Additional Considerations
6	**Increase in roadway safety concerns**	Investigate Triggers	N/A	N/A	Continue tracking future trends in traffic volume and crashes to determine long-term impacts
7	**Rerouting of shipments through NY/NJ**	Investigate Triggers	Encourage increased use of underutilized gateway infrastructure (ports and airports)	Move from *Hedging and Shaping* to *Robust*	Coordination with MassPort to develop strategies that attract ocean carriers
8	**Communication delays for OS/OW vehicle routing**	Investigate Triggers	Better integrate supply chain information to reduce administrative and regulatory delays	Move from *Hedging and Shaping* to *Robust*	Explore additional tools to facilitate integration including dashboards and mobile-app technologies
9	**Decrease in seafood demand**	Investigate Triggers	N/A	N/A	Continue to monitor seafood demand trends using the NOAA Commercial Fisheries Landings database
10	**Decrease in roadway congestion**	Test System Resiliency	Resolve key bottlenecks on highways	No change	Monitor changes in truck volumes on major highways and monitor bottlenecks; consider applicable strategies developed in Quick Response Freight Methods: Third Edition
11	**Deindustrialization of the urban core**	Test System Resiliency	N/A	N/A	Monitor trends in deindustrialization and identify the main factors impacting it; consider applicable strategies developed in NCHRP Research Report 998: Planning Freight-Efficient Land Uses: Methodology, Strategies, and Tools

No.	Pandemic Impact	Suggested Response	Applicable 2017 Strategy	Modification to Strategy	Additional Considerations
12	**Inconsistent state policies related to OS/OW operations**	Test System Resiliency	Harmonize OS/OW permitting across New England	No change	Consider applicable strategies developed in NCHRP Report 830: Multi-State, Multimodal, Oversize/Overweight Transportation
13	**Increased demand for air cargo deliveries**	Investigate Triggers/ Possible Noise	Improve the efficiency of air cargo processing at Logan Airport and in surrounding areas	No change	Outlook for air cargo in the short and long term remains strong, though staff shortages continue to remain a major concern.
14	**Reduction in GHG emissions**	Possible Noise	Support policies to reduce carbon dioxide emissions from all freight vehicles	No change	The pandemic's impact on GHG emission reduction was short term thus a need to examine longer-term solutions based on lessons learned.

GHG = greenhouse gas

N/A = not applicable

OS/OW = oversize/overweight

Table 19. Infrastructure: Summary of the Pandemic's Impacts and Suggested Response

No.	Pandemic Impact	Suggested Response	Applicable 2017 Strategy	Modification to Strategy	Additional Considerations
1	**First/last mile curb space accessibility issues**	Address Immediately	Provide collaborative guidance and support to MPOs and local governments in integrating freight, distribution, and loading into their planning and zoning land use decision-making processes	Move from *Hedging and Shaping* to *Immediate*	Conduct more robust studies to determine best practices to implement for curb sharing; consider applicable strategies developed in Managing Increasing Demand for Curb Space in the City of the Future (Urban Freight Lab)
2	**Truck parking shortage**	Address Immediately	Build or expand truck stops on primary truck routes	No change	Truck parking availability continues to be a concern and is expected to continue in the long term. Consider applicable strategies developed in the ongoing MassDOT Truck Parking Study.
3	**Truck noise pollution in neighborhoods**	Address Immediately	Develop delivery areas in urban districts and town centers	Move from *Hedging and Shaping* to *Immediate*	Conduct studies to determine appropriate locations for delivery areas that minimize truck traffic in residential neighborhoods; consider applicable strategies developed in NCHRP Research Report 998: Planning Freight-Efficient Land Uses: Methodology, Strategies, and Tools
4	**Rise in property value due to increase in warehouse demand**	Investigate Triggers/ Address Immediately	Build right-sized distribution centers inside Route 128	Move from *Hedging and Shaping* to *Immediate*	Expand strategy to address efficient land use and monitor locations with increased e-commerce demand; consider applicable strategies developed in NCHRP Research Report 998: Planning Freight-Efficient Land Uses: Methodology, Strategies, and Tools

No.	Pandemic Impact	Suggested Response	Applicable 2017 Strategy	Modification to Strategy	Additional Considerations
5	**Increased demand for warehousing facilities for e-commerce**	Investigate Triggers	Identify and preserve existing rural and industrial sites for warehousing and distribution development	Move from *Hedging and Shaping* to *Robust*	Consider applicable strategies developed in NCHRP Research Report 998: Planning Freight-Efficient Land Uses: Methodology, Strategies, and Tools
6	**Physical retail decline**	Investigate Triggers	N/A	N/A	Investigate trends in physical retail repurposing and foreseeable impacts. Many small shops are moving from brick-and-mortar to online shops or temporary pop-ups to meet increasing e-commerce demands
7	**Truck diversions due to logistics changes**	Investigate Triggers/Possible Noise	N/A	N/A	Investigate major truck routes over the next 5 years and identify any major shifts and trends
8	**Increase in demand for electric vehicle charging stations**	Test System Resiliency	Electrify truck stops	No change	There are opportunities through the IIJA to explore the feasibility and development of electric charging stations

MPO = Metropolitan Planning Organization

Table 20. Policy: Summary of the Pandemic's Impacts and Suggested Response

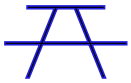
No.	Pandemic Impact	Suggested Response	Applicable 2017 Strategy	Modification to Strategy	Additional Considerations
1	**Transition to hybrid work**	Address Immediately	N/A	N/A	Investigate the impact of hybrid work on major bottlenecks and urban congestion; consider applicable strategies developed in the Future of Work Report.
2	**Vaccinations, testing, and mask requirements**	Investigate Triggers	Develop a workforce strategy for freight professions	No change	Expand strategy to incorporate the impact of such mandates on freight labor shortages and recommend future workforce employment programs that account for these impacts
3	**Hours of service emergency declarations by FMCSA**	Investigate Triggers/Possible Noise	N/A	N/A	Consider applicable strategies developed in the ongoing MassDOT Truck Parking Study that address the needs of truckers.
4	**Availability of new funding opportunities for infrastructure business – IIJA, CHIPS Act**	Test System Resiliency/Address Immediately	Improve the condition of freight network assets	No change	Expand strategy to identify funding buckets that can be used to address different freight asset improvements

FMSCA = Federal Motor Carrier Safety Administration

Table 21. Workforce: Summary of the Pandemic's Impacts and Suggested Response

No.	Pandemic Impact	Suggested Response	Applicable 2017 Strategy	Modification to Strategy	Additional Considerations
1	**Labor shortage**	Address Immediately	Develop a workforce strategy for freight professions	No change	Labor shortage continues to be a concern, requiring upskilling, incentives (such as flexible work hours), or other strategies that make freight-intensive industries attractive.
2	**Increase in warehouse automation**	Address Immediately	Develop a workforce strategy for freight professions	No change	Consider strategies that incorporate workforce upskilling and complements rather than competing with warehouse automation
3	**Unemployment**	Investigate Triggers/Address Immediately	Develop a workforce strategy for freight professions	No change	Consider strategies that address workforce upskilling and incentive shifts from one industry to another.
4	**De-urbanization of workforce**	Investigate Triggers	N/A	N/A	Conduct studies to investigate the trends and causes of workforce de-urbanization (such as increased cost of living) and determine how this trend will evolve in the long term and its implications mitigated.

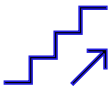
Some immediate considerations based on input from the Freight Advisory Committee and the impact certainty about the future matrices include:



Develop and deploy a truck parking availability system that detects, monitors, and provides real-time parking availability to truck drivers.

Develop and promote a safety campaign that prepares drivers to return to normal life after long periods of lockdowns.

Collaborate with on-demand mobility service providers to ensure adequate driver training and monitoring during last-mile deliveries.



Promote workforce upskilling to meet demand and address the labor shortage.

Promote multistate collaboration in addressing interstate over-dimensional load movements.

Take advantage of recent legislation (for example, the CHIPS and Science Act and the IIJA) to favor Massachusetts' long-term economic growth.

Create and promote clear communication channels to address inquiries regarding oversized and overweight vehicle movement.

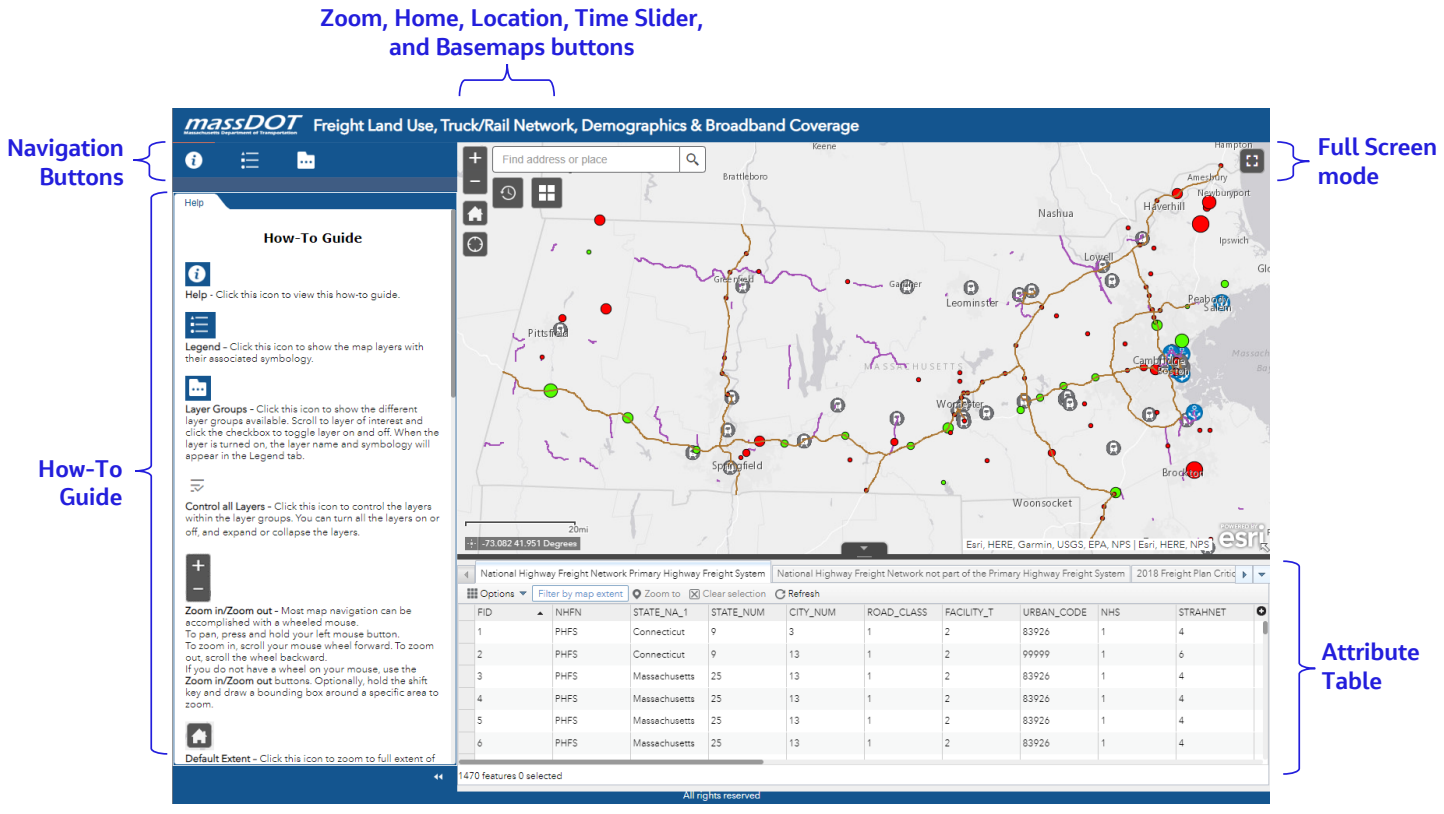
Appendices

Appendix A: Online Maps and Dashboards

A.1. Freight Land Use, Truck/Rail Network, Demographics & Broadband Coverage

Published at:
https://massdot.maps.arcgis.com/apps/webappviewer/index.html?id=c5a2848b91e24d93a04e44a631b2954c

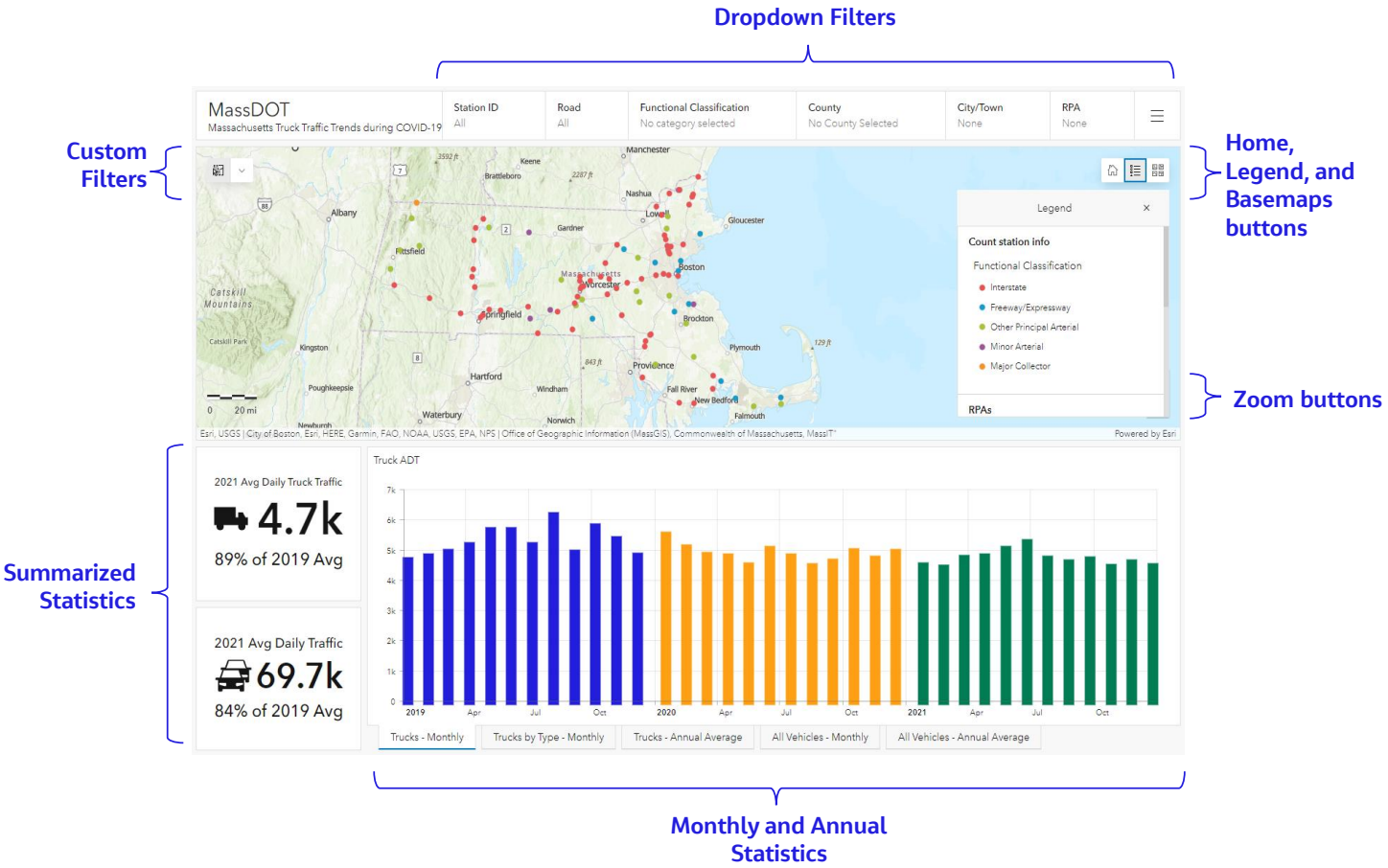
This dashboard provides information on Massachusetts' freight land use, truck/rail network, demographics, and broadband coverage. Layers can be toggled on and off and overlaid on top of each other to derive insights and identify trends. The list of layers published on the dashboard can be accessed through the Layer Groups navigation button.



A.2. Massachusetts Truck Traffic Trends During COVID-19

Published at:
https://massdot.maps.arcgis.com/apps/dashboards/70ff9df0c4fa4bb6876e43f410ccad77

This dashboard provides a simple-to-use interface to query truck volumes by station, road, functional classification, county, city/town, and regional planning agency (RPA). Statewide traffic volume trends before the pandemic, during the pandemic's peak, and recovery period can be examined. The data is limited to MassDOT permanent count stations for which vehicle classification counts were readily available. For additional and more up-to-date traffic counts, visit https://www.mass.gov/traffic-volume-and-classification-in-massachusetts.



Appendix B: Summary of Data Sources Used

Name (with data source link)	Description	Type	Study use	Geography
US Census American Community Survey 5-Year Estimates	Geodatabases that provide geography information from the 2020 TIGER/Line Shapefiles and data from the 2016-2020 American Community Survey 5-year estimates; includes demographics, employment, and minority populations	Economic and demographic data	Existing conditions, demographics, socioeconomics, and Title VI, employment	Block Groups, County, State
US Census 2020 Decennial Census 2020 Census Redistricting Summary	National-level shapefiles to join with the geometry and selected attributes from the 2020 Census TIGER/Line Shapefiles and the 2020 Census Summary File 1 Demographic Profile for the United States and Puerto Rico	Economic and demographic data	Existing conditions, demographics, socioeconomics, and Title VI, employment	County, Census Tract
US Bureau of Labor Statistics, Mass.gov Department of Economic Research	Labor force, employment/unemployment rate	Economic and demographic data	Existing conditions, employment, and economic profile	City/Town, County, State
Quarterly Census of Employment and Wages	North American Industry Classification System (NAICS) industry, county, number of employees	Economic and demographic data	Existing conditions, employment, and economic profile	County, State
US Bureau of Economic Analysis	Gross Domestic Product	Economic and demographic data	Existing conditions, economic profile	County, State

Name (with data source link)	Description	Type	Study use	Geography
National Oceanic and Atmospheric Administration (NOAA) Commercial Fisheries Landings	Statistics on the volume and value of seafood landings, exports, and imports	Economic data	Existing conditions, economic profile	State
Freight Analysis Framework	Comprehensive picture of freight movement among states and along major road networks	Economic data	Freight volumes, origin-destination movements by mode, and commodity	State, Major road network
BTS - Air Carrier Statistics - Air Freight Data Summary by Origin and Destination	Cargo volume movement between major airports, monthly	Air cargo data	Air cargo volumes, origin-destination movements	Origin and Destination facility location
FAA - All-Cargo Data for U.S. Airports	Annual tonnage shipped and received at major airports in the US	Traffic, freight infrastructure characteristics	Air cargo	Facility location
Port of Boston - Conley Terminal Monthly Volume Summary	Monthly summary of twenty-equivalent unit containers (TEUs) by import/export and market, vessel calls, and passengers at the Port of Boston - Conley Terminal	Container freight summary data	Freight travel trends	Facility location
Bureau of Transportation Statistics Container Port Activity Dashboard	Information about cargo goods movement to and from the top 10 container ports in the US	Container freight summary data	Freight travel trends	Facility location

Name (with data source link)	Description	Type	Study use	Geography
StreetLight Data	Origin and destination analysis by vehicle class, annual average daily traffic, and top truck routes	Traffic	Truck origin-destination analysis, traffic volumes, vehicle classification	Traffic analysis zones, network links
Geotab	Origin and destination by vehicle class, industry, and vocation analysis	Traffic	Truck origin-destination analysis, traffic volumes, vehicle classification	Traffic analysis zones
Crash data 2021 Crashes	Massachusetts crash statistics	Safety	Safely analysis and improvements	Latitude and Longitude
Statewide Roadway Inventory	Geographic database of all roads in Massachusettes	Roadway physical characteristics, traffic	Traffic volumes, right-of-way, geometric characteristics, operational characteristics	All public roadways in the State
Railroad Facilities	Geographic database of railroad infrastructure	Freight infrastructure characteristics	Infrastructure conditions	Railroad system linework
Rest Areas	Location of safety rest areas throughout the study area	Freight infrastructure characteristics	Freight-supportive infrastructure	Truck parking locations
Vehicle Classification Counts	Truck and passenger classification counts by month for all available stations in Massachusetts	Traffic trends, truck volumes	Traffic analysis, COVID-19 recovery monitoring	Count station location (point)
4G LTE Coverage	Geographic database of 4G LTE Data and Voice Coverage for AT&T Mobility, T-Mobile, Uscellular, and Verizon	Existing broadband coverage	Broadband availability	State

Name (with data source link)	Description	Type	Study use	Geography
FCC Broadband Health in America	Geographic database of broadband access statistics	Existing broadband access by county	Broadband availability	County
Intermodal Freight Facilities Pipeline Terminals	Geographic database of pipeline terminals. The data consists of location information, truck/rail/water mode connections, storage capacity, and a list of commodities handled at the terminal	Freight infrastructure characteristics	Infrastructure conditions	Latitude and Longitude
Intermodal Freight Facilities Air-to-Truck	Geographic database of the location of air-to-truck intermodal freight facilities for the top 60 airports by total freight moved in 2017	Freight infrastructure characteristics	Infrastructure conditions	Latitude and Longitude
Intermodal Freight Facilities Rail TOFC/COFC	Geographic database of the location of rail TOFC/COFC freight transfer facilities	Freight infrastructure characteristics	Infrastructure conditions	Latitude and Longitude
Freight Rail Yards	Geographic database of the location of freight rail yards in Massachusetts	Freight infrastructure characteristics	Infrastructure conditions	Latitude and Longitude
2018 Freight Plan Critical Urban and Rural Freight Corridors	Geographic database of roadways identified as a critical urban or rural freight corridor	Freight infrastructure characteristics	Infrastructure conditions	Roadway network linework

Name (with data source link)	Description	Type	Study use	Geography
Massachusetts Seaports	Geographic database of the location of passenger and freight seaport locations in Massachusetts	Freight infrastructure characteristics	Infrastructure conditions	Latitude and Longitude
Census 2020 Environmental Justice Populations	Geographic database of Census 2020 environmental justice populations	Economic and demographic data	Existing demographics and socioeconomics	Block Groups
Historically Disadvantaged Communities	Geographic database of census tracts identified as historically disadvantaged based on at least four of the six transportation disadvantaged indicators	Economic and demographic data	Existing demographics and socioeconomics	Census Tract
National Highway Freight Network	Geographic database of the national highway freight network including the Primary Highway Freight System and non-Primary Highway Freight System	Freight infrastructure characteristics	Infrastructure conditions	Roadway network linework
MassGIS Data: Property Tax Parcels	Parcel information including build year, build size, and freight land use type for parcels	Freight infrastructure characteristics	Infrastructure conditions	Land parcels

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