Northeastern University
Dukakis Center For Urban and Regional Policy

Staying on Track

A Framework and Benchmark Indicators for Achieving a Sustainable Transportation System in Greater Boston

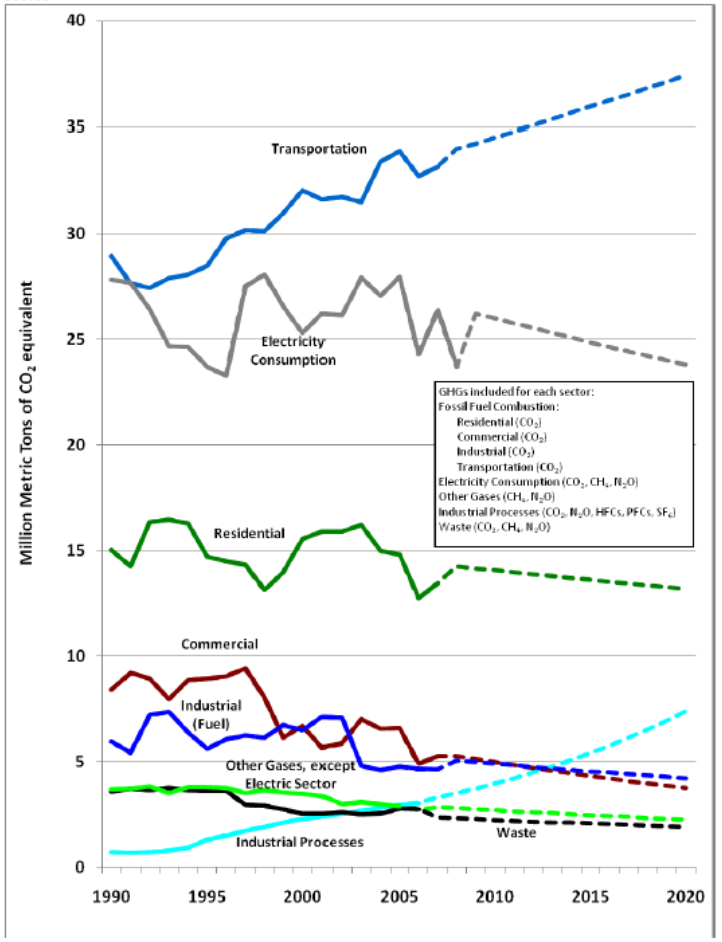
November 19, 2012

Transportation and sustainability

"Transportation is responsible for 36 percent of Massachusetts's greenhouse gas emissions, the largest, fastest growing share by sector, and perhaps the hardest to tackle."

MassINC Rising to the Challenge report (April 2012)

Figure 2: Massachusetts Baseline and BAU Projection of GHG emissions 1990-2020 by sector



Dukakis Center projects on better understanding our transportation systems

Project	Geography
Sustainable transportation system framework and benchmark indicators report	Varies (some state, some Boston-Cambridge-Quincy Metropolitan Statistical Area, some greater Boston/MetroFuture region)
Community sustainable transportation rating system (SUSTAIN)	All 351 cities and towns
MBTA station areas database and rating system for equitable transit-oriented development (eTOD Score)	Neighborhoods (within ½ mile) around MBTA commuter rail and rapid transit stations and Key Routes bus stops

Selecting sustainable transportation metrics

- Indicators selected to best characterize key attributes of the new sustainable transportation paradigm given the limits of current data collection and availability
- Tracking indicators were chosen to capture must be updated regularly (preferably annually)
- Benchmarks compare Massachusetts/Greater Boston to other similar places to help assess how we are doing compared to other states and regions

What's missing?

- **Travel Behavior**
  - –Most available data is American Community Survey data which is limited to commute trips
  - –Recent state travel survey provides important information but cannot be used as an indicator since it will not be updated regularly
- **Bike/Ped**: Very little data on bicycle and pedestrian travel and infrastructure, as well as key safety metrics, is collected and updated regularly
- **Transit**: Due to Beyond Boston effort more baseline data is available on regional transit authorities (RTAs) but consistent annual data collection and reporting and additional data (eg on asset condition) is needed
- **Congestion**: Data only collected for driving, not for transit or bicycle/pedestrian facilities

A Framework for Sustainable Transportation in Greater Boston and Massachusetts

Shifting paradigms: Rethinking the key attributes of a transportation system

Transportation planning and policy historically focused on	The new sustainable transportation paradigm focuses more on
Mobility	Accessibility
Modes	Options
Transportation (and recently land use)	Places and People
Congestion	Convenience
Distances	Time

A sustainable transportation system

- is **well-maintained** and sustainably **funded**;
- allows everyone to have **equitable access** to a region's jobs, homes and important goods, services, and opportunities;
- provides users with real **transportation options** that are **affordable**, **safe** and **convenient**;
- and ensures long-term environmental **sustainability** by minimizing greenhouse gas emissions

Selecting sustainable transportation metrics

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Nine categories of metrics

- System condition
- Funding sustainability
- Transportation options
- Accessibility
- Equity
- Affordability
- Safety
- Convenience
- Sustainability

31 Indicators

10 Benchmarks

Setting a Baseline: Measuring Travel

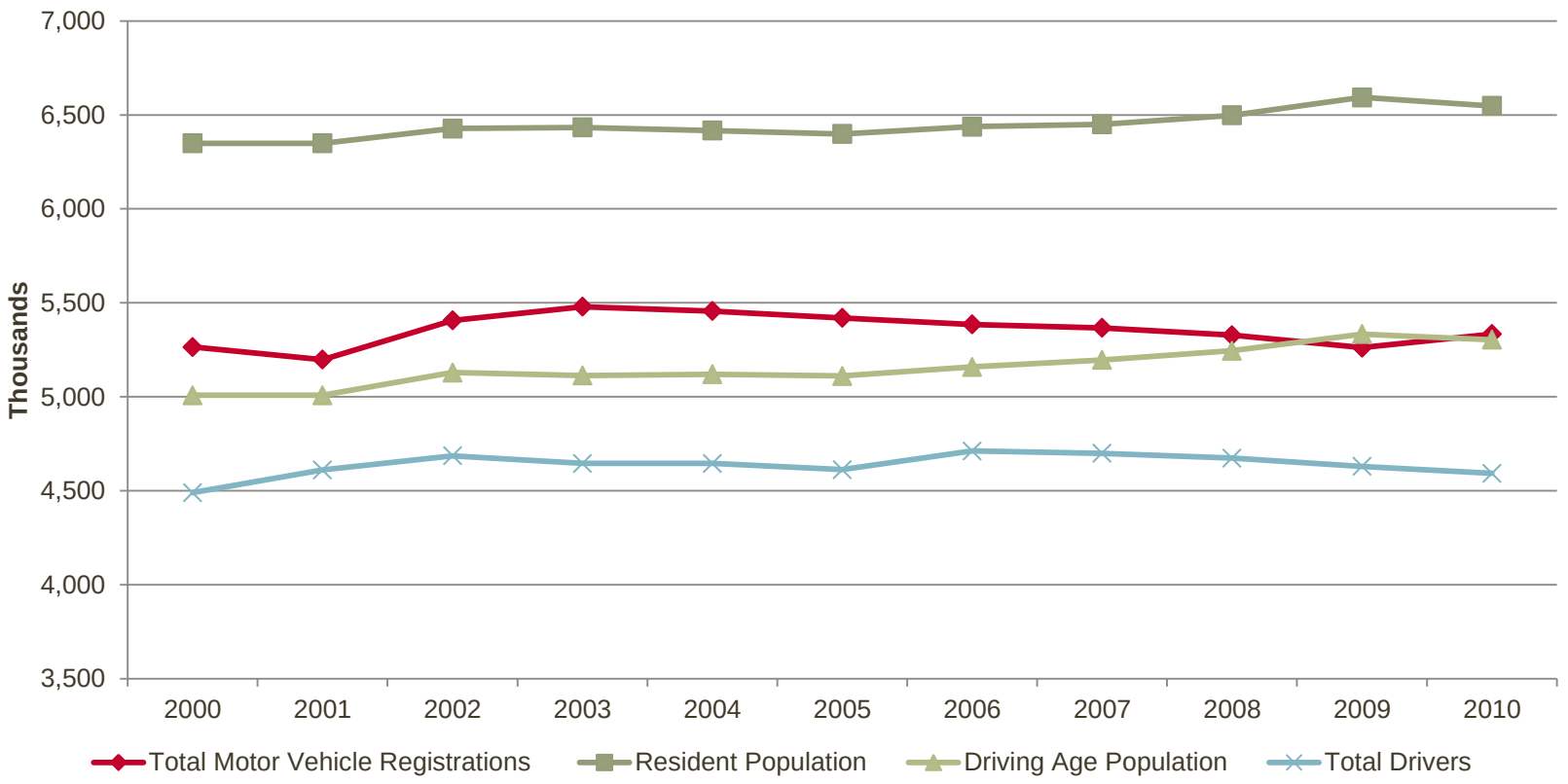
What is the best overall way to track progress toward more sustainable travel patterns?

- **Vehicle Miles of Travel**
  - –Although it should NOT be used as a measure of “throughput”
  - –VMT is an important measure from a sustainability perspective because it is proportional to greenhouse gas emission
  - –Tracking VMT, in addition to person miles of travel by mode, will allow for comparison to other metros and states
- Personal miles of travel by mode should also be used as an overall tracking indicator once MassDOT begins tracking (as part of monitoring mode shift goal) that should also

Travel Metrics

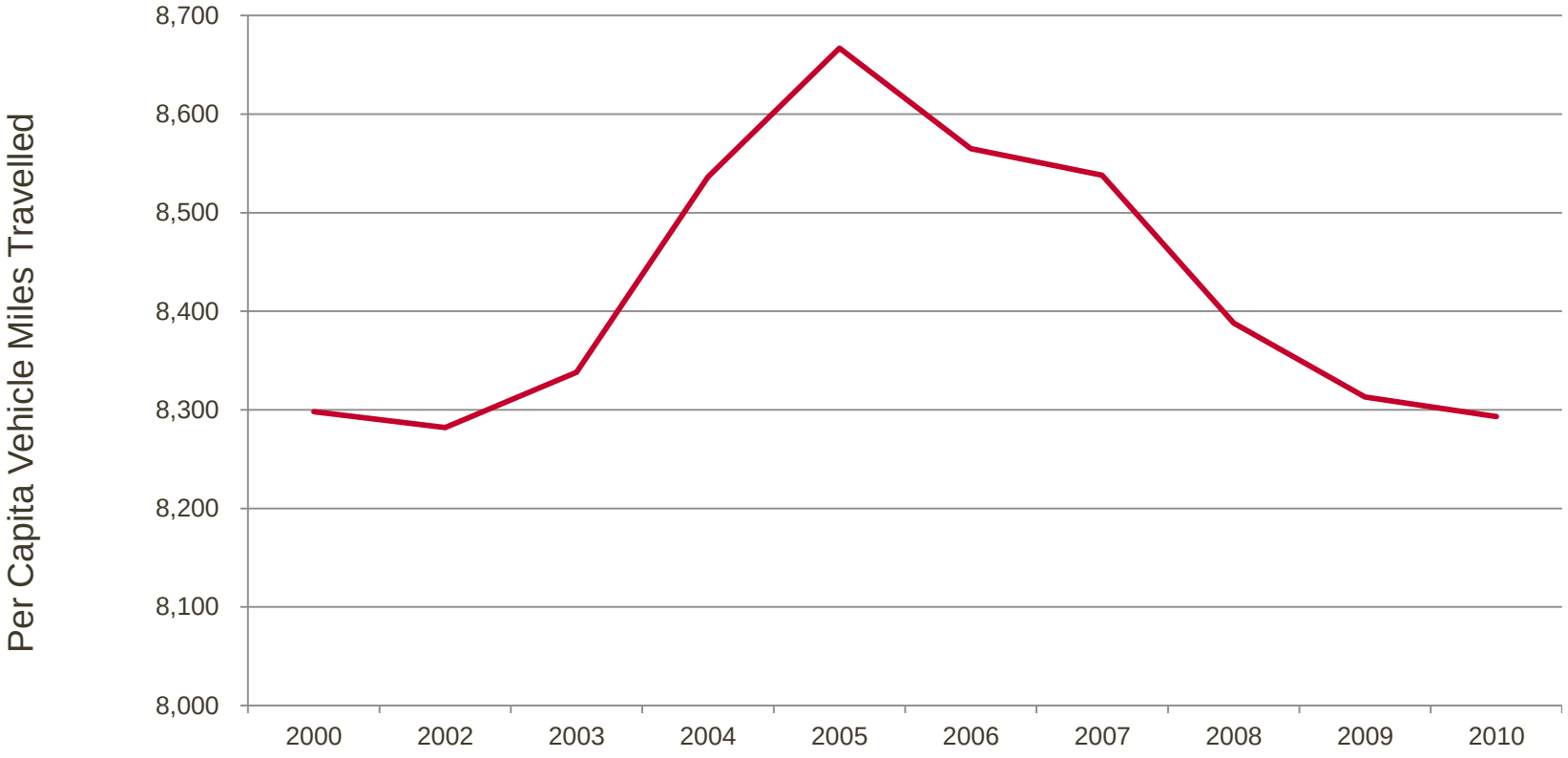
Metric	Type
Changes in Population, Vehicles and Drivers in Massachusetts	Indicator
Statewide Vehicle Miles Travelled Per Capita	Indicator
Daily Vehicle Miles Travelled Per Household By Community	Indicator
VMT Per Capita, Massachusetts and Peer States	Benchmark
Mode Shift: Combined Walk/Bike/Transit Share of Statewide Personal Miles of Travel	Indicator (future)

Changes in Population, Vehicles and Drivers in Massachusetts



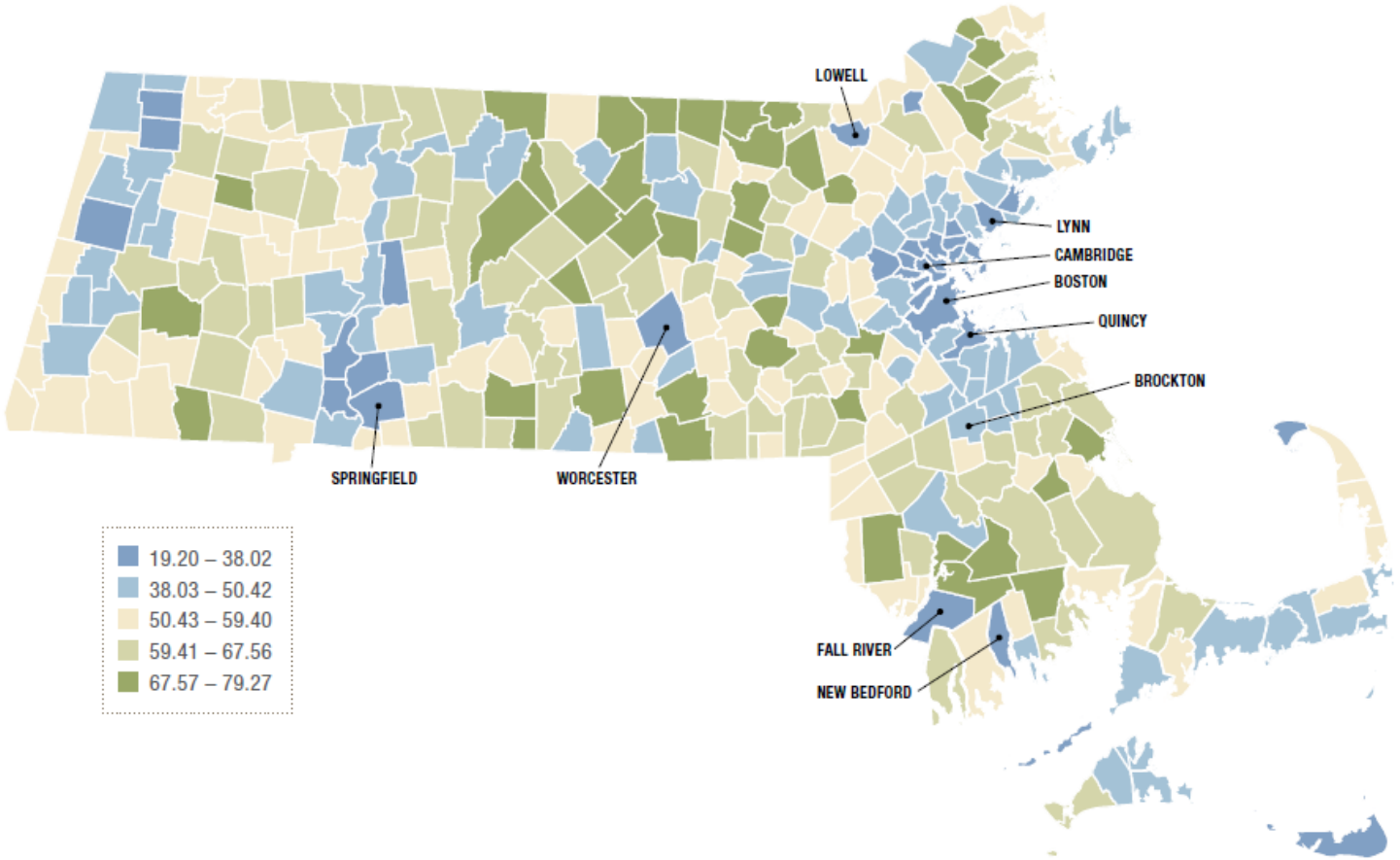
Source: FHWA Highway Statistics Series, 2000-2010

Massachusetts Per Capita Vehicle Miles Travelled



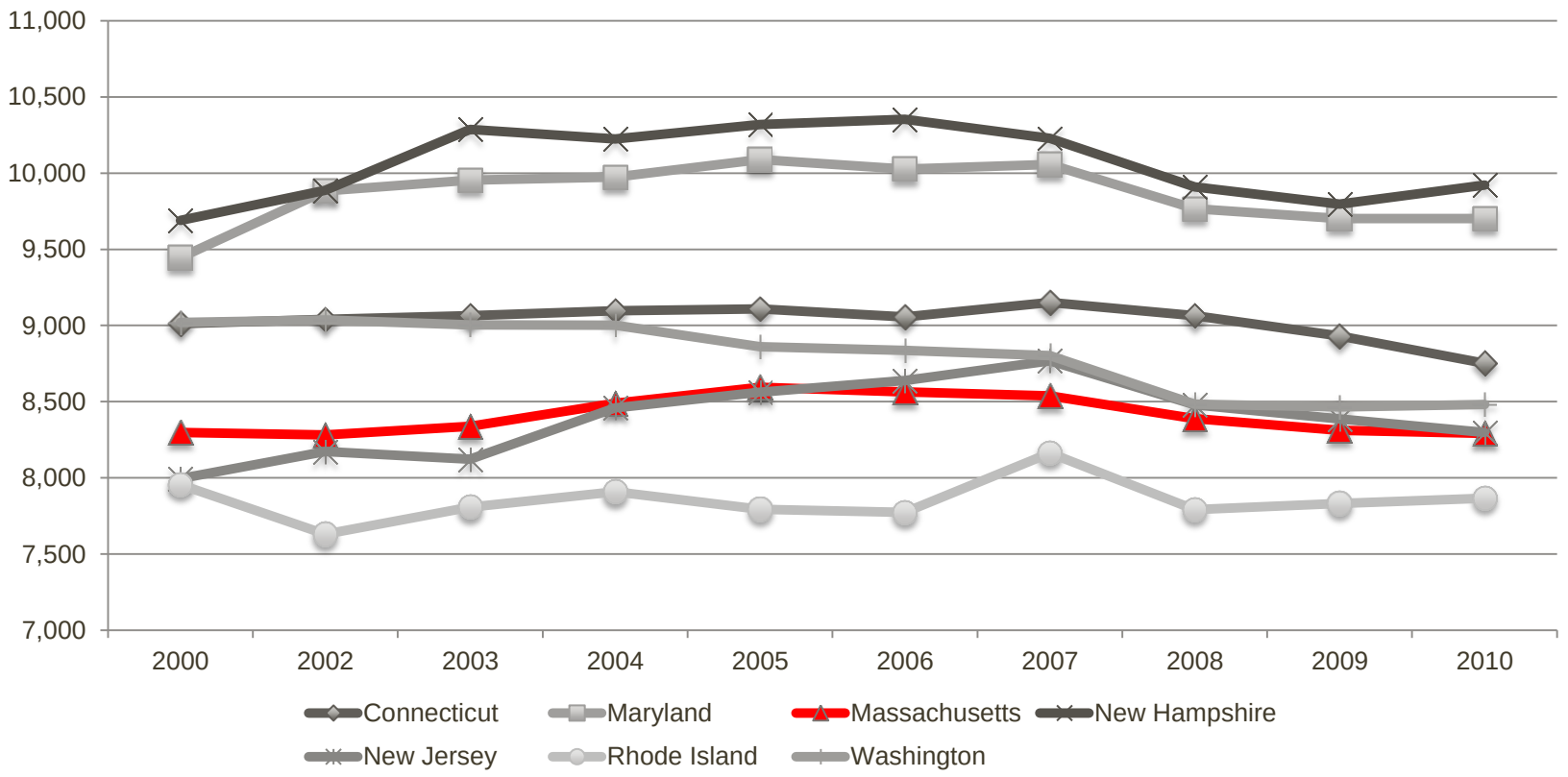
Source: FHWA Highway Statistics Series, 2000-2010

Daily Vehicle Miles Travelled Per Household By Community



Source: Registry of Motor Vehicles data compiled by Metropolitan Area Planning Council

BENCHMARK: Per Capita VMT in Massachusetts and "Peer" States



Source: US Bureau of Transportation Statistics, State Transportation Statistics

Future Indicator: Mode Shift Measured by Person Miles of Travel

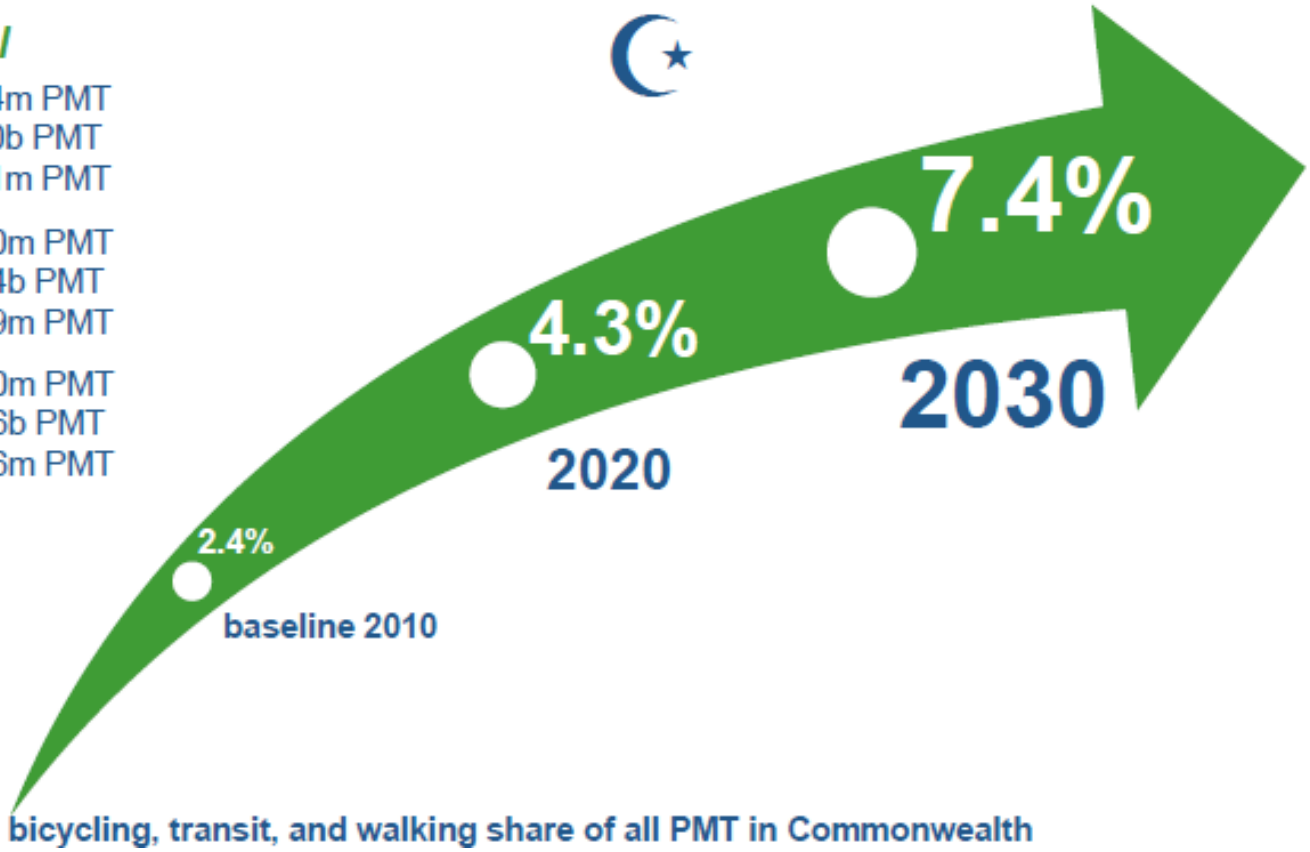
Mode shift in PMT

Baseline to goal

2010
- bicycling = 150.4m PMT
- transit = 1.830b PMT
- walking = 101.1m PMT

2020
- bicycling = 333.0m PMT
- transit = 3.994b PMT
- walking = 223.9m PMT

2030
- bicycling = 516.0m PMT
- transit = 5.926b PMT
- walking = 333.6m PMT



Transportation Options

Paradigm shift: From modes to options

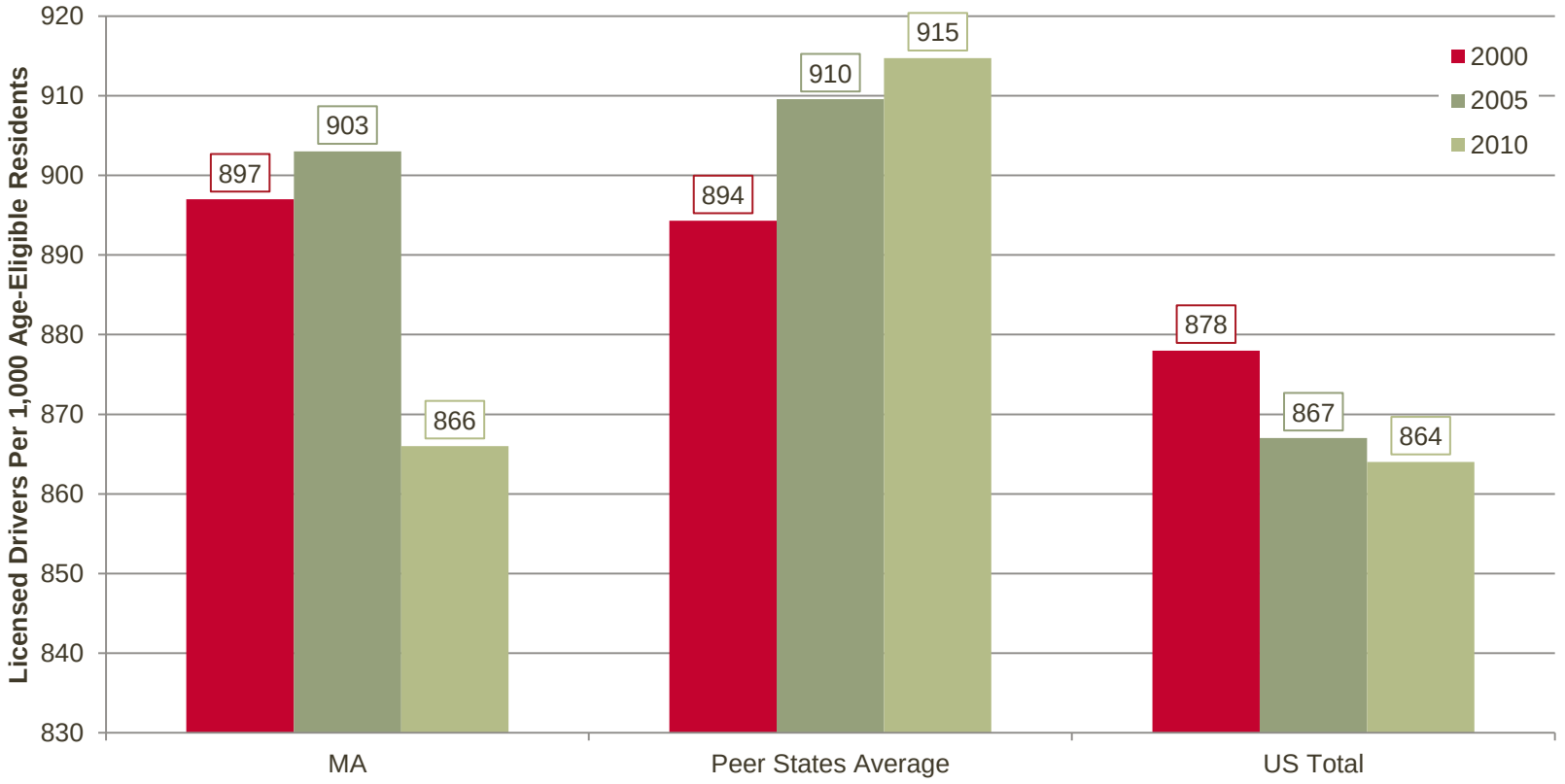
- Current patterns of travel behavior ("mode splits") reflect not only preference/choice but what options are available
- Transportation planners need to focus on providing a variety of transportation options, rather than focusing on individual modes

In a recent MassINC poll, 57% of respondents strongly agreed with the statement "I have no choice but to drive as much as I do" and 63% strongly or somewhat agreed with the statement "I would like more transportation options, so I have the freedom to choose how I get where I need to go."

Transportation Options Metrics

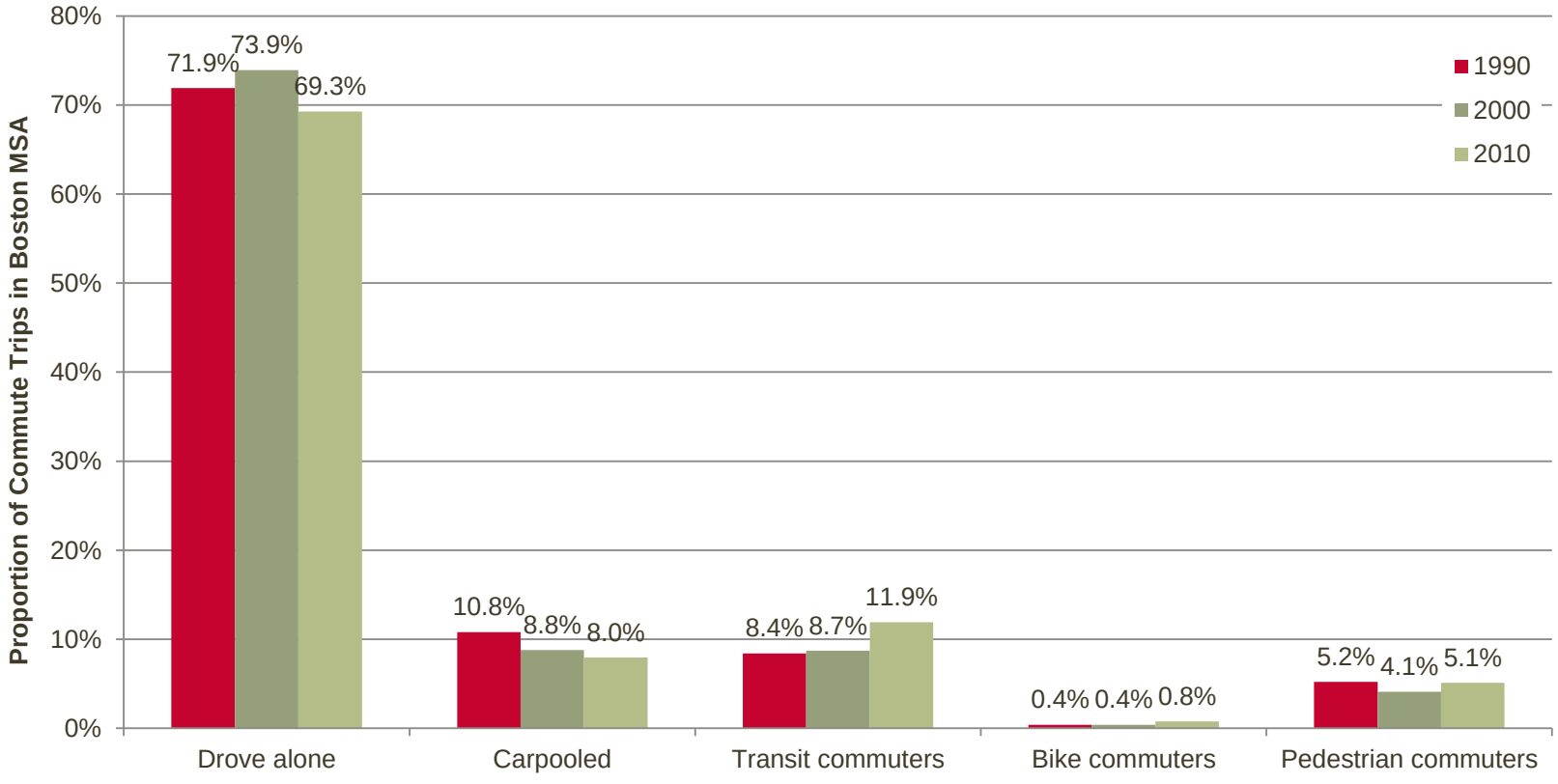
Metric	Type
Proportion of Residents Licensed to Drive	Benchmark
Commute Choices	Indicator
Increase in Bike Commuting in City of Boston	Benchmark
MBTA Average Weekday Ridership	Indicator
MBTA Service Provided (Revenue Service Hours)	Indicator
Regional Transit Authorities' Ridership and Service Hours Provided	Indicator

BENCHMARK: Proportion of Residents Licensed to Drive



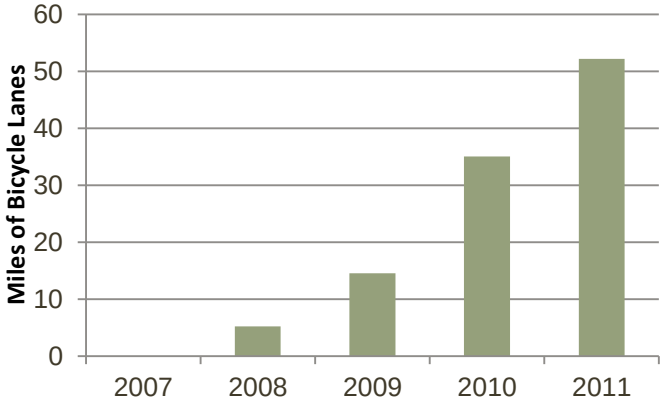
Source: US Bureau of Transportation Statistics, State Transportation Statistics

Commute Choices



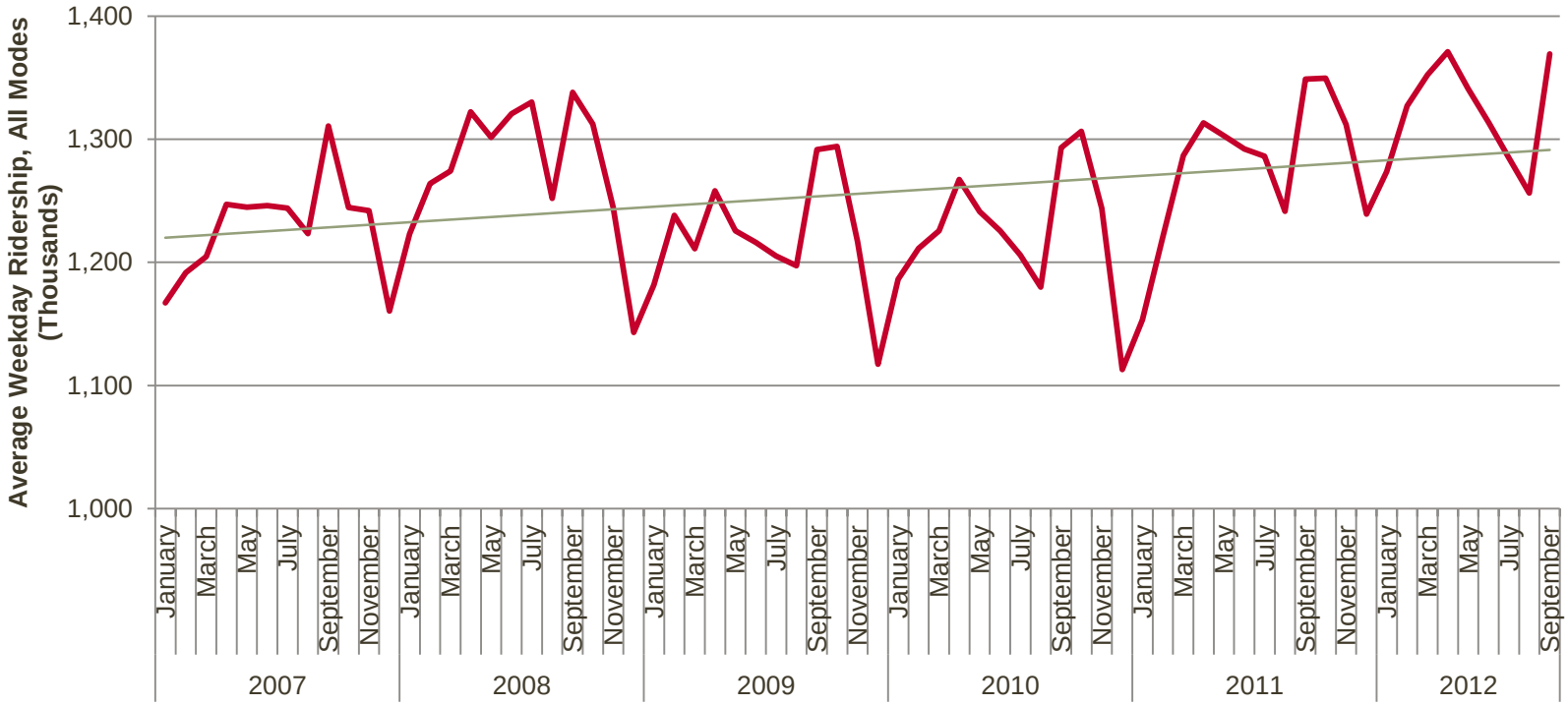
Source: Census 1990, Census 2000, ACS 2006-2010

BENCHMARK: Increase in Bike Commuting in City of Boston



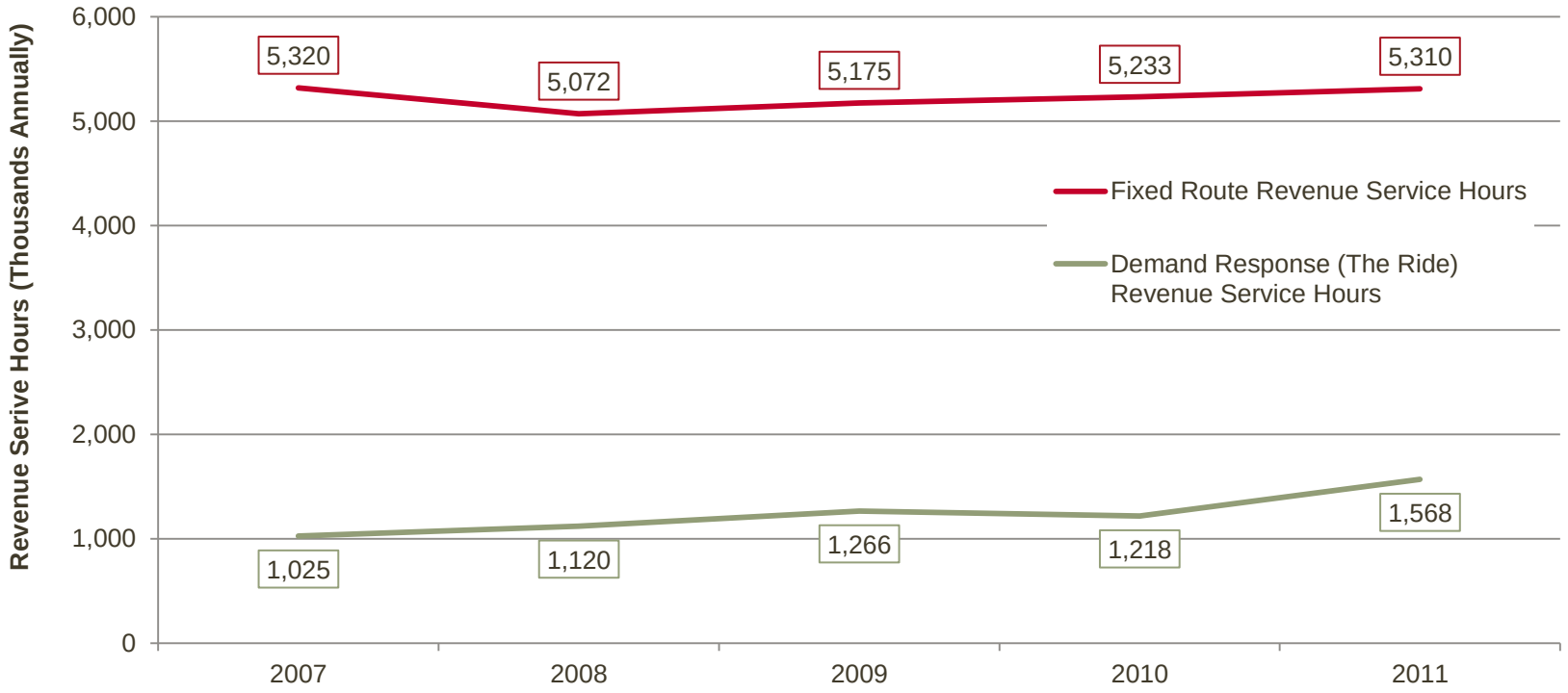
Source: League of American Bicyclists and City of Boston Boston Bikes program

MBTA Average Weekday Ridership



Source: MBTA

MBTA Service Provided (Revenue Service Hours)



Source: National Transit Database, 2007-2012

Regional Transit Authorities' Ridership and Service Hours Provided

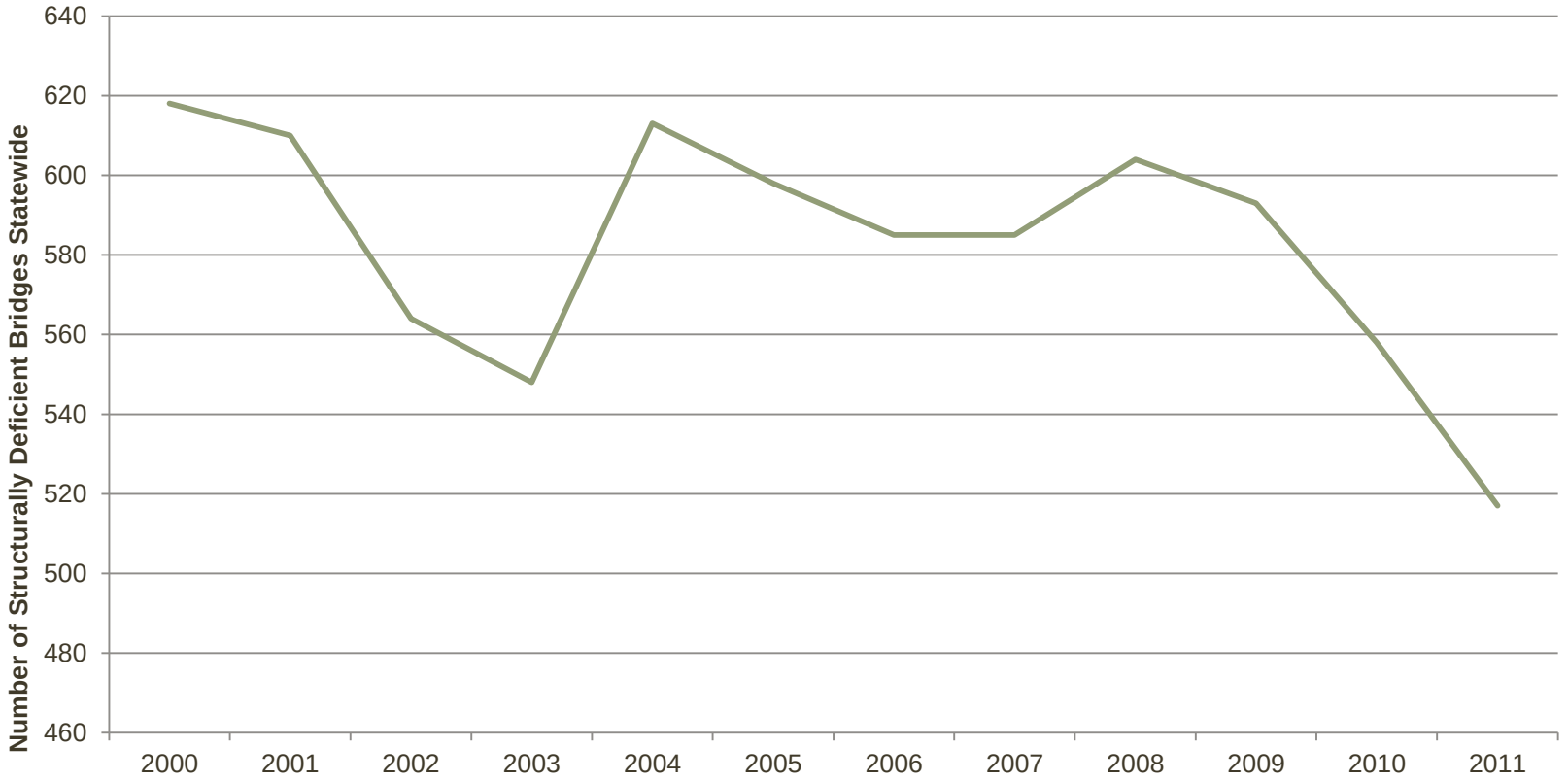
Source: MassDOT data collected for Beyond Boston study

Assets and Liabilities: Greater Boston's Transportation System and Its Current Condition

Assets and Liabilities: Indicators and Benchmarks

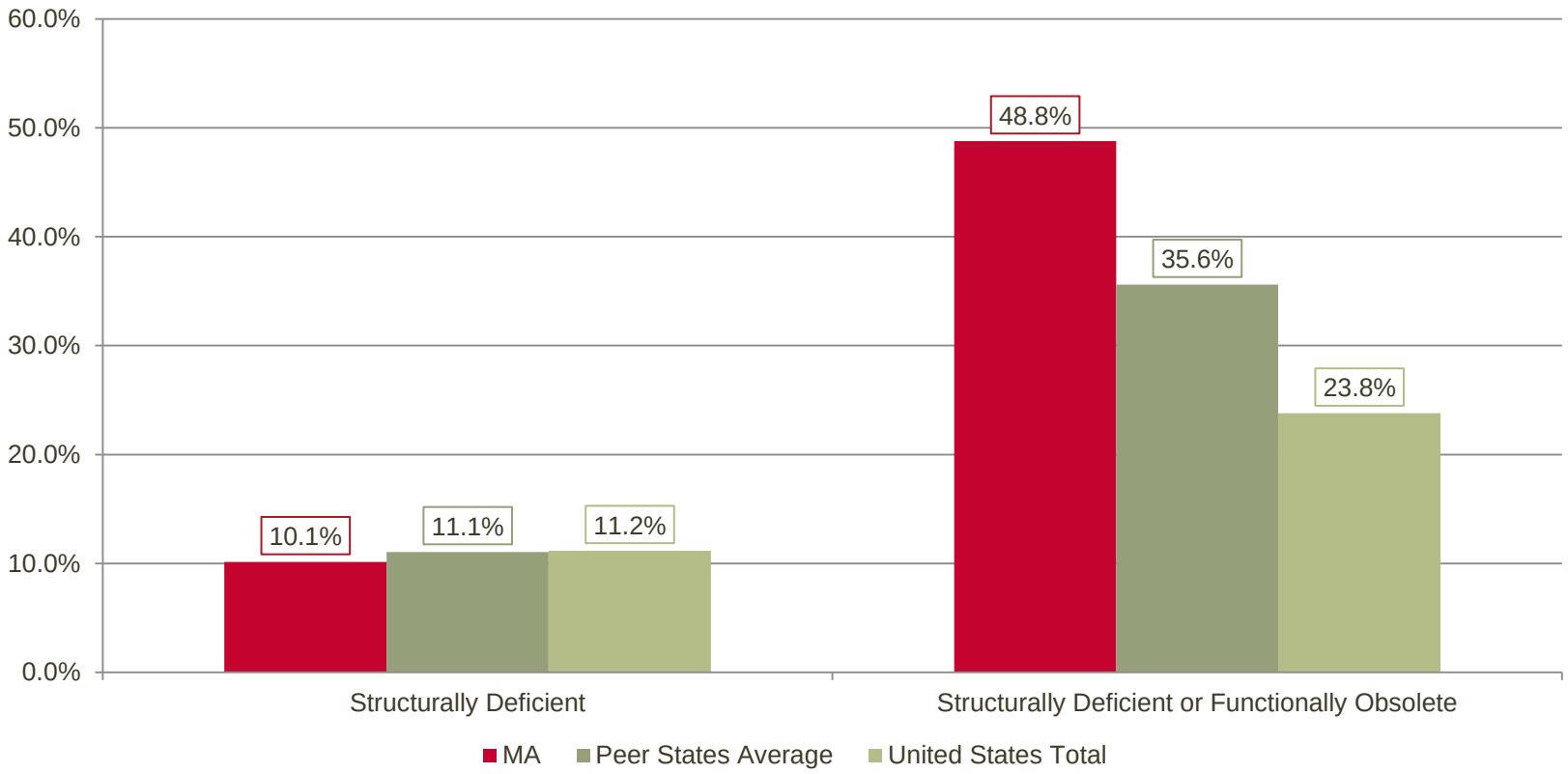
Metrics	Type
Bridge Condition: Structurally Deficient Bridges	Indicator
Bridge Condition: Structurally Deficient and Functionally Obsolete Bridges	Benchmark
Pavement Condition	Indicator
MBTA Vehicles Past Useful Life	Indicator

Bridge Condition: Structurally Deficient Bridges



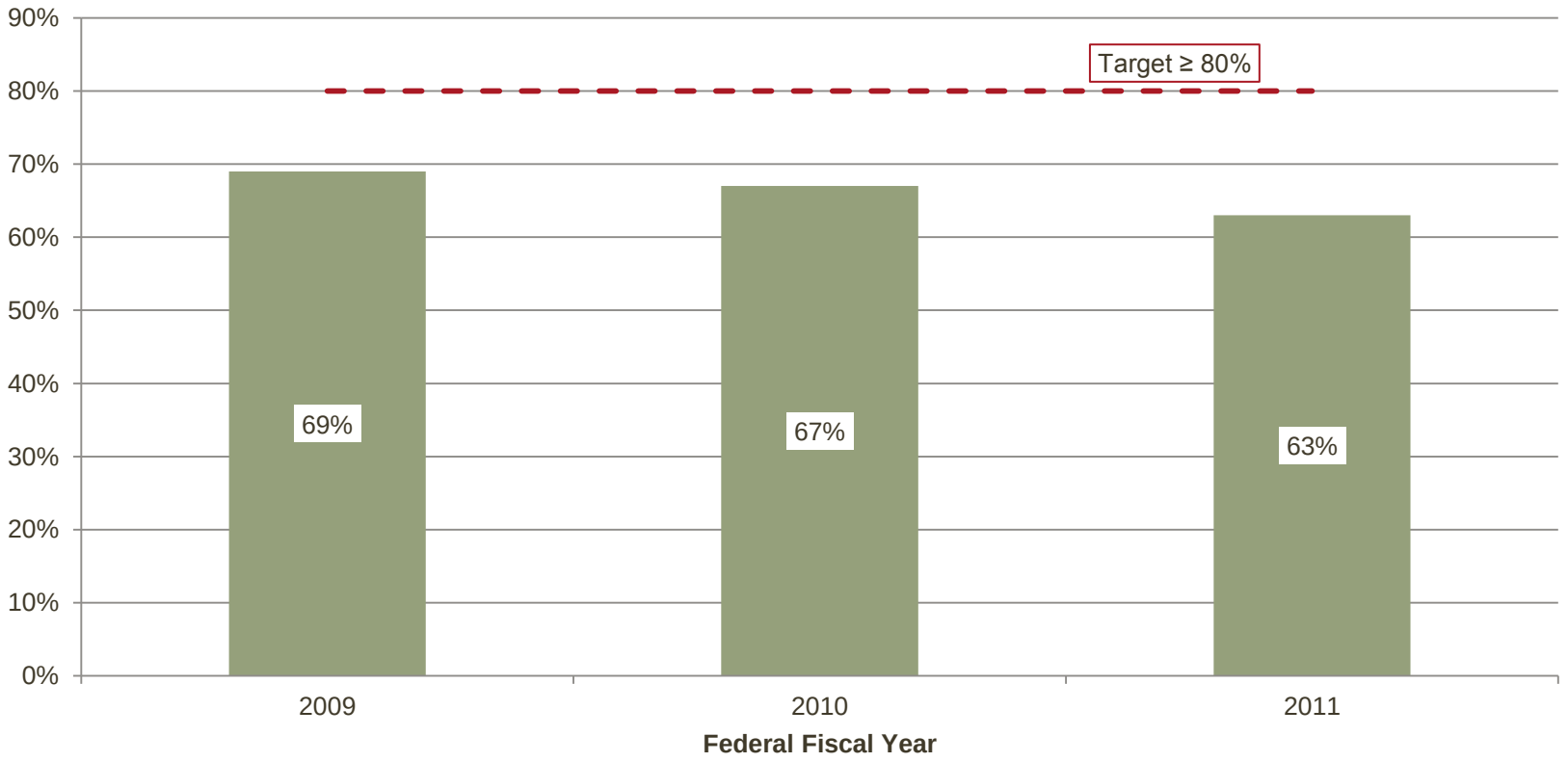
Source: National Bridge Inventory

BENCHMARK: Bridge Condition



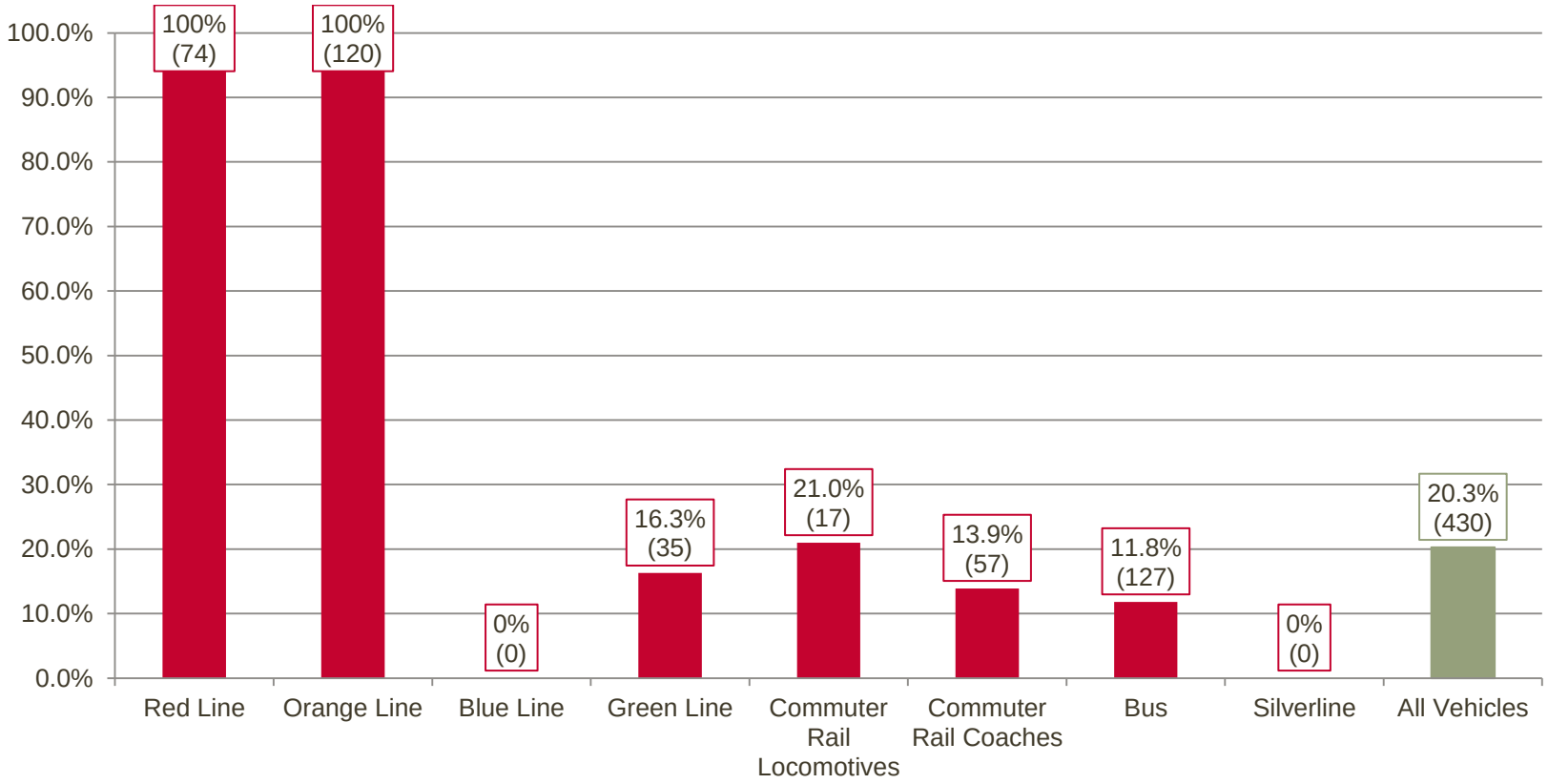
Source: National Bridge Inventory

Pavement of the National Highway System in Good or Excellent Condition



Source: MassDOT Accountability Indicators

MBTA Vehicles Past Useful Life



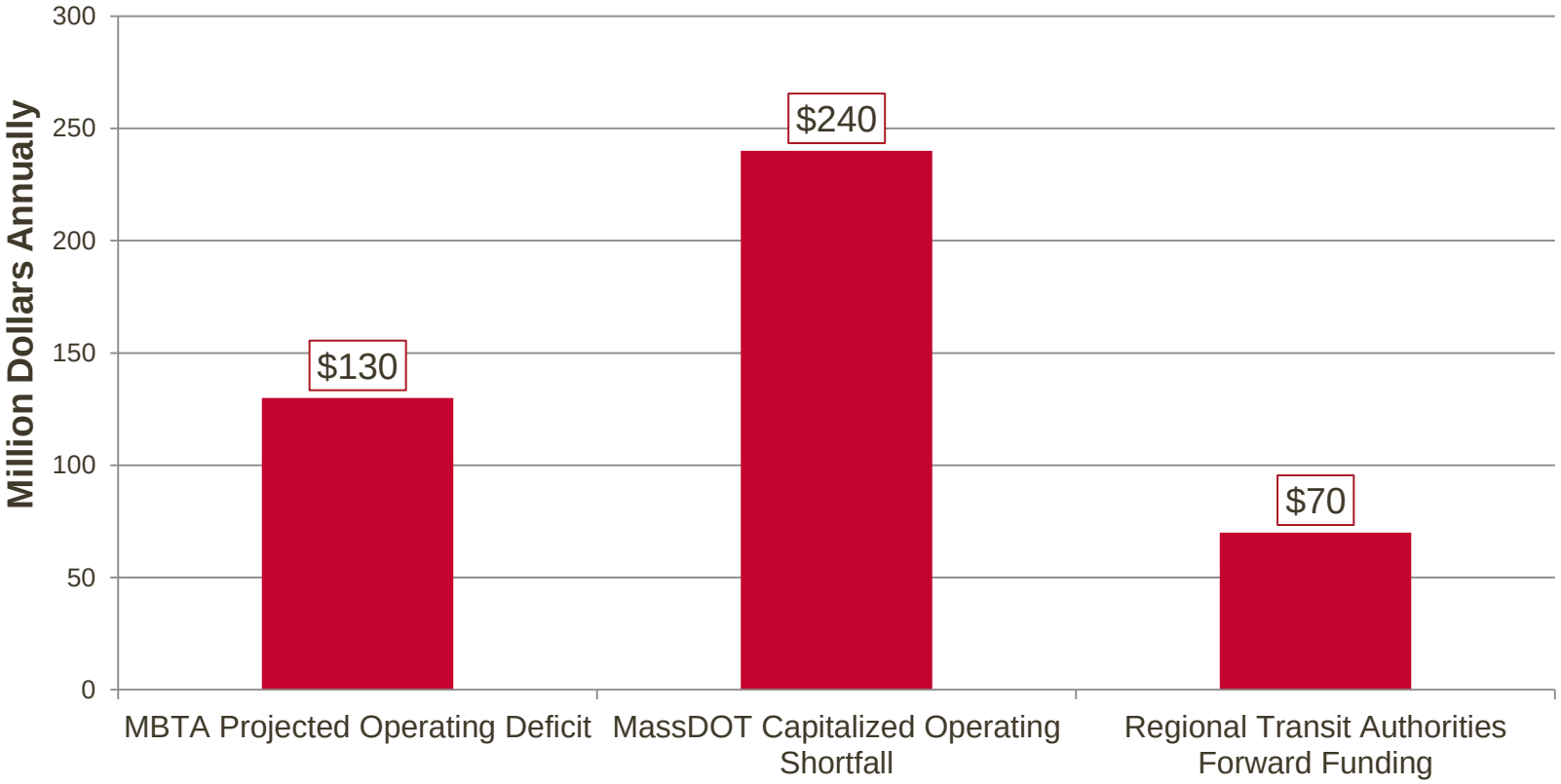
Source: MBTA Capital Investment Program

Money Matters

Money Matters: Financial Metrics

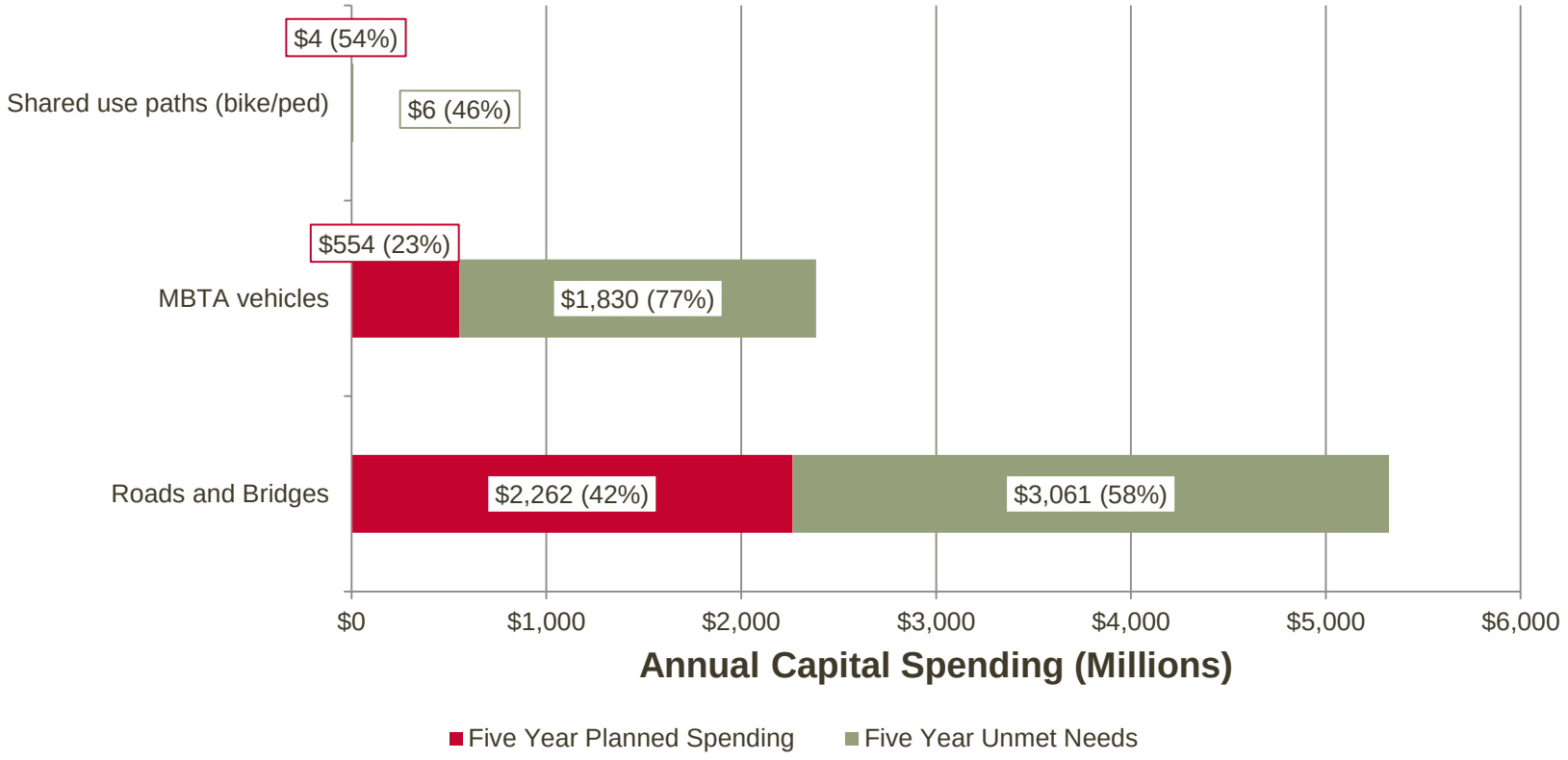
Metric	Type
FY14 Projected Operating Shortfall	Indicator
Five Year Capital Spending Shortfall	Indicator
Capital Spending on Transportation	Indicator
Debt Burden (Systemwide)	Indicator
Debt Burden (MBTA)	Indicator

Annual Operating Shortfall (FY14)



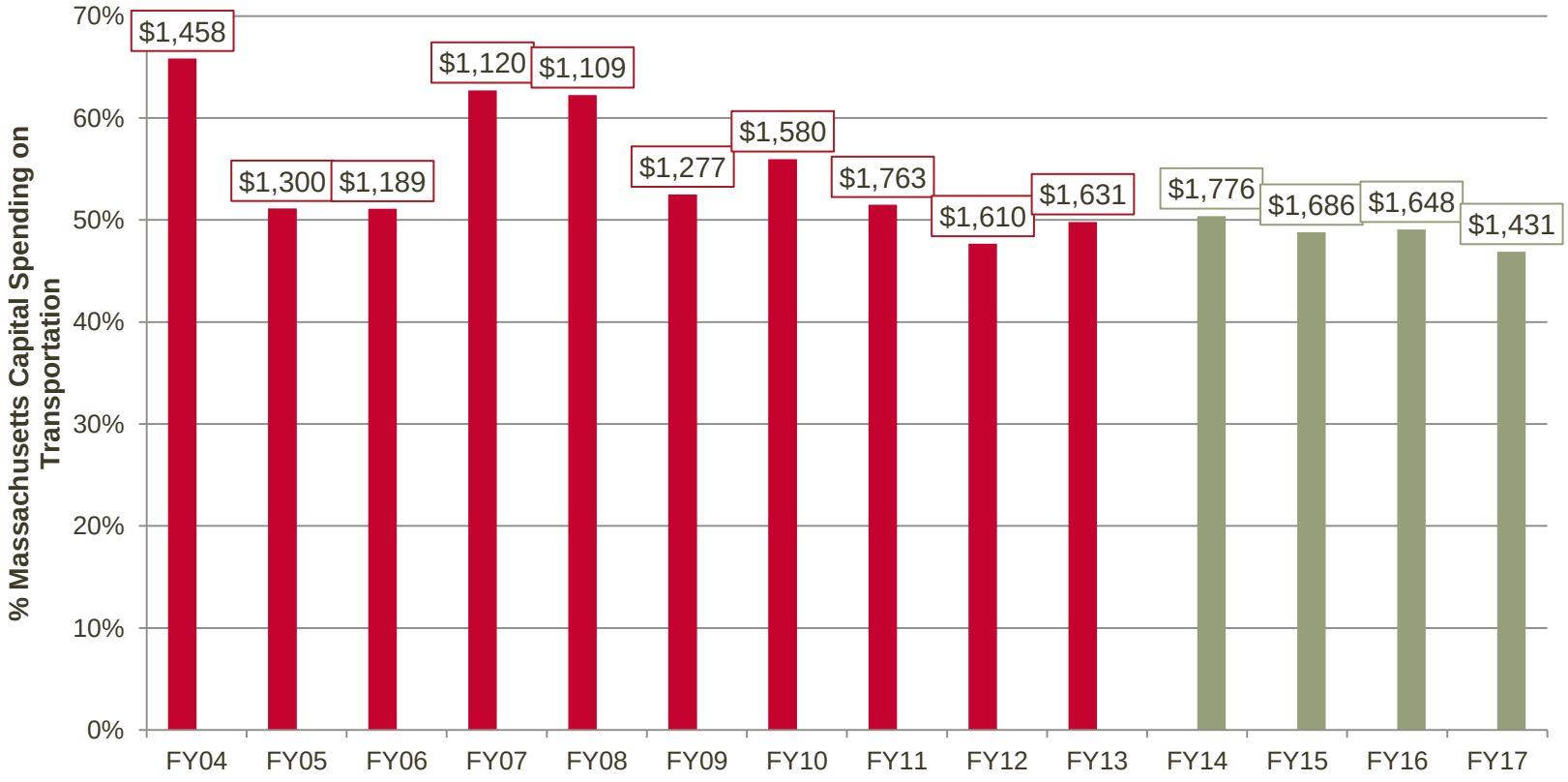
Source: MBTA and MassDOT documents, Massachusetts five year capital plan

Five Year Capital Spending Shortfall



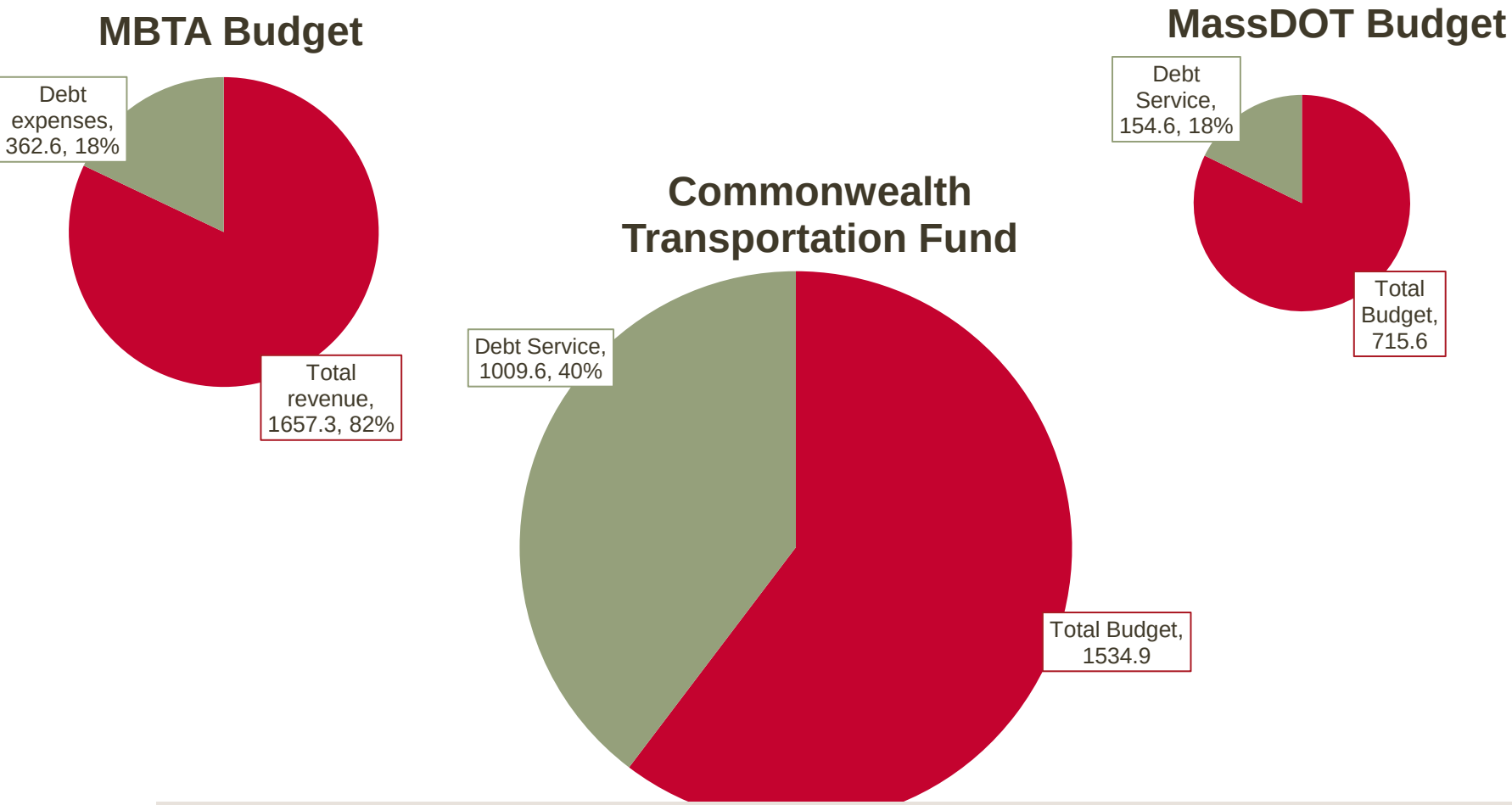
Source: MBTA and MassDOT capital investment plans

Capital Spending on Transportation



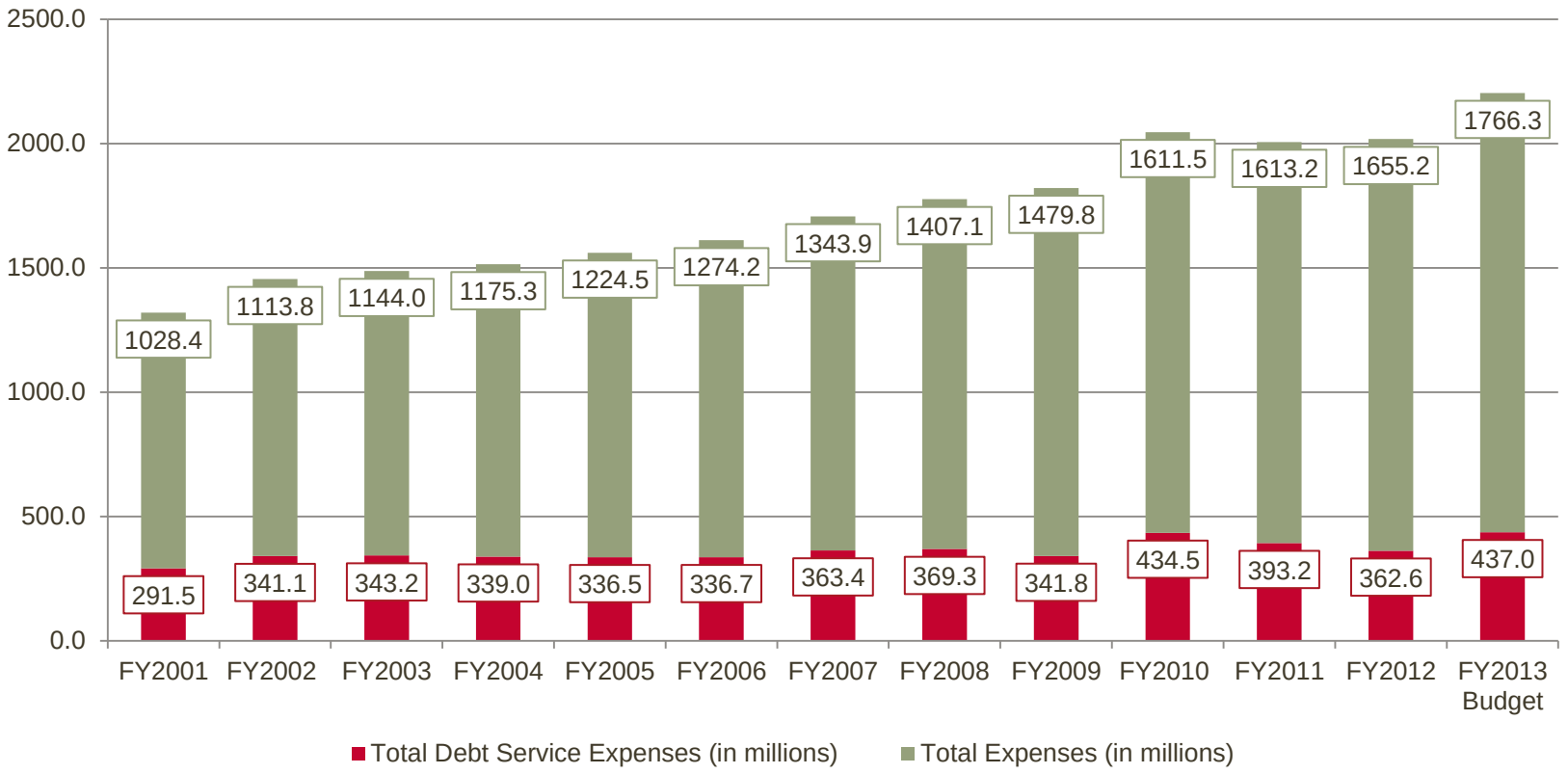
Source: Massachusetts 5-Year Capital Plans

Debt Burden Systemwide (in millions)



Source: MBTA, MassDOT, and Commonwealth of Massachusetts budget documents

Debt Burden (MBTA)



Source: MBTA

Accessibility

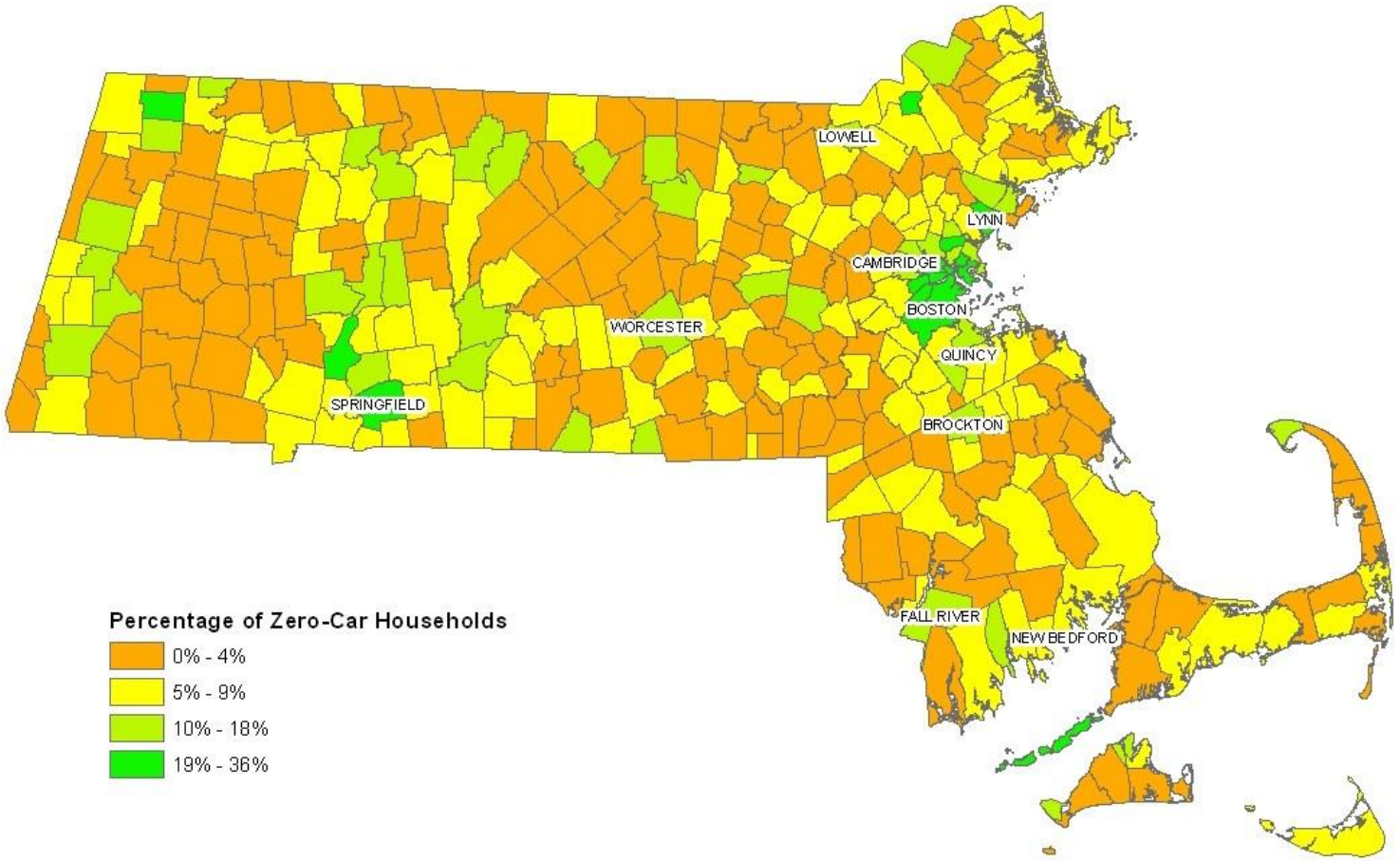
Paradigm shift: From mobility to accessibility

- Mobility is actually one means to the broader end of accessibility
  - –Mobility = movement from one place to another
  - –Accessibility = ability to reach desired goods, services, activities and destinations
- Accessibility is difficult to measure because we need to understand
  - –Access to what (work, school, child care, etc.)?
  - –Access for who (workers, students, parents)?
  - –Access by what mode of transportation (driving, transit, walking, biking)?

Accessibility: Indicators and Benchmarks

Metrics	Type
MA Zero-Vehicle Households	Indicator
MBTA transit coverage	Indicator
Population Near Transit	Indicator
Access for workers to jobs by transit (with a trip of 45 minutes or less)	Benchmark

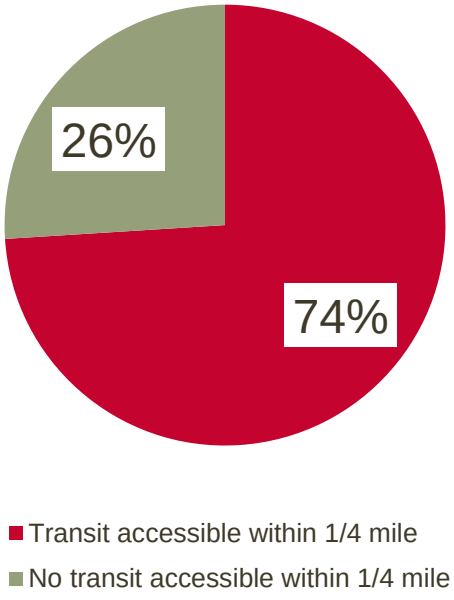
Zero-Vehicle Households

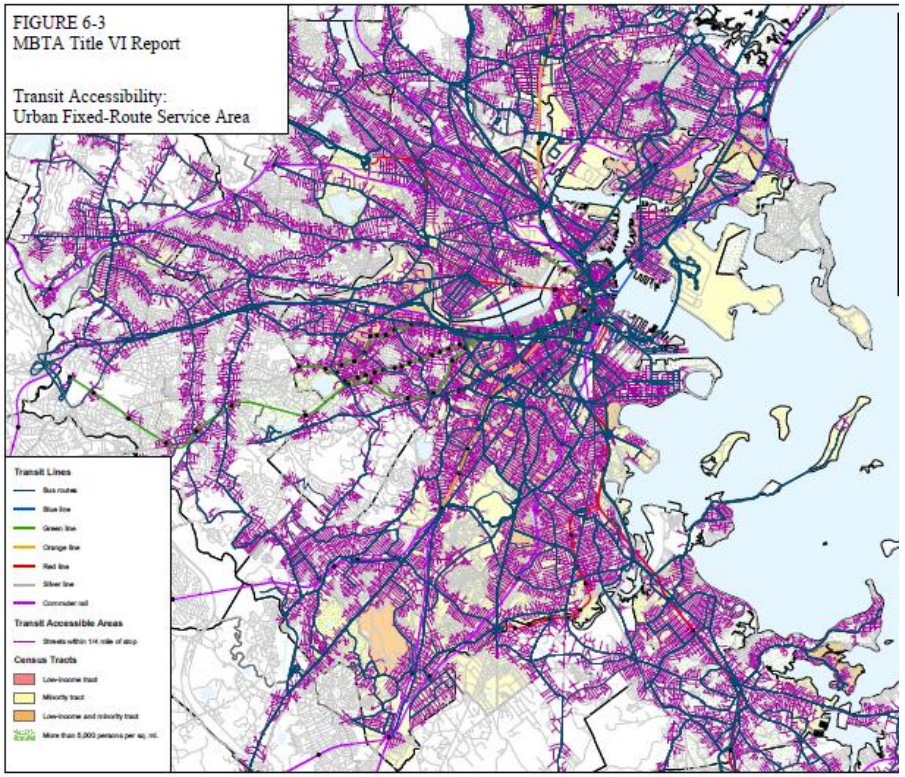


Source: American Community Survey 2006-2010 5-Year Data

MBTA Transit Coverage

High-Density Areas Within MBTA District





MBTA transit shed employment and commute mode

	Boston-Cambridge-Quincy MSA	MBTA Transit Shed
Workers 16 years and over	2,277,958	484,736 (21%)
Percent who take public transportation	12%	27%
Percent who take public transportation, bicycle, or walk	18%	42%
Percent of households with 0 vehicles available	13%	28%

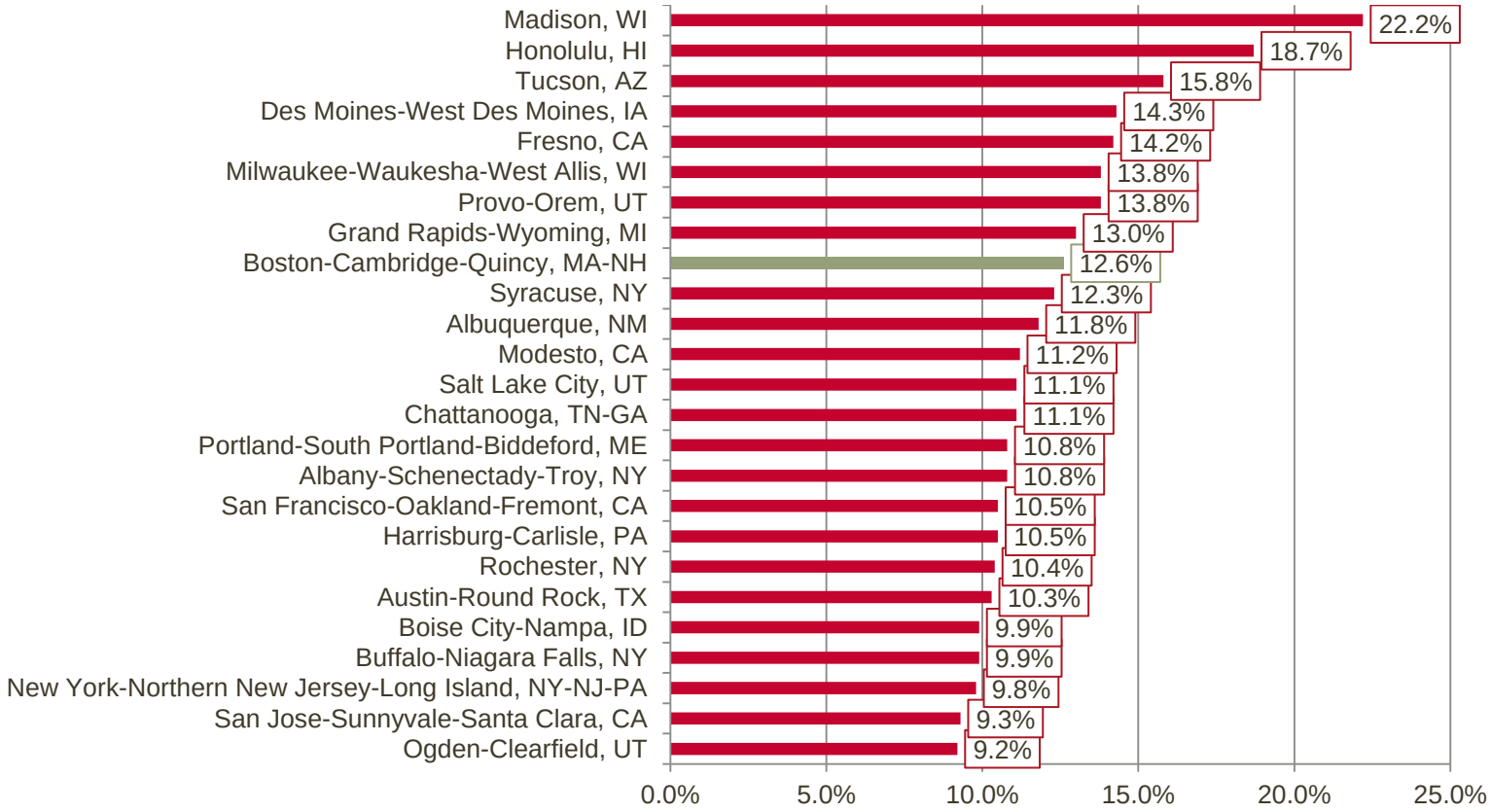
Source: American Community Survey 2005-2009 5-Year Data

MBTA transit shed employment and commute mode

	Boston-Cambridge-Quincy MSA	MBTA Transit Shed
Population	4,552,402	981,225 (22%)
Households	1,344,257	402,801 (30%)
Residential Density (households/acre)	0.6	5.2
Proportion of units that are renter-occupied	38.5%	61%

Source: Census 2010

BENCHMARK: Access for workers to jobs by transit (with a trip of 45 minutes or less)



Source: Brookings Transit Access and Zero-Vehicle Households (August 2011)

Equity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The challenge of measuring equity

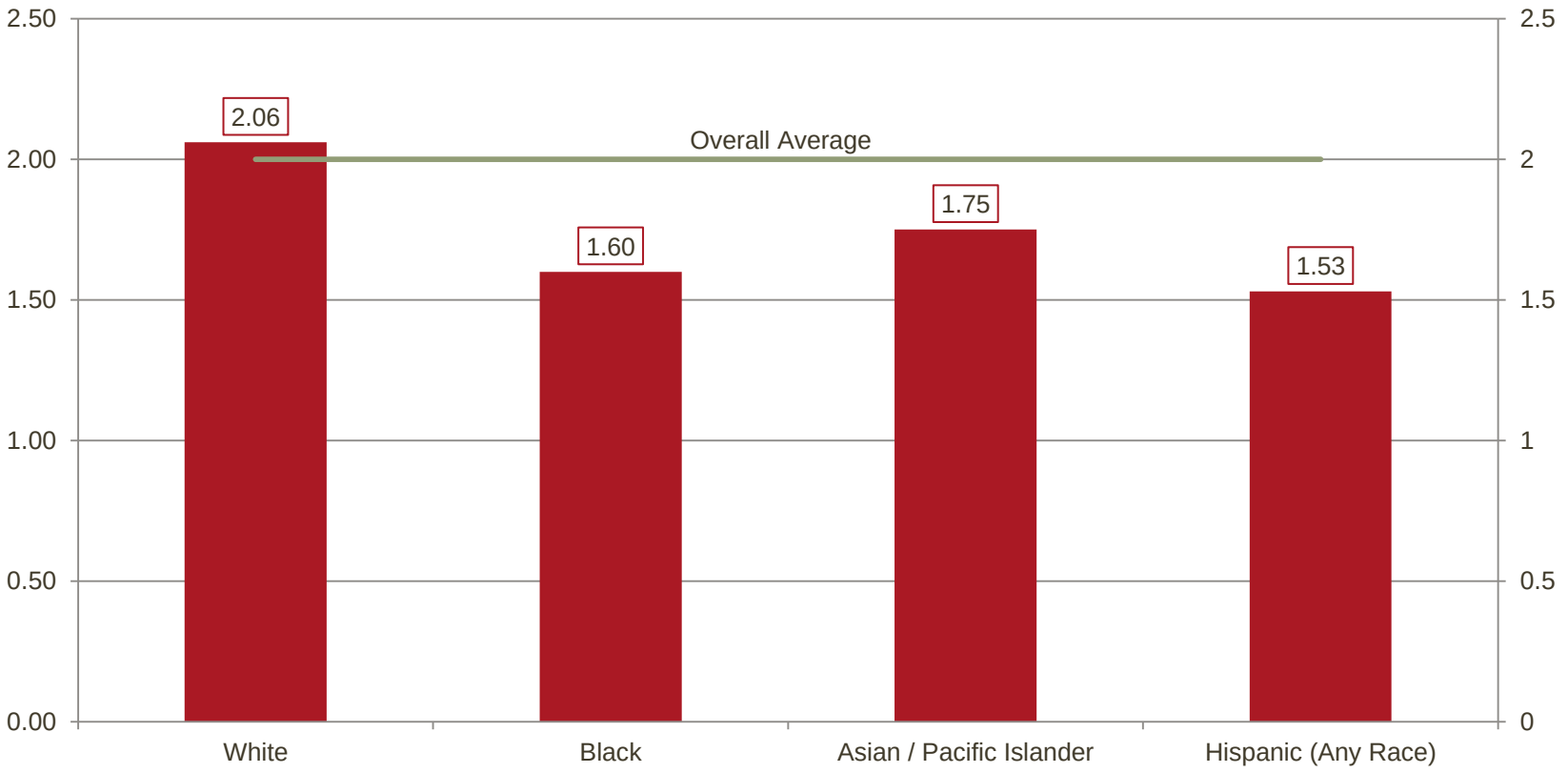
- Few true measures of transportation equity exist
- Using PUMS data, the Dukakis Center created a dataset to analyze disparities in commute times by race

Equity refers to an ideal state in which everyone has full and equal access to opportunities and amenities, regardless of their race or ethnicity, gender, age or wealth.

Equity: Indicators and Benchmarks

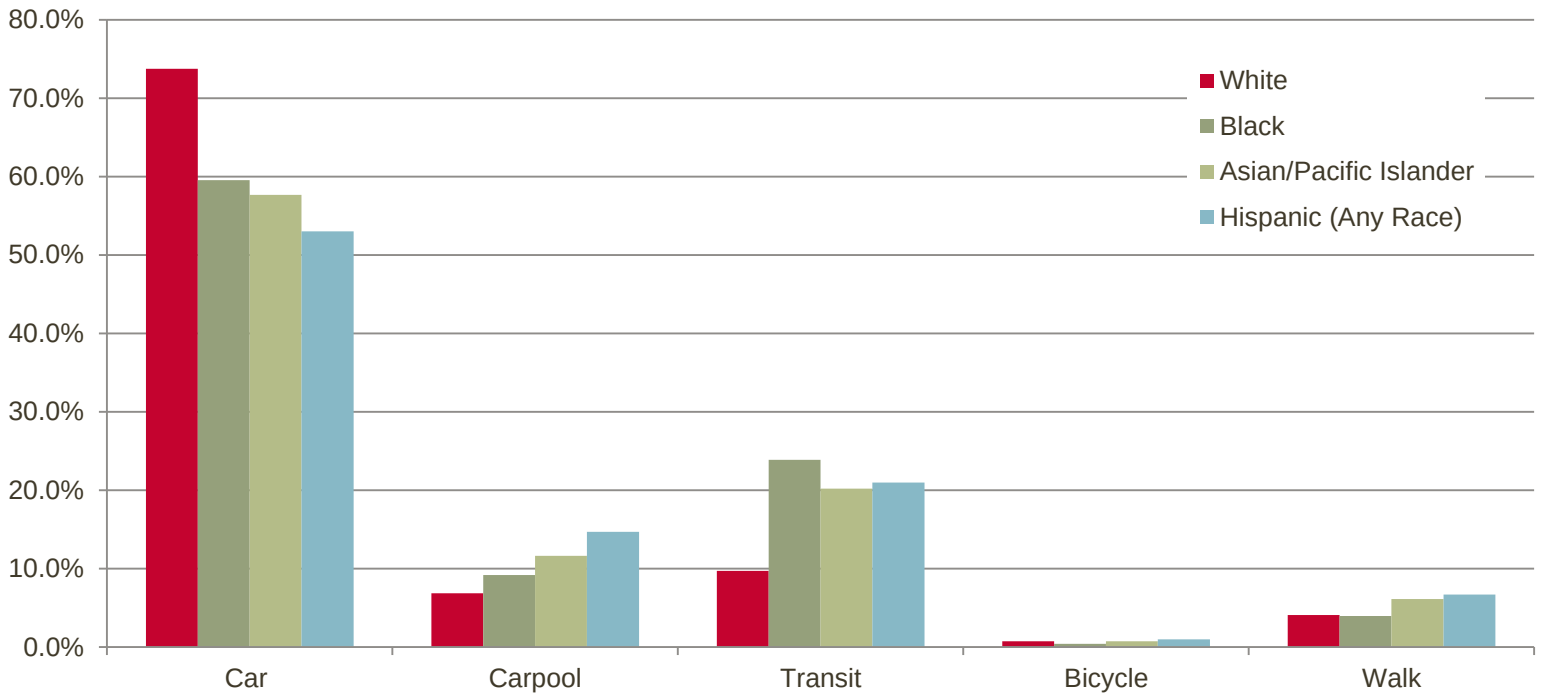
Metric	Type
Number of Vehicles by Race	Indicator
Mode of Travel by Race	Indicator
Travel Time Disparity by Race and Mode	Indicator

Number of Vehicles by Race



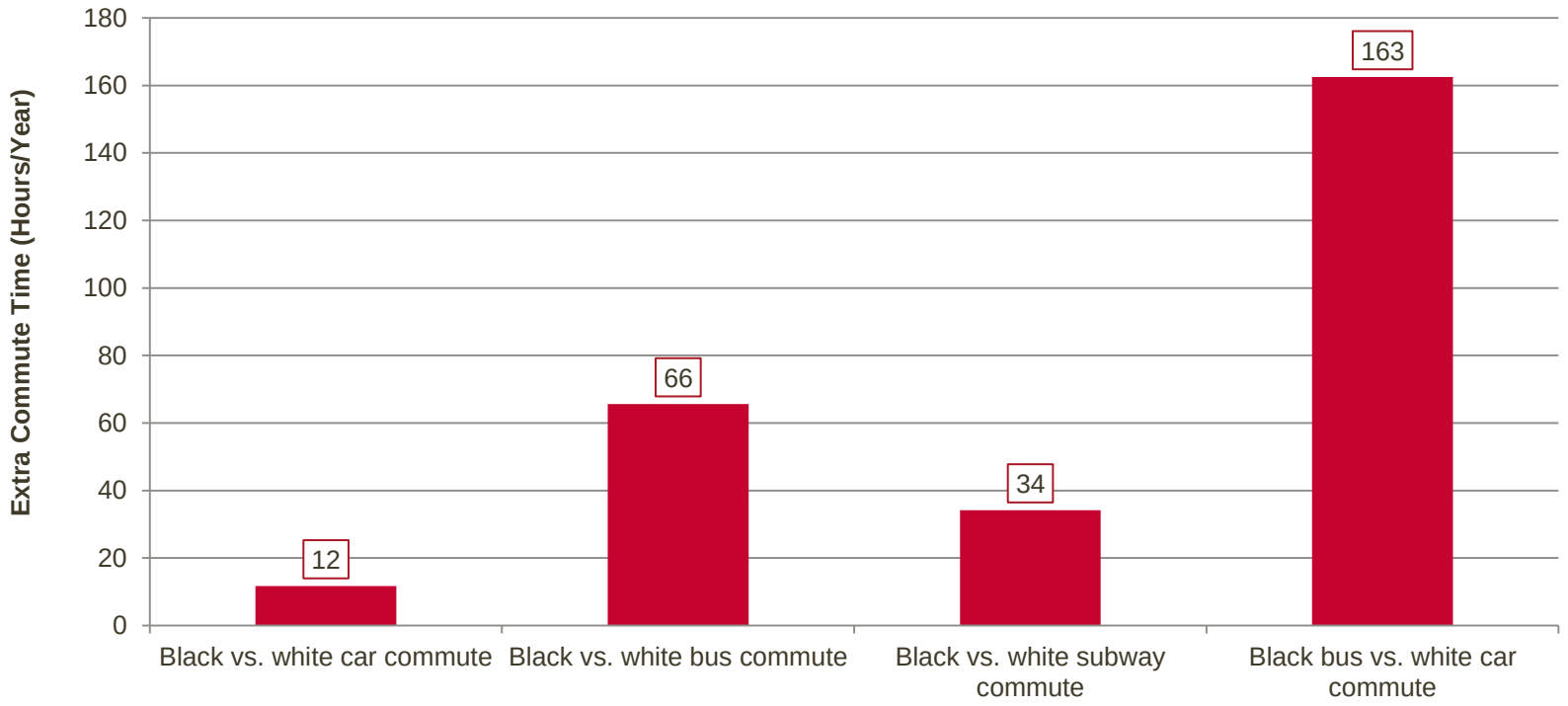
Source: Dukakis Center analysis of PUMS data for greater Boston (5 year ACS 2005-2009)

Mode of Travel by Race



Source: Dukakis Center analysis of PUMS data for greater Boston (5 year ACS 2005-2009)

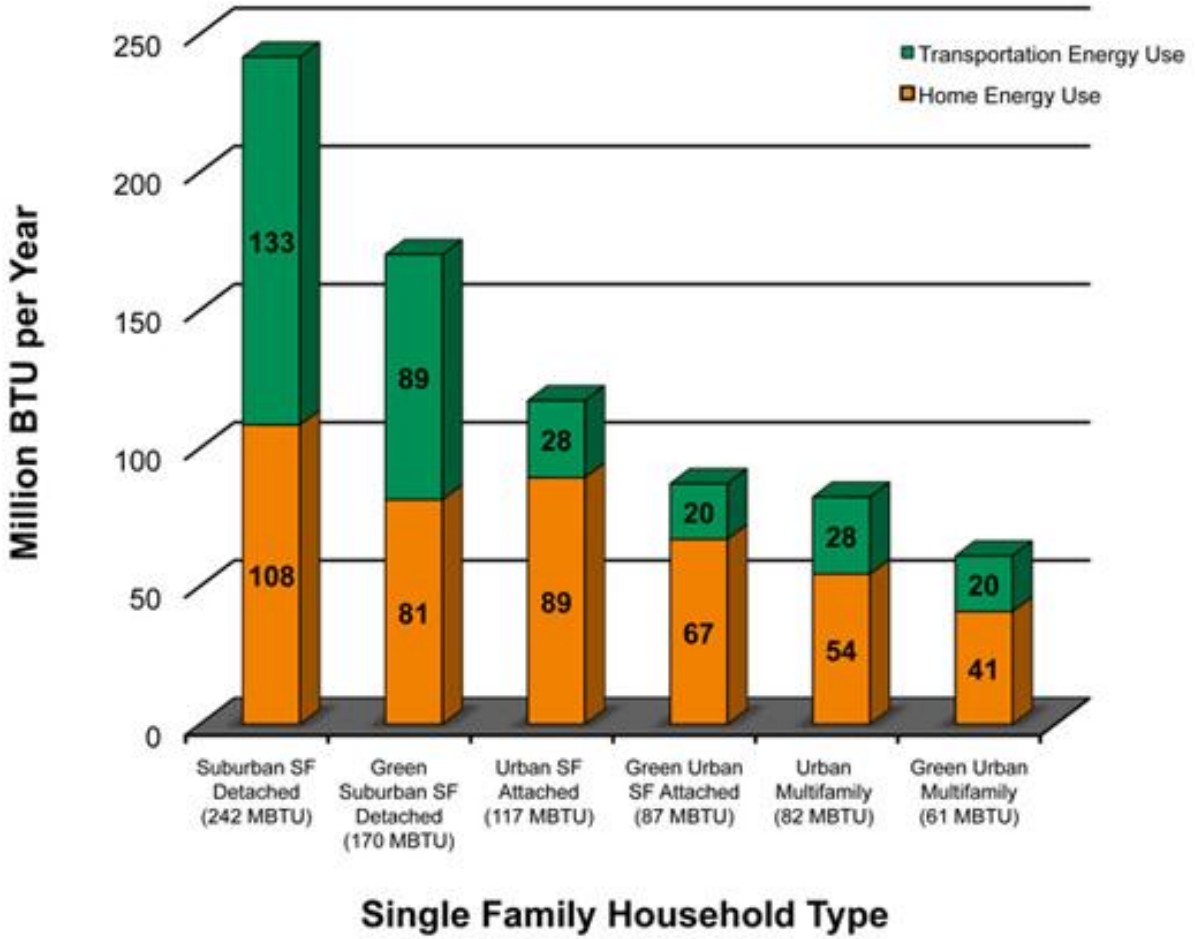
Travel Time Disparity by Race and Mode



Source: Dukakis Center analysis of PUMS data for greater Boston (5 year ACS 2005-2009)

Sustainability and SUSTAIN

Transportation should be part of evaluating how “green” a community is



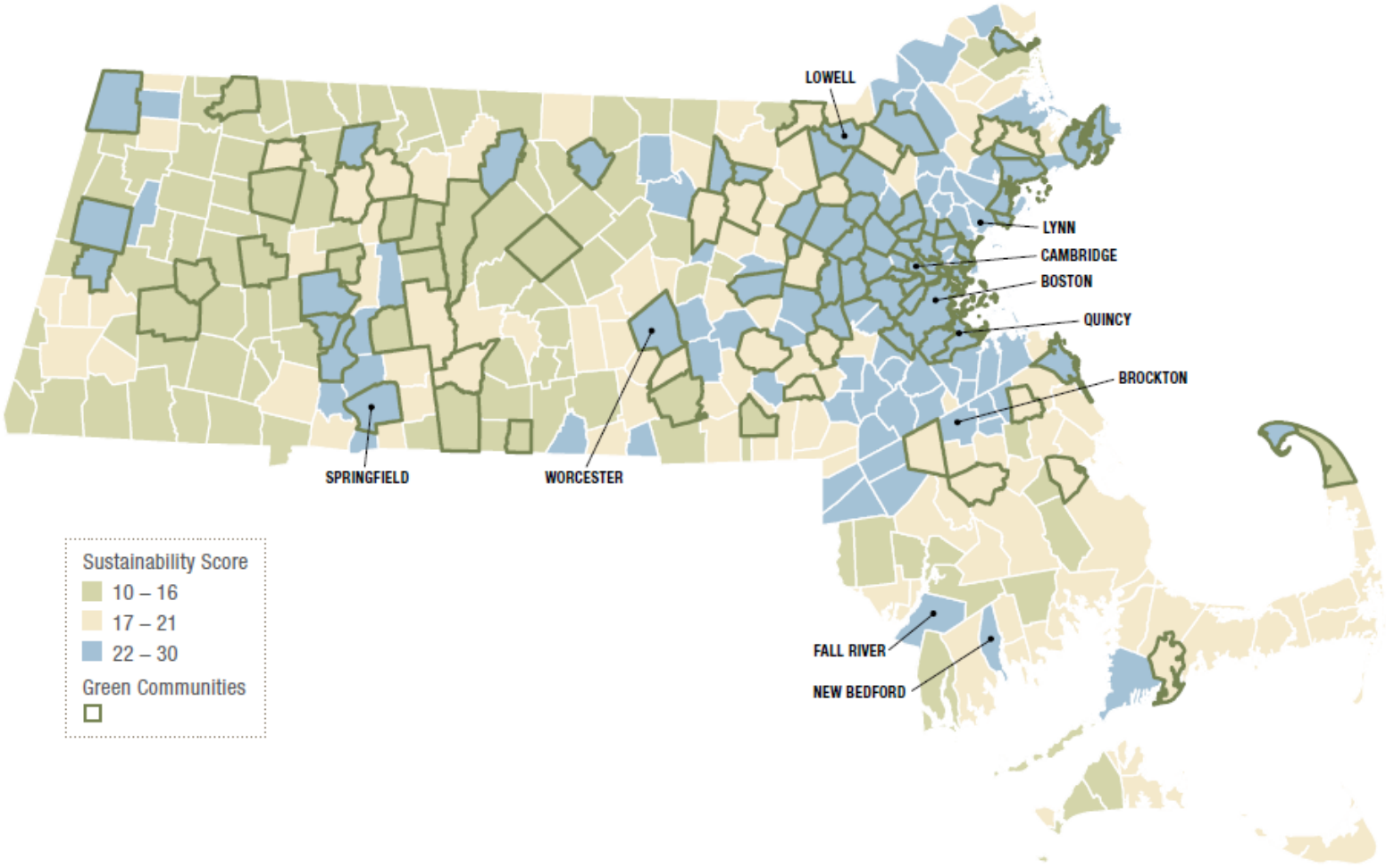
Measuring transportation sustainability at the municipal level

- Place-based attributes
  - –Availability of transit (MBTA and/or RTA)
  - –Residential density
  - –WalkScore®
  - –Road lane miles per resident
- Cleanliness of residents' vehicles
  - –Vehicle age
  - –Mix of automobiles and SUVs/light trucks
  - –Proportion of clean vehicles
- Travel patterns
  - –Household vehicle miles travelled
  - –Commute share for transit/bike/walk
  - –Zero vehicle households

Creating a scoring system

Metric	Coding Direction
Availability of transit	Positive
Residential density	Positive
WalkScore®	Positive
Lane Miles per Resident	Negative
ABC Commute	Positive
VMT 2008-2010	Negative
Proportion zero-vehicle households (2006-2010 ACS)	Positive
Age of Fleet	Negative
Auto Mix (% autos)	Positive
Alternate Fuel Vehicles as a proportion of total vehicles	Positive

SUSTAIN: Scoring to Understand Sustainable Transportation Attributes and Indicators



Convenience and Congestion

Paradigm shift: From congestion to convenience

- Traffic congestion has been seen as a driving force in transportation planning
- The Texas Transportation Institute's Travel Time Index is the most widely used metric for congestion
  - The Boston MSA is the 20th most congested large metro in the US
  - A driver in the Boston MSA spends 47 hours per year sitting in traffic
- But traffic congestion is just one measure of inconvenience
  - Similar measures need to be developed for other system users
- Convenience metrics should focus on time
  - For now, the best data available is the commute time data collected by the Census

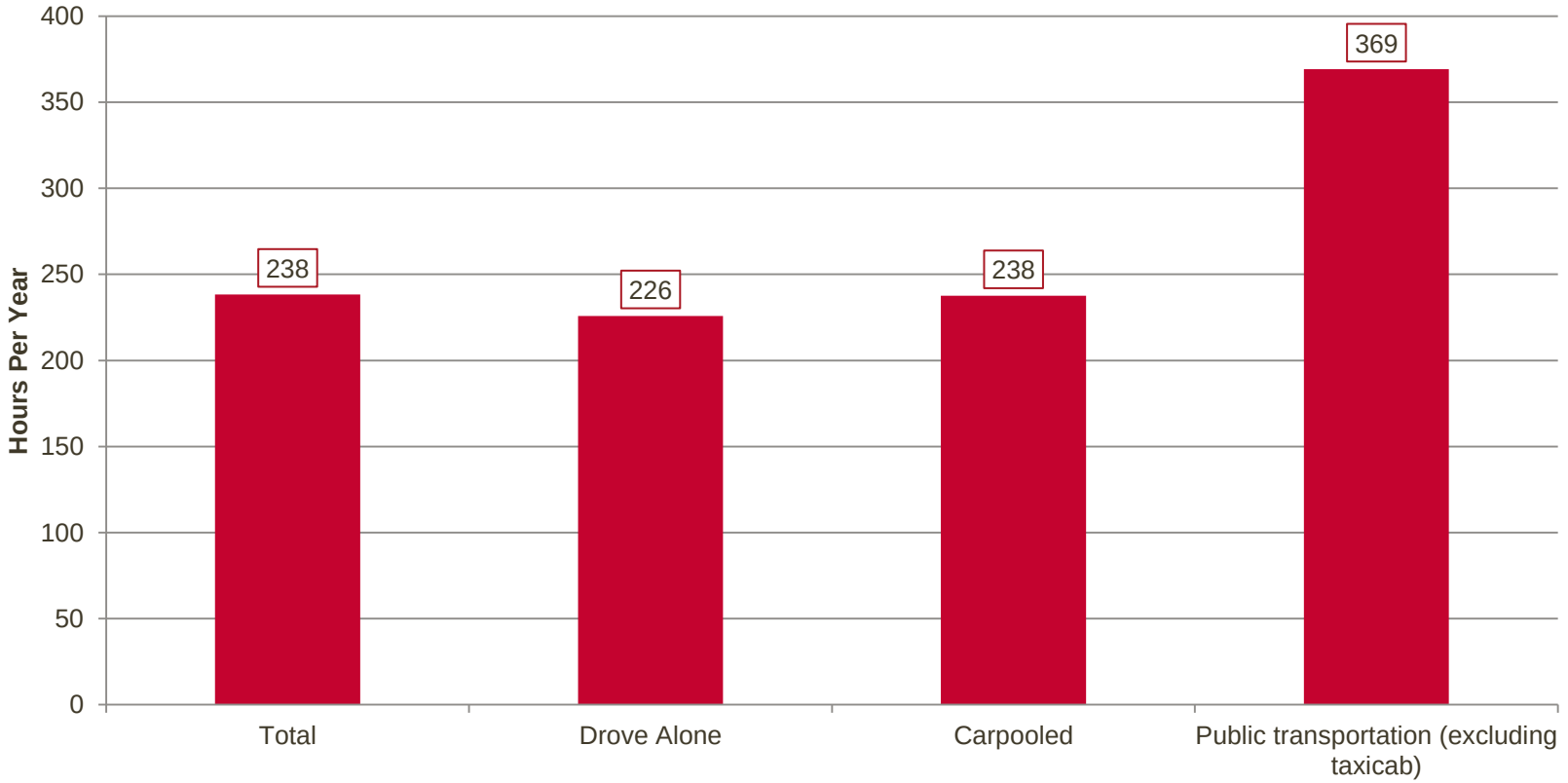
Convenience and congestion

Metric	Type
Commute Times by Travel Mode	Indicator
Commute Time Differentials by Mode	Indicator
Mean Travel Time to Work By Residential and Work Locations	Indicator
Congestion by Metropolitan Area	Benchmark

Commute times by travel mode

Source: American Community Survey 2006-2010 5-Year Data

Commute time differentials by mode (hours)



Source: American Community Survey 2006-2010 5-Year Data

Mean Travel Time to Work By Residential and Work Locations

Mean Travel Time to Work (in Minutes), Employed Residents Aged 16+, by Residential Location and Work Location, 2005-2009.

		Place of Work						
		Boston	Inner Suburb	Outer Suburb	New Hampshire	Rhode Island	Other	All Places of Work
Place of Residence	Boston	24.7	32.6	37.3	55.2	53.9	35.8	27.7
	Inner Suburb	35.3	20.6	31.3	48.3	51.9	50.1	26.7
	Outer Suburb	56.0	39.1	20.1	32.6	32.0	55.7	27.7
	All Places of Residence	35.9	27.7	21.8	35.1	33.5	50.7	27.3

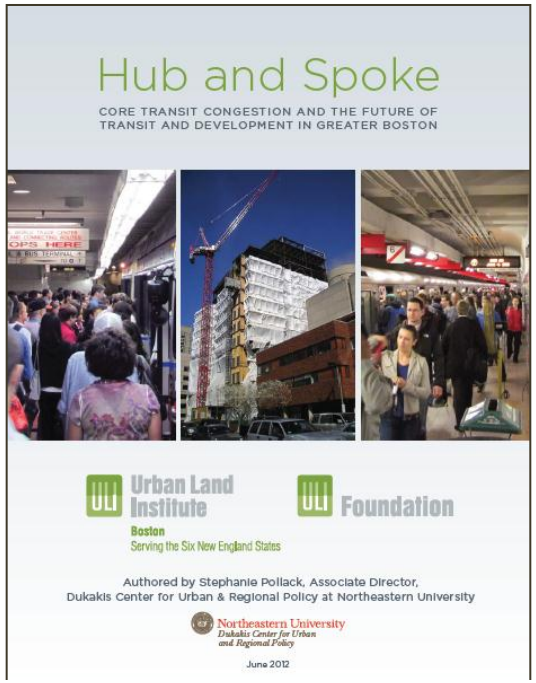
Source: Dukakis Center analysis of PUMS data for greater Boston (5 year ACS 2005-2009)

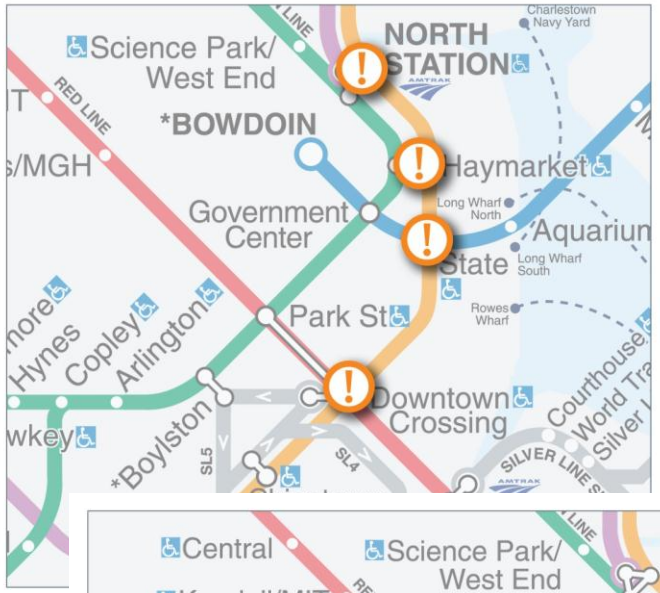
BENCHMARK: Congestion by Metropolitan Area

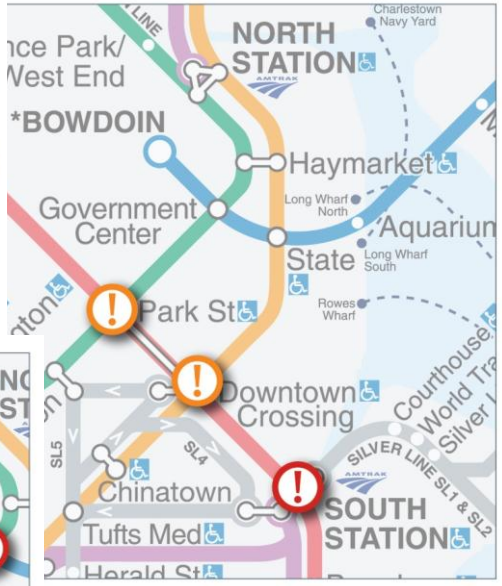
	Total Peak Travel Time Rank
Nashville-Davidson-Murfreesboro-Franklin TN	1
Oklahoma City OK	2
Birmingham-Hoover AL	3
Richmond VA	4
Raleigh-Cary NC	5
Memphis TN-MS-AR	6
Detroit-Warren-Livonia MI	7
Orlando-Kissimmee FL	8
Kansas City MO-KS	9
Louisville/Jefferson County KY-IN	10
St. Louis MO-IL	11
Houston-Sugar Land-Baytown TX	12
Indianapolis-Carmel IN	13
Washington-Arlington-Alexandria DC-VA-MD-WV	14
Atlanta-Sandy Springs-Marietta GA	15
Dallas-Fort Worth-Arlington TX	16
Los Angeles-Long Beach-Santa Ana CA	17
Jacksonville FL	18
Boston-Cambridge-Quincy MA-NH	19
San Antonio TX	20
Minneapolis-St. Paul-Bloomington MN-WI	21
San Jose-Sunnyvale-Santa Clara CA	22
Charlotte-Gastonia-Concord NC-SC	23
Providence-New Bedford-Fall River RI-MA	24
Tampa-St. Petersburg-Clearwater FL	25

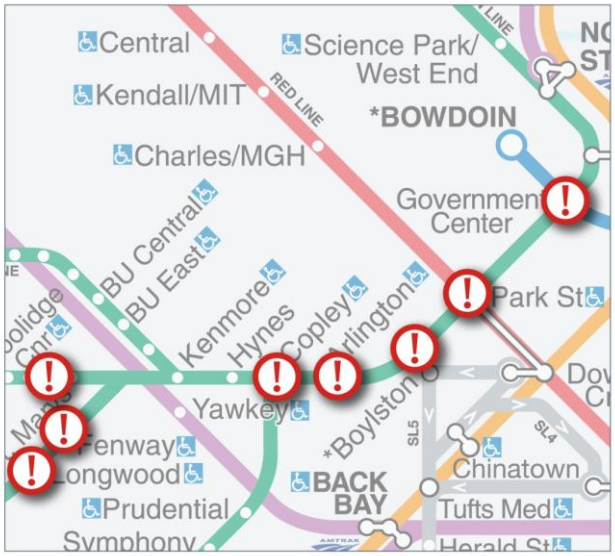
Source: Cortright, Joe. (2010). Driven apart: Why sprawl is lengthening our commutes and why misleading mobility measures are making them worse. Executive summary.

What's Missing: A congestion measurement system for transit riders









PROPOSED MBTA CONGESTION ASSESSMENT AND MANAGEMENT SYSTEM

A service is **congested** if peak hour ridership volumes are (or are forecast to be) consistently at 80%-100% of the Service Policy standard. In order to avoid future capacity constraints and violations of the Service Policy, steps should be taken to relieve congestion.

A service is **highly congested** if peak hour ridership volumes consistently exceed (or are forecast to exceed) the Service Policy standard but are below "crush capacity". A congestion relief plan should be put in place to bring vehicle loads below the Service Policy standard.

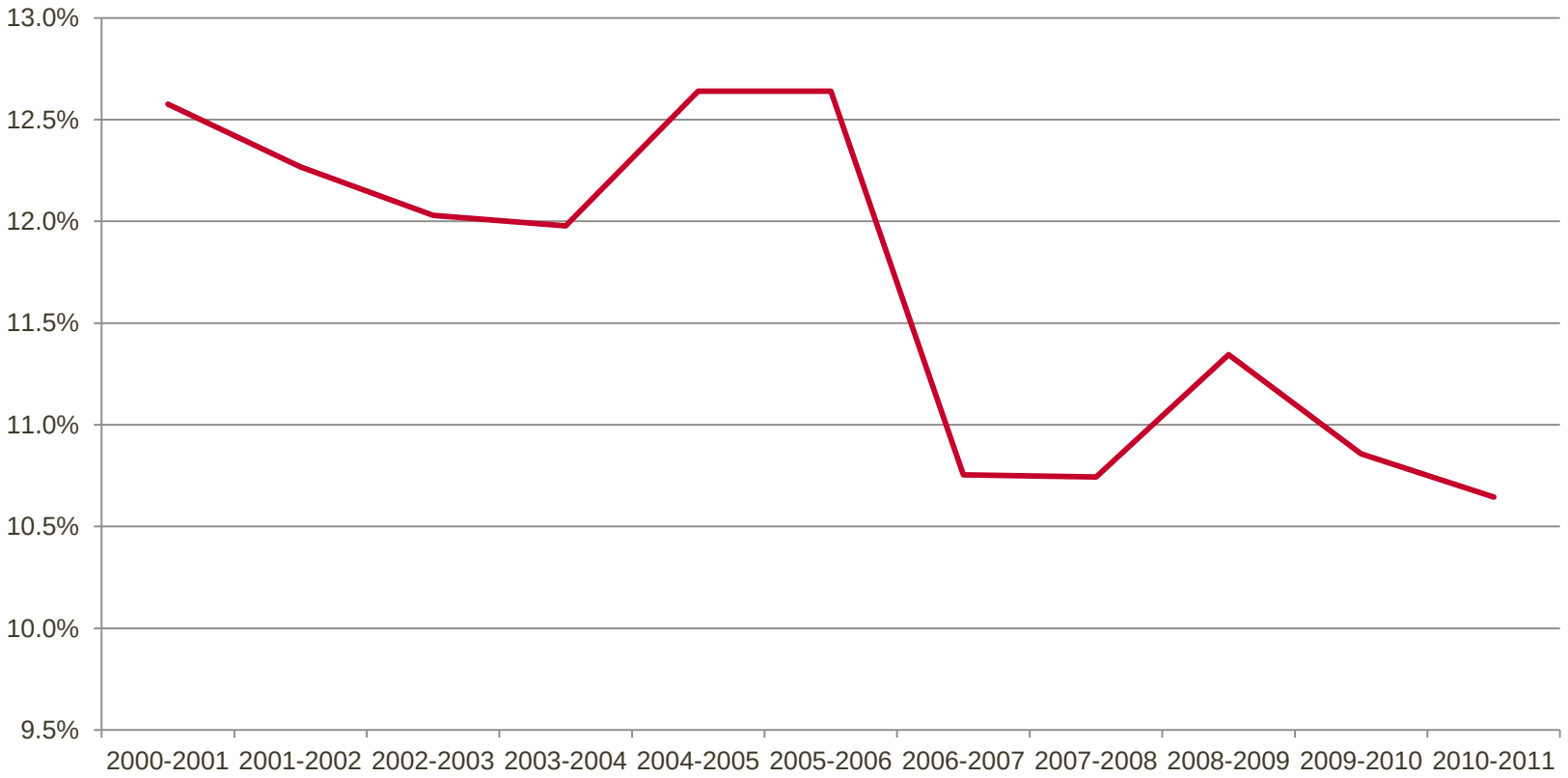
A service is **over capacity** if peak hour ridership volumes consistently exceed (or are forecast to exceed) crush capacity. A congestion relief and capacity expansion plan should be put in place immediately and should include both shorter-term measures to reduce vehicle loads and longer-term measures to expand capacity to meet projected ridership demand without experiencing violations of Service Policy standards.

Affordability

Affordability: Indicators and Benchmarks

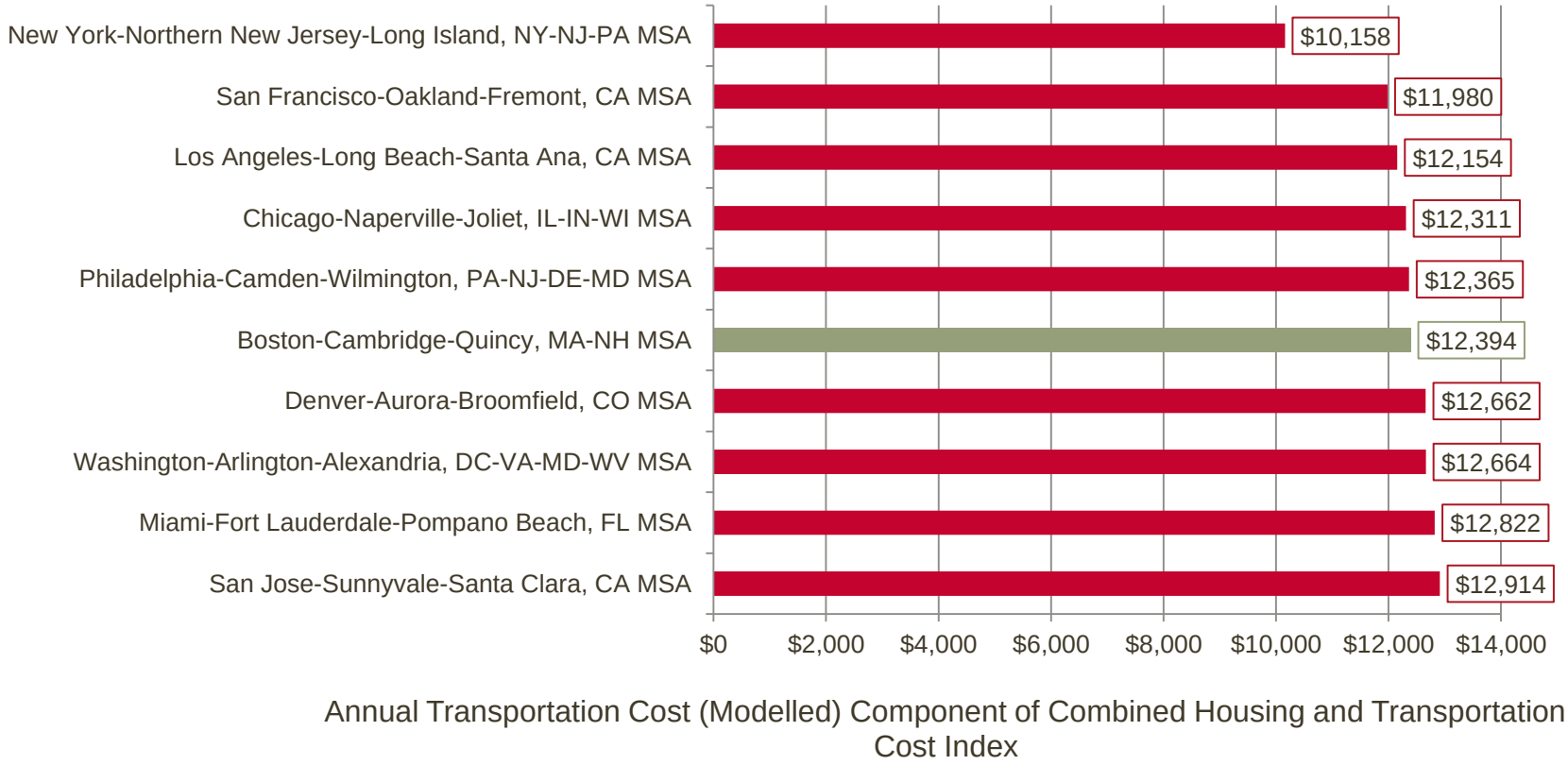
Metric	Type
Personal spending (% of income) on Transportation	Indicator
Transportation costs for large metropolitan areas	Benchmarks
Historical T Fares	Indicator
Consumer Price Changes for MBTA fares and gasoline 2000-2012	Indicator

Personal spending on transportation in Boston MSA



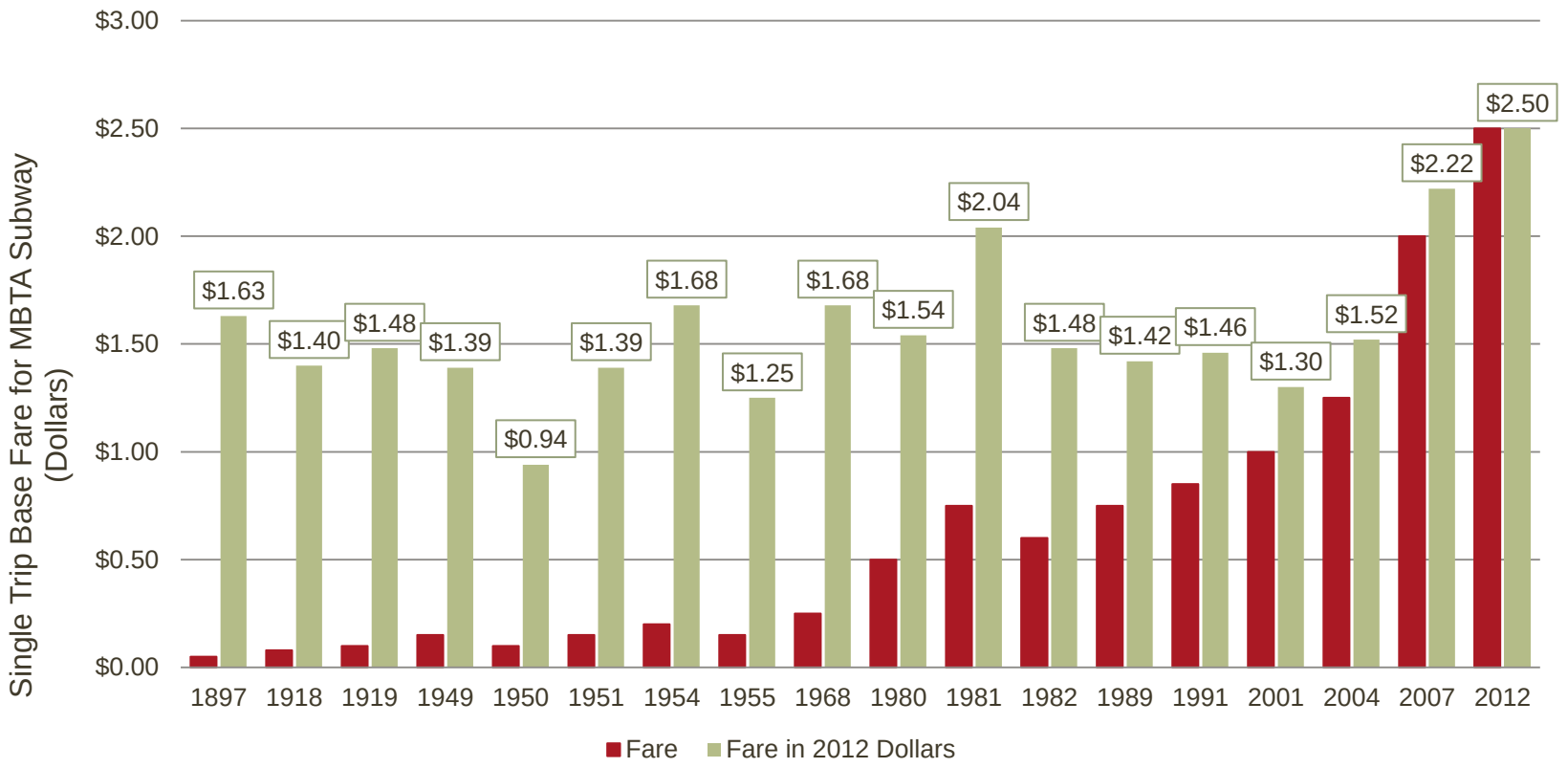
Source: Consumer Expenditure Survey data for Boston-Cambridge-Quincy MSA

BENCHMARK: Transportation costs for large metropolitan areas

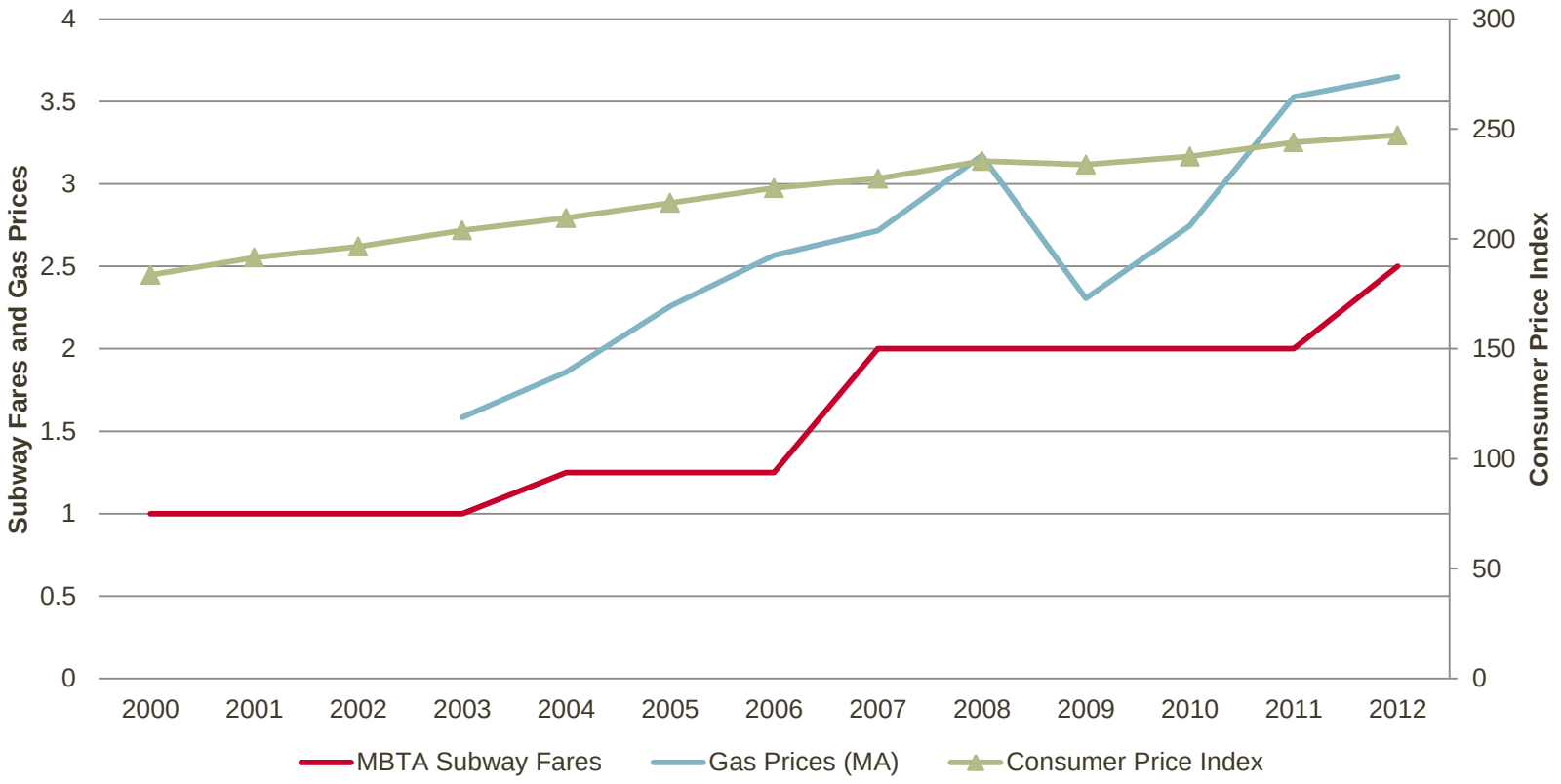


Source: Center for Neighborhood Technology's H+T Affordability Index

MBTA Fares Adjusted for Inflation



Consumer prices for MBTA fares and gasoline compared to inflation rate



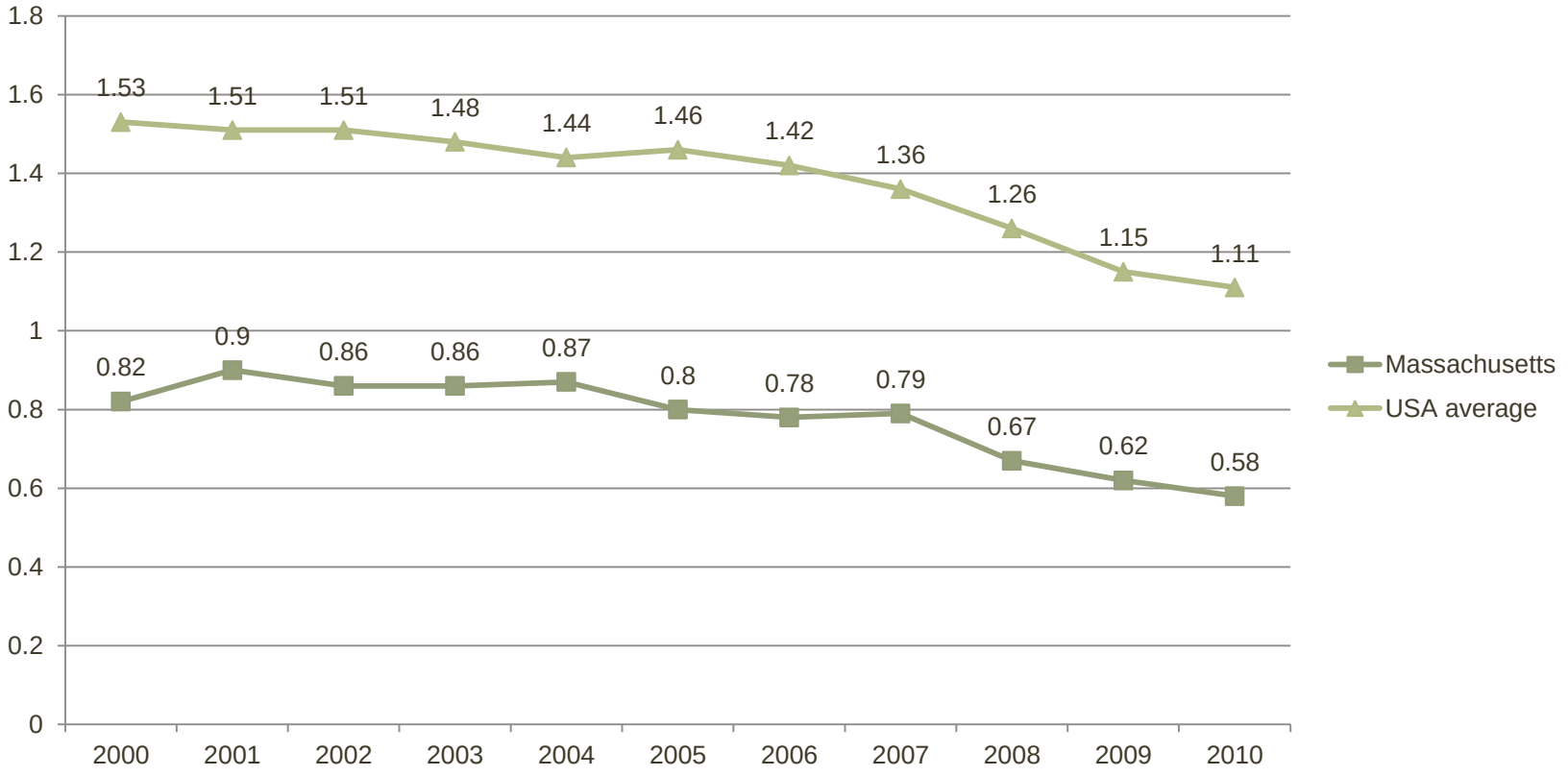
Safety


NORTHEASTERN UNIV
LVX
VERITAS
VIRTVS
FOUNDED AD 1898
BOSTON

Safety: Indicators and Benchmarks

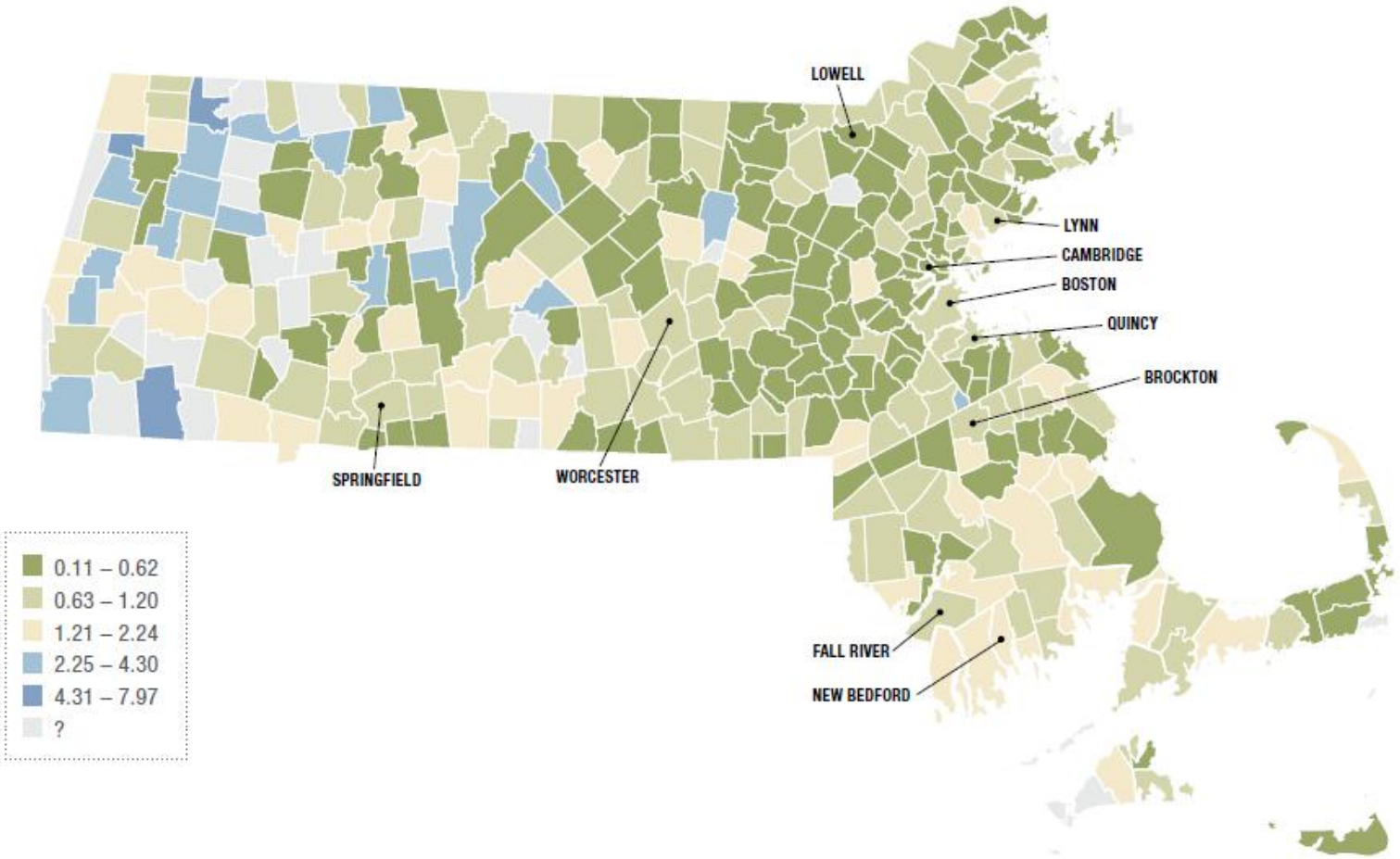
Metric	Type
Fatal Crash Rate per 100M VMT	Benchmark
MV Injuries per 100M VMT	Benchmark
Seat Belt Use	Benchmark
20 Safest Pedestrian Metros	Indicator
Fatal Crashes per 100M VMT by town	Indicator
Proportionality of Fatalities by Commute Mode	Indicator

Fatal Crash Rate per 100M VMT



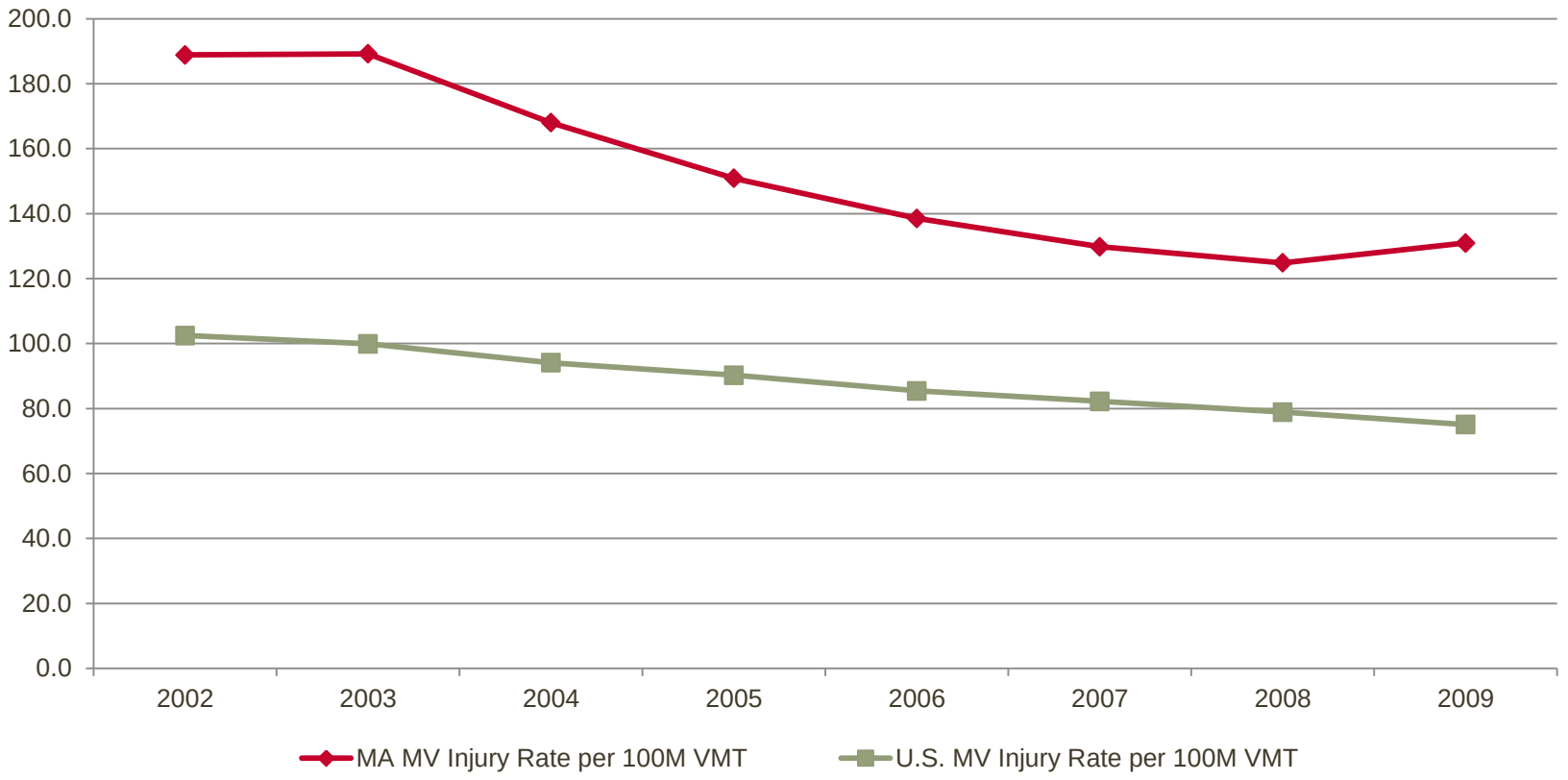
Source: Fatality Analysis Reporting System (FARS)

Fatal Crashes per 100MVMT by Town



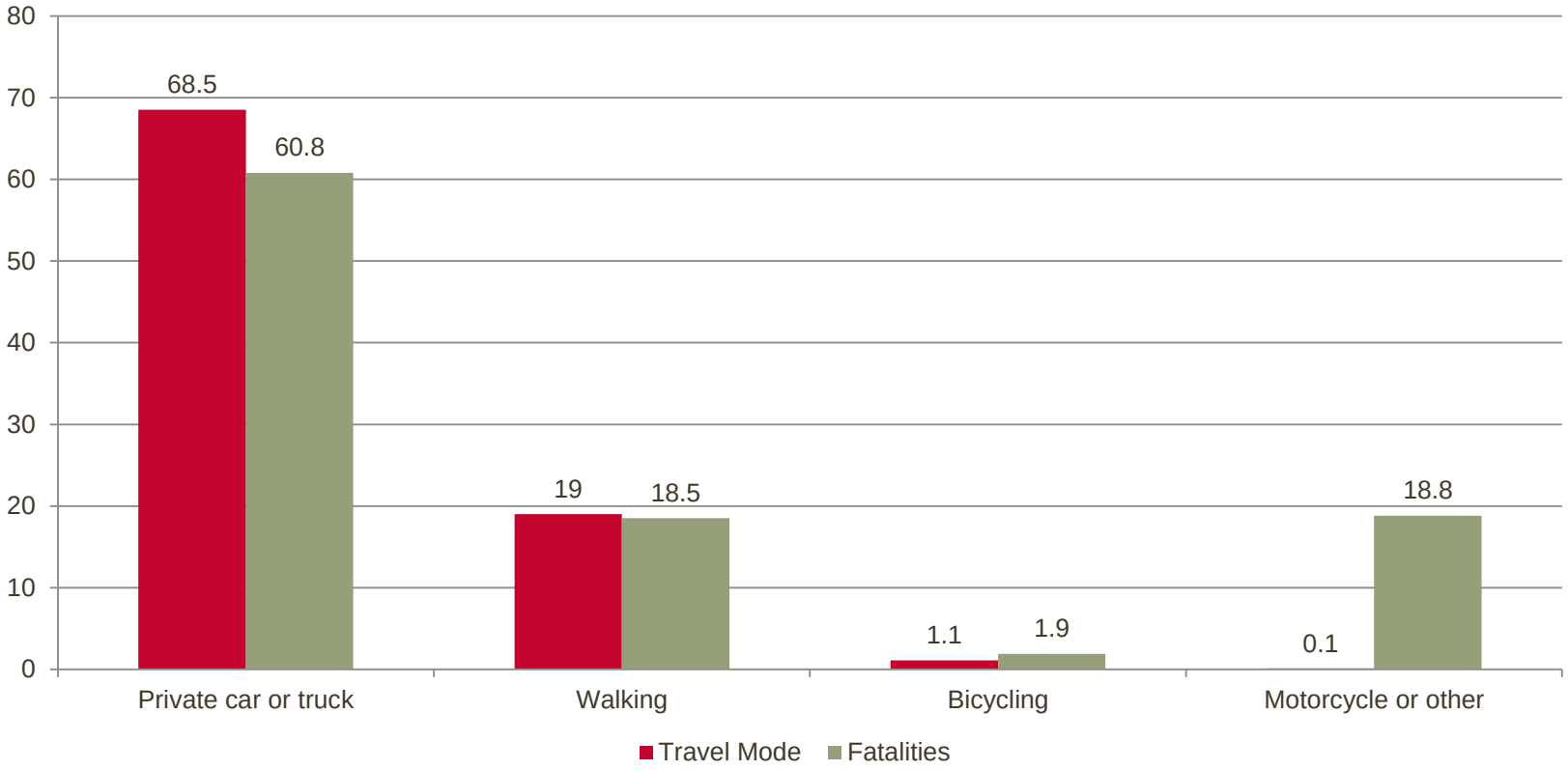
Source: Fatality Analysis Reporting System (FARS)

MV Injuries per 100M VMT



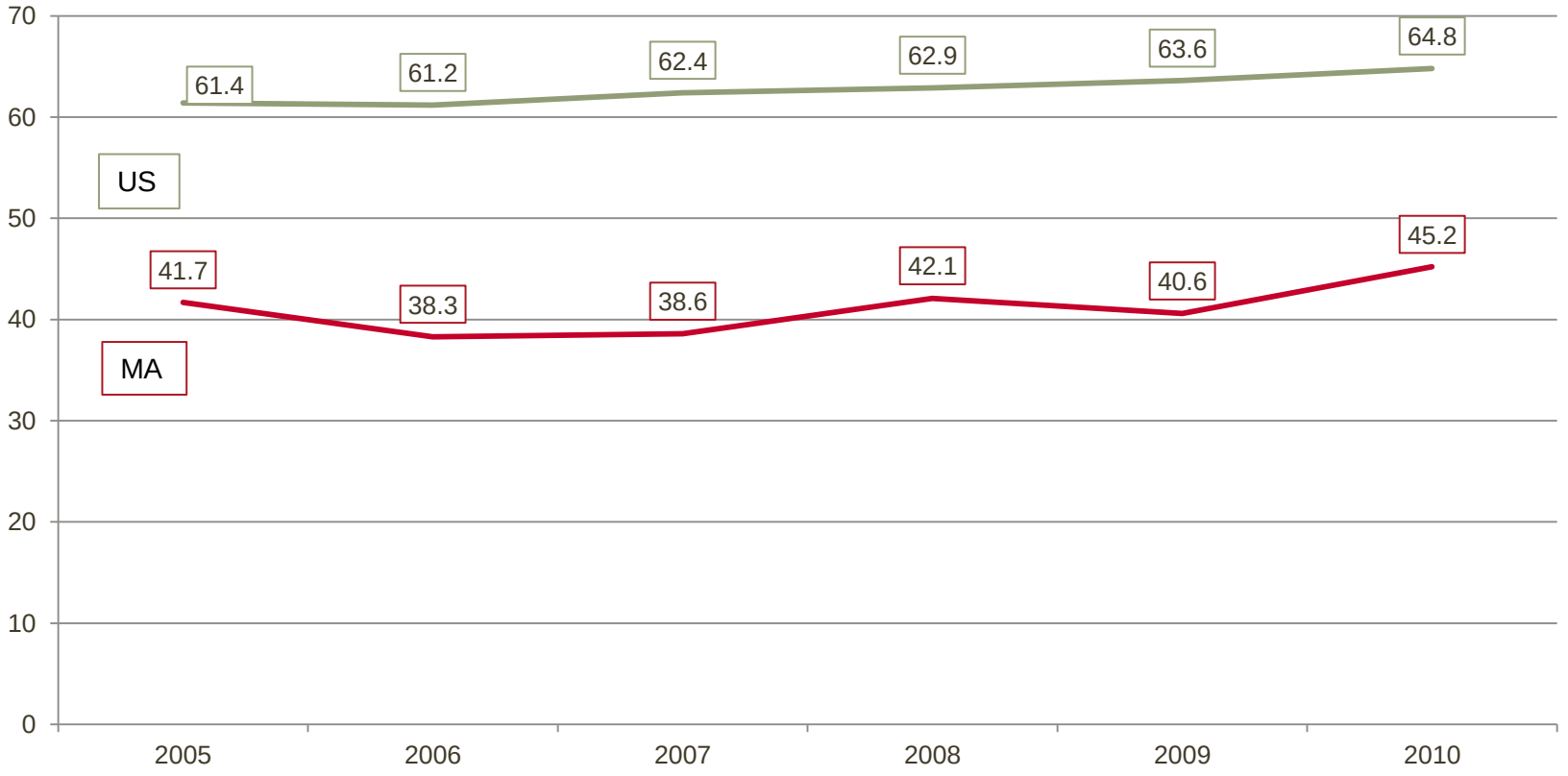
Source: National Highway Traffic Safety Administration Traffic Safety Facts, BTS State Transportation Statistics

Proportionality of Fatalities by Mode



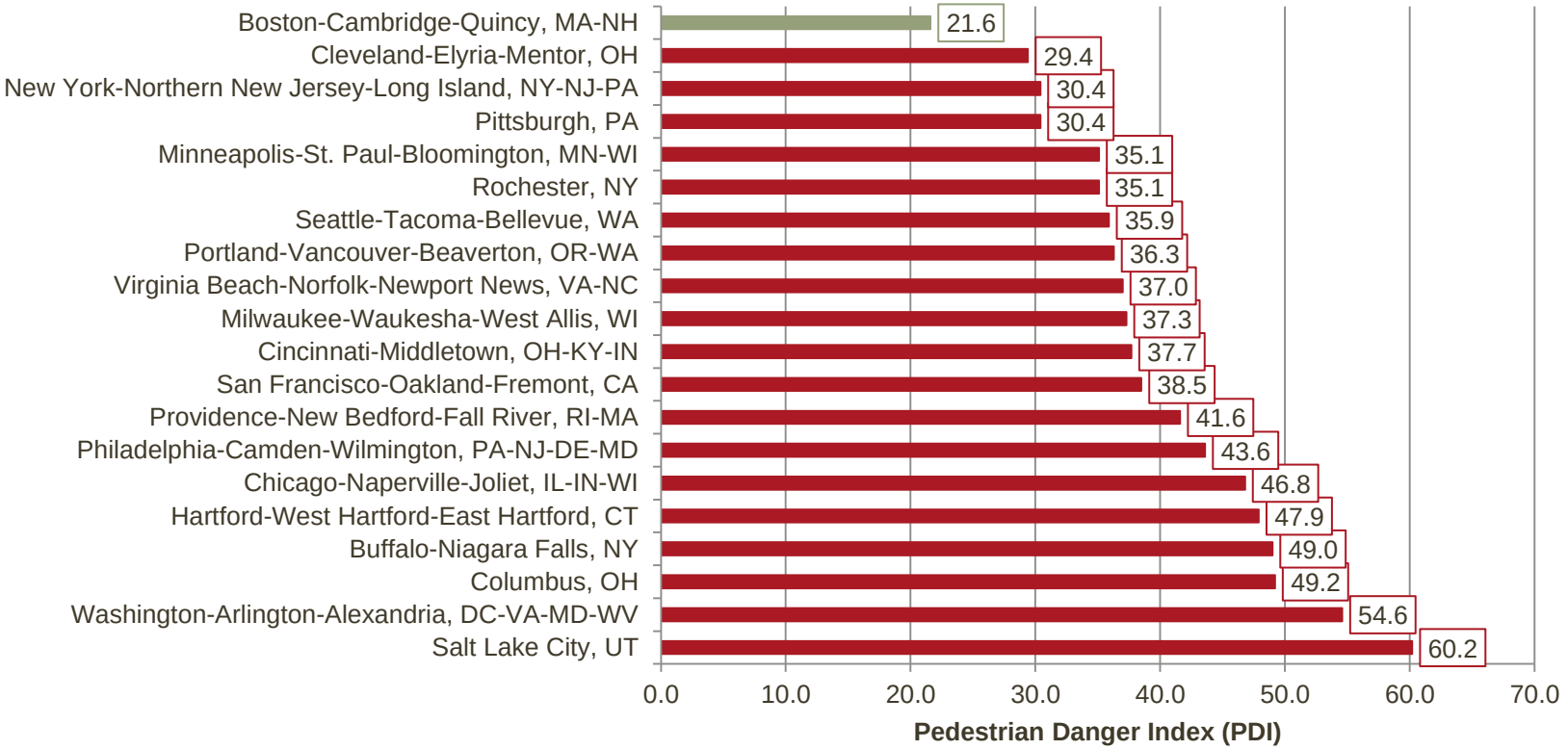
Source: Fatality Analysis Reporting System (FARS), MassDOT Massachusetts Travel Survey

Seat Belt Use



Source: Fatality Analysis Reporting System (FARS

BENCHMARK: Safest Metropolitan Areas for Pedestrians



Source: Transportation for America, Dangerous by Design (2011)

Conclusions: Staying on Track

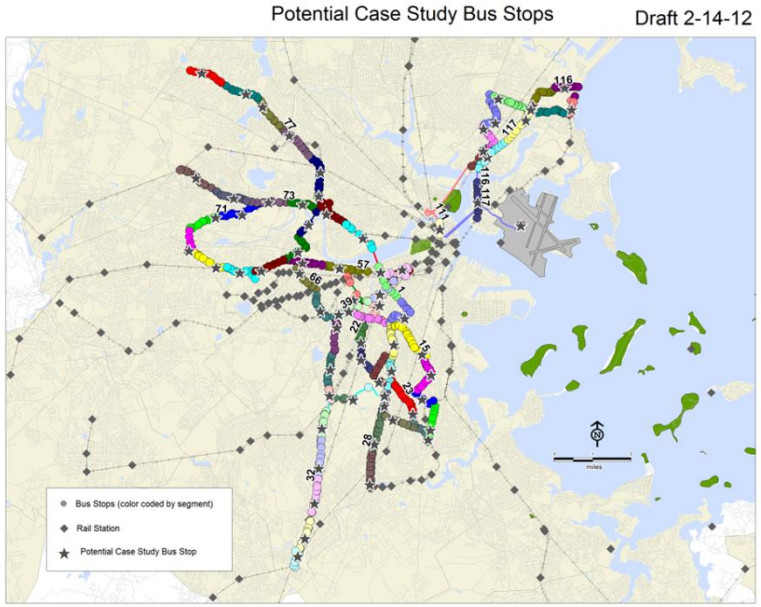
Conclusions

- Massachusetts' current transportation system is neither well maintained nor sustainably funded
- Baseline travel patterns reflect relatively lower amounts of driving and greater amounts of transit use than in many other peer metros and states
  - Particularly in metropolitan Boston
  - And especially in the MBTA's transit shed
- But travel options and land use patterns that support sustainable mobility are not distributed evenly across communities and so the system does not yet
  - Provide equitable access to the region's jobs and other opportunities, particularly for those who lack cars and/or rely on public transportation
  - Provide all users with convenient transportation options

MBTA Station Areas and Equitable TOD: eTOD Score

Developing a TOD rating system

- Why develop a rating system?
- No consensus definition of equitable TOD, so
- No way to distinguish “good” from “not as good” equitable TOD
- Key issue: what geography?
  - Station areas
  - Projects



Including high frequency bus stops

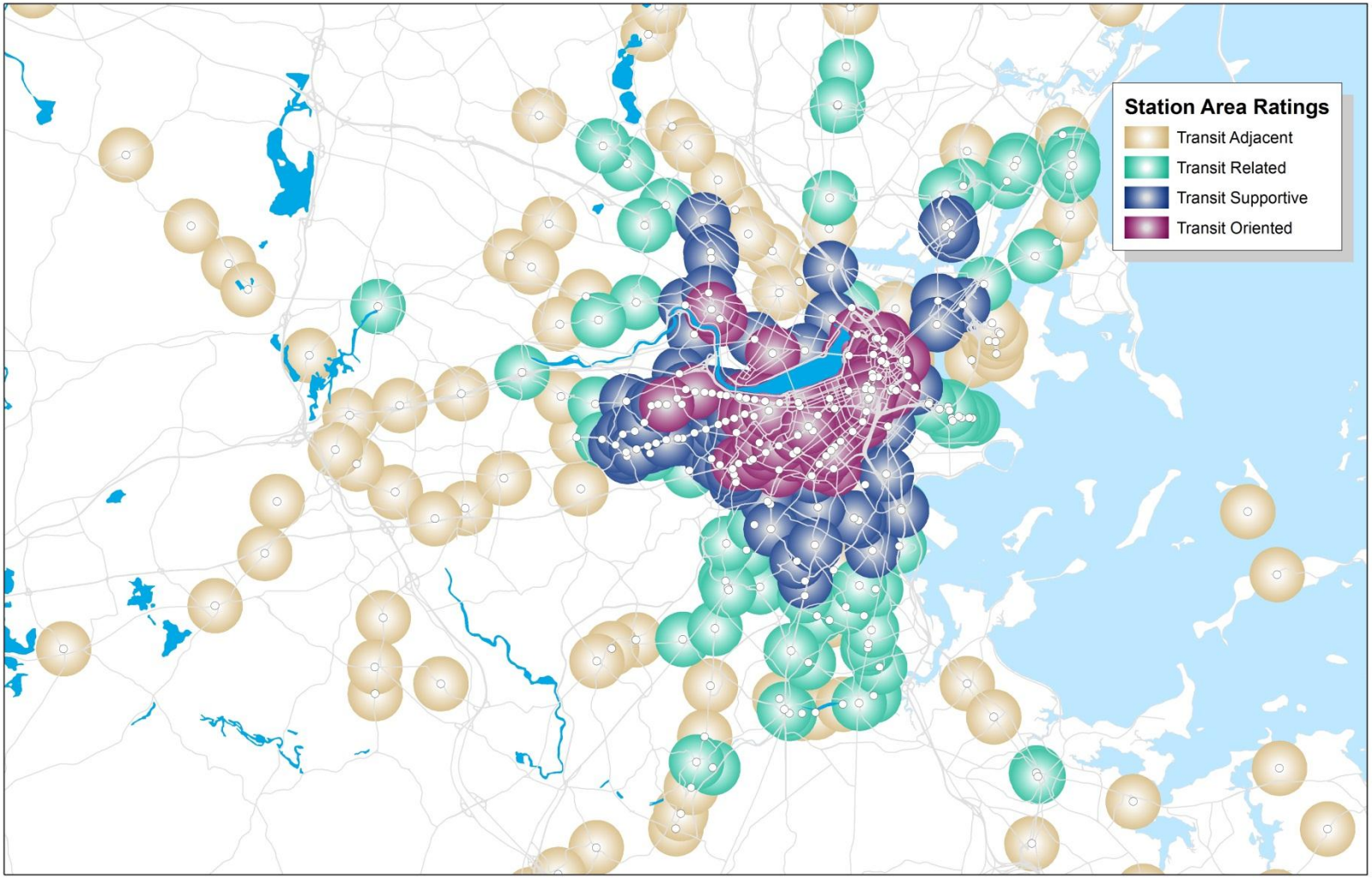
Components of eTOD Score

Transit	Availability, quality, connectivity, and use of public transit
Orientation	Demographic and socioeconomic orientation toward transit usage
Development	Presence of existing transit-oriented development with higher densities and mix of uses

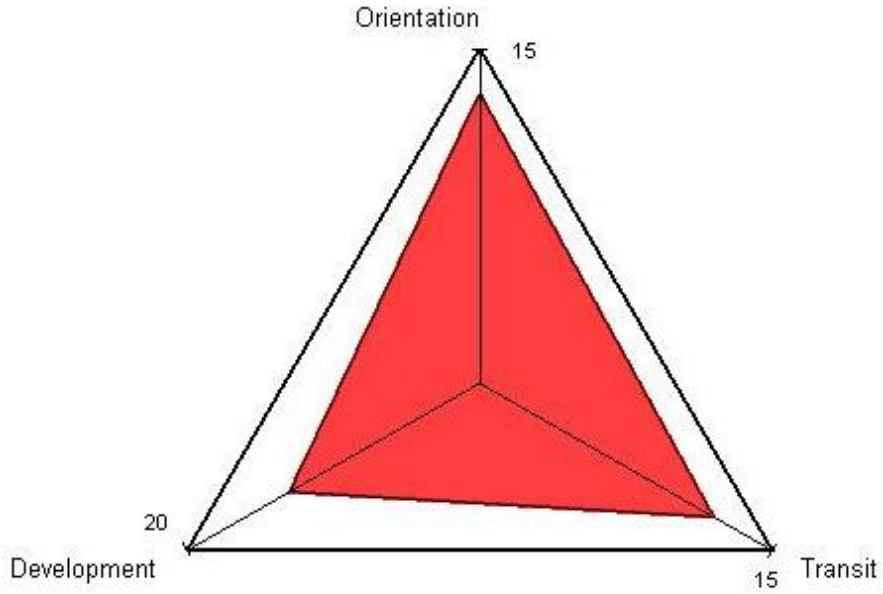
eTOD Score Draft Rating System

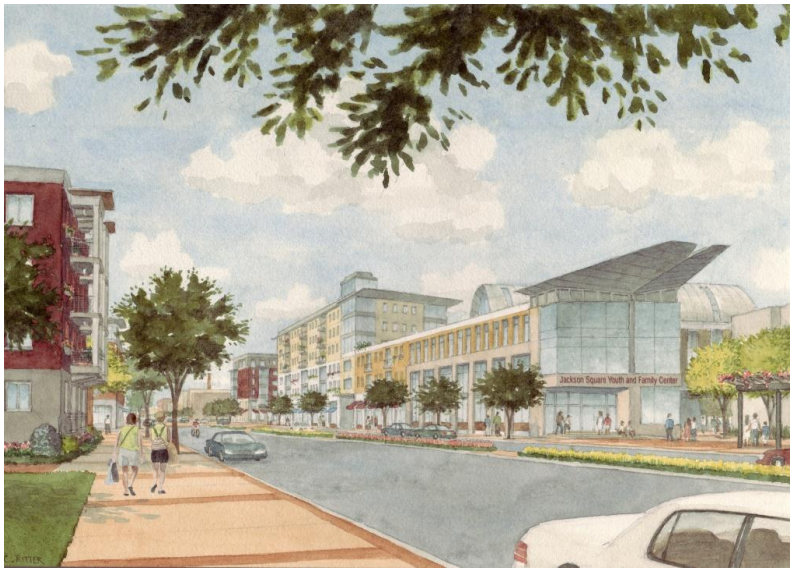
		Metric	Measure
Category	Transit	Distance	Transit Access Shed Index (TAS)
		Depth of Service	Transit Connectivity Index (TCI)
		Use	Percentage workers who use transit, bike, or walk to work (ABC)
	Orientation	Transit Dependency	Percentage of 0-car households
		Lower income	Percentage of households with income <$25,000
		Housing Ownership	Percentage renters
	Development	Walkability	WalkScore®
		Residential density	Households per residential acre
		Employment gravity	Employment Gravity Measure
		Affordability	Percent of Income Spent on Transportation

Station Area Ratings



eTOD Score example: Jackson Square





Interactive Web-Based Tool

http://www.northeastern.edu/dukakiscenter/focus-areas/transportation/etodscore/

Q&A/Discussion