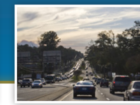



BOTTLENECKS ON FLORIDA SIS

YEAR 2011

Strategic Intermodal System





Demand for highway travel by Floridians continues to grow as population increases, particularly in metropolitan areas. Construction of new highway capacity to accommodate this growth in travel has not kept pace. Congestion is largely thought of as a big city problem, but delays are becoming increasingly common in small cities and rural areas as well.

Need for Studying Bottlenecks

The growth of traffic congestion and bottlenecks on Florida's streets and highways is a major concern to travelers, administrators, merchants, developers and to the community at large. Its detrimental impacts in longer journey times, higher fuel consumption, increased emissions of air pollutants, greater transport and other affected costs, and changing investment decisions are increasingly recognized and felt across the state of Florida. Congestion and bottlenecks reduce the effective accessibility of residents, activities and jobs and results in lost opportunities for both the public and business.

Mitigating congestion and eliminating bottlenecks by managing traffic better, expanding transport capacity, managing travel demands, or modifying land use requires basic information on how, where, why and to what extent congestion and bottlenecks occur.

Common Locations for Bottlenecks

Bottlenecks are usually found at certain locations on roadways such as lane drops, weaving areas, freeway on and off ramps, interchanges, changes in highway alignments, narrow lanes or lack of shoulders, and traffic control devices.

Lane Drops

Freeway On-Ramps

Freeway Exit Ramps

Interchanges

Changes in Highway Alignment

Narrow Lanes/ Lack of Shoulder

Traffic Control Devices

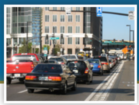
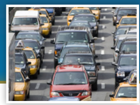
Tunnels/Underpasses

Scope and Methodology

This study presents a methodology to identify bottlenecks on Florida's Strategic Intermodal System (SIS) using vehicle probe data and travel time reliability measures. The vehicle probe data, obtained from INRIX, provided travel speed on roadways for an entire year at five-minute interval. Travel time reliability is a measure of consistency in travel time and is being encouraged by FHWA as a measure for managing and operating transportation systems. The top bottlenecks at the statewide and district-wide level are identified. This methodology can be used to update the bottleneck locations on Florida's SIS with the latest vehicle probe data on an annual basis.

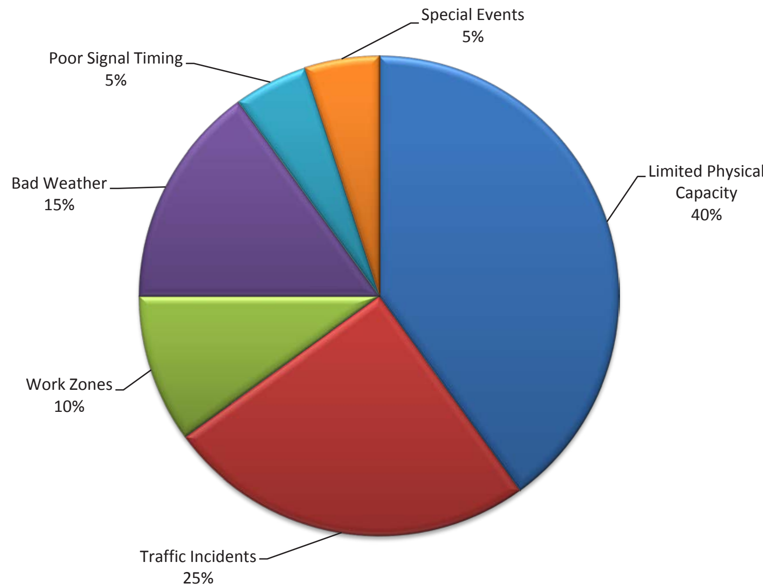
Information about the roadway geometry at the identified bottleneck locations can help to determine its cause and suggest corrective action. Identification of bottlenecks and estimation of their activation times and delay impact can aid the Department of Transportation in focusing on relief efforts and ranking them by priority. Applying the methodology routinely over time and with the latest vehicle probe data allows the identification of new bottlenecks and monitoring of existing ones to discern congestion trends.

photos courtesy of www.seefloridago.com


Federal Highway Administration (FHWA) defines congestion as an excess of vehicles on a roadway at a particular time resulting in speeds that are slower – sometimes much slower – than normal or free flow speeds. Congestion is stop-and-go traffic. FHWA's research has shown that congestion is the result of six root causes often interacting with one another. The six contributing sources and an estimate of how much each of these sources contributes to total congestion are:

- Limited physical capacity;
- Poor traffic signal timing;
- Traffic incidents;
- Work zones;
- Bad weather; and,
- Special events.



A bottleneck can be defined as a localized section of highway that experiences reduced speeds and inherent delays due to a recurring operational influence or a nonrecurring impacting event. Simply put, a bottleneck is a localized constriction of traffic flow. A bottleneck is distinguished from congestion because it occurs on a subordinate segment of a parent facility, and not pervasively along the entire facility. In this context then, ***a bottleneck certainly constitutes congestion, but congestion is often more than a bottleneck***.

Quantifying Congestion/Bottlenecks

National Cooperative Highway Research Program (NCHRP) Report 398 Volume 1: Quantifying Congestion presented methods to measure congestion on roadway systems. The report finds that while it is difficult to conceive of a single value that will describe all of the travelers' concerns about congestion, there are four components that interact in a congested roadway or system. These components are duration, extent, intensity and reliability.

- **Duration –** This is defined as the amount of time congestion affects the travel system.
- **Extent –** This is described by estimating the number of people or vehicles affected by congestion, and by the geographic distribution of congestion.
- **Intensity –** This is the severity of the congestion that affects travel. It is typically used to differentiate between levels of congestion on transportation systems and to define the total amount of congestion.
- **Reliability –** This key component of congestion estimation is described as the variation in the other three elements. Reliability is the impact of non-recurrent congestion on the transportation system.

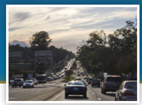
Identifying a Bottleneck

Recurring bottlenecks have an identifiable cause, resulting in recurring delays of generally predictable times and durations. The following conditions help to identify a recurring bottleneck condition:

- A traffic queue upstream of the bottleneck;
- A beginning point for a queue;
- Free flow traffic conditions downstream of the bottleneck that have returned to nominal conditions;
- Predictable recurring cause; and,
- Traffic volumes that exceed capacity.

Non-recurring bottlenecks are usually caused by amorphous, random events such as traffic incidents, bad weather or work zones.





FDOT Data Sources

FDOT uses a combination of field data and calculation programs to develop performance measures. The field data includes information from the Roadway Characteristics Inventory and Traffic Monitoring Program.

Roadway Characteristics Inventory (RCI)

The RCI is a computerized database of information related to the roadway network maintained by or of special interest to FDOT. In addition to data required by FDOT, the RCI contains other data as required for special Federal and State reporting obligations. RCI identifies the different roadway segments with a unique roadway ID, with each segment containing information on roadway features, characteristics, and other data elements.

Traffic Monitoring Program

The FDOT Transportation Statistics office's Traffic Data Section maintains data on the usage of the State Highway System, such as annual average daily traffic, vehicle classification, speed, and weight. Data for this program is collected using two types of sources:

- **Telemetered Traffic Monitoring Sites (TTMSs) –** Approximately 300 permanent counters that continuously monitor traffic are placed at specific locations to record hourly, daily, and monthly variation of traffic flow.
- **Portable Traffic Monitoring Sites (PTMSs) –** Coverage counters are used at about 5,000 to 6,000 locations, collecting hourly data for 24 to 48 hours, and are deployed one to four times a year.

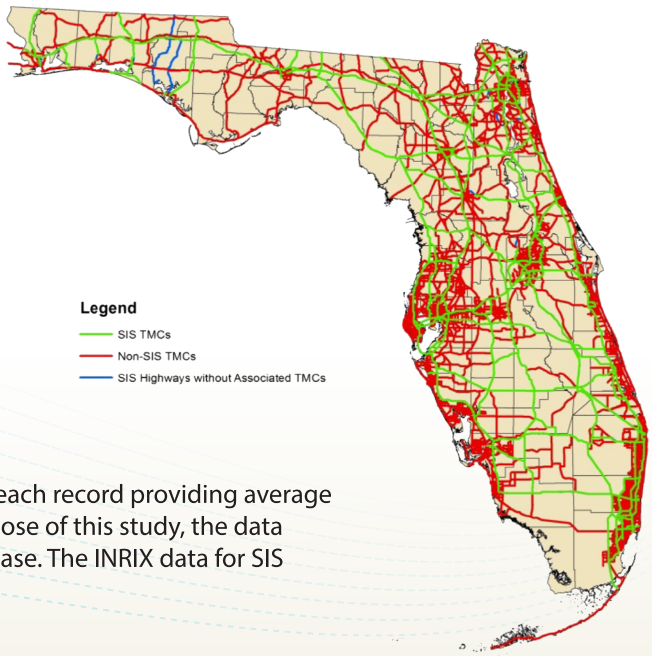
Vehicle Probe Data from INRIX

INRIX is a private provider of vehicle probe data which combines real-time data from traditional sensors, a crowd-sourced network of over 4 million GPS-enabled vehicles, historical traffic speeds database and hundreds of other traffic impacting factors like accidents, construction and other local variables. INRIX Historical Traffic Flow data is a spatial and temporal database of average speeds for major roadways and arterials across all fifty (50) states.

INRIX Data Sources

INRIX derives historical flow data using the following:

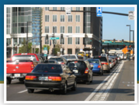
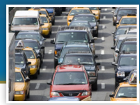
- **Traffic Sensors –** Sensors (induction loop sensors, radar sensors, and toll tag readers) put in place by local DOTs or private sector companies are utilized by INRIX from which traffic speed is either reported or can be inferred.
- **Probe Vehicles –** The INRIX network includes hundreds of thousands of probe vehicles—trucks, taxis, busses and passenger cars—with onboard GPS devices and a transmit capability to return speed and location back to a central location anonymously.
- **INRIX Smart Dust Network –** It derives speed by combining data from one or more physical sensors as well as all available data from probe vehicles that fall within a specific segment of road for a particular time window. A patented component gathers all input points, weights them appropriately based on input quality and latency, and calculates the speed of that road segment to a measured degree of accuracy.



The data is updated twice a year, incorporating both changes to map databases as well as additional historical data from the INRIX Smart Dust Network.

Summary of INRIX Data for Florida

FDOT purchased vehicle probe data from INRIX along Florida's roadways at five minute intervals from July 2010 to June 2011. This data for the state of Florida included 711 million records with each record providing average speed on a roadway segment at five-minute intervals. For the purpose of this study, the data pertaining to the SIS network was extracted from the overall database. The INRIX data for SIS network contained 293 million records.


Historically, the most common measures of congestion used by agencies were volume-to-capacity ratio, vehicle hours of delay and mean speed. Recent research efforts including those by FDOT identify the importance of using travel time and reliability as measures of congestion. FHWA provides a methodical approach for agencies considering adoption of reliability measures. This methodology was used as the basis and adapted to identify bottlenecks and congestion on Florida's SIS network.

Define Study Parameters

For the purposes of this study, bottlenecks were identified based on the following sets of parameters:

- Auto mode along the general purpose lanes and HOV lanes will be considered.
- Bottlenecks will be identified based on weekday travel patterns along the SIS network. For the purpose of bottleneck identification, weekday is considered as Monday through Friday.
- Travel time reliability measures will be used for identifying bottlenecks. Travel time reliability allows agencies to evaluate the performance of a facility beyond just the peak hour, and to consider operations over a longer period of time. Travel time reliability is defined as how much travel times vary over the course of time.
- Annual trends of travel time reliability measures will be prepared.

Calculate Performance Measures

The following four annual performance measures were calculated for the whole year:

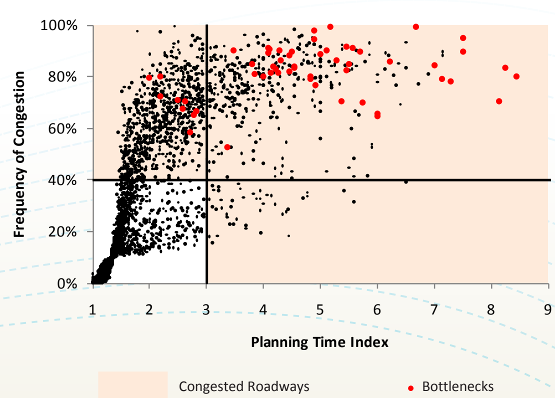
- **90th Percentile Travel Time –** This measure indicates that 90 percent of the time, the travel time on a roadway segment is lower than the 90th percentile value. So, the higher the 90th percentile travel time, the longer it takes to travel on a roadway.
- **Free-flow Travel Time –** This measure indicates the travel time on a roadway under free-flow conditions, with little to no interaction from traffic. In order to calculate this measure, the travel times during overnight hours are considered because of low traffic volumes.
- **Planning Time Index –** The planning time index is computed as the 90th percentile travel time divided by the free-flow travel time. For example, a planning time index of 1.60 means that, for a 15-minute trip in light traffic, the total time that should be planned for the trip is 24 minutes. So, the higher the planning time index the longer the travel time that should be budgeted to reach a destination on time.
- **Frequency of Congestion –** This is expressed as the percent of time that travel speeds fall below 75% of the free-flow speed during daytime. For example, a frequency of congestion of 60% means that the speeds on that roadway are less than 45 mph (for freeways with 60 mph speed limit) and 30 mph (for arterials with 45 mph speed limit) for 60% of the time. So, the higher the frequency of congestion, the longer the roadway is congested.

Identify Bottlenecks

Bottlenecks were identified using a combination of planning time index and frequency of congestion. Both congested roadways and bottlenecks were identified as follows:

- **Congested Roadways –** The portion of the roadway network with planning time index greater than 3.0 (for freeways) and 2.0 (for arterials) or frequency of congestion greater than 40 percent is identified as a congested roadway.

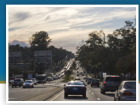
  If the frequency of congestion on a roadway is greater than 40 percent, it indicates that the roadway is congested for a minimum of 5 hours during the day. This would identify roadway segments that have slower speeds at a minimum during the morning and evening peak periods. As such, the frequency of congestion greater than 40 percent was considered as a criterion for identifying congested roadways. Traffic on the arterial streets behaves very differently from traffic on the freeways. As such, different thresholds for planning time index were selected for freeways and arterials for identifying congested roadways.



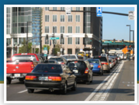
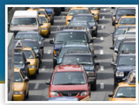
- **Bottleneck –** The portion of the congested roadway network which has the highest combination of planning time index and frequency of congestion is identified as a bottleneck.

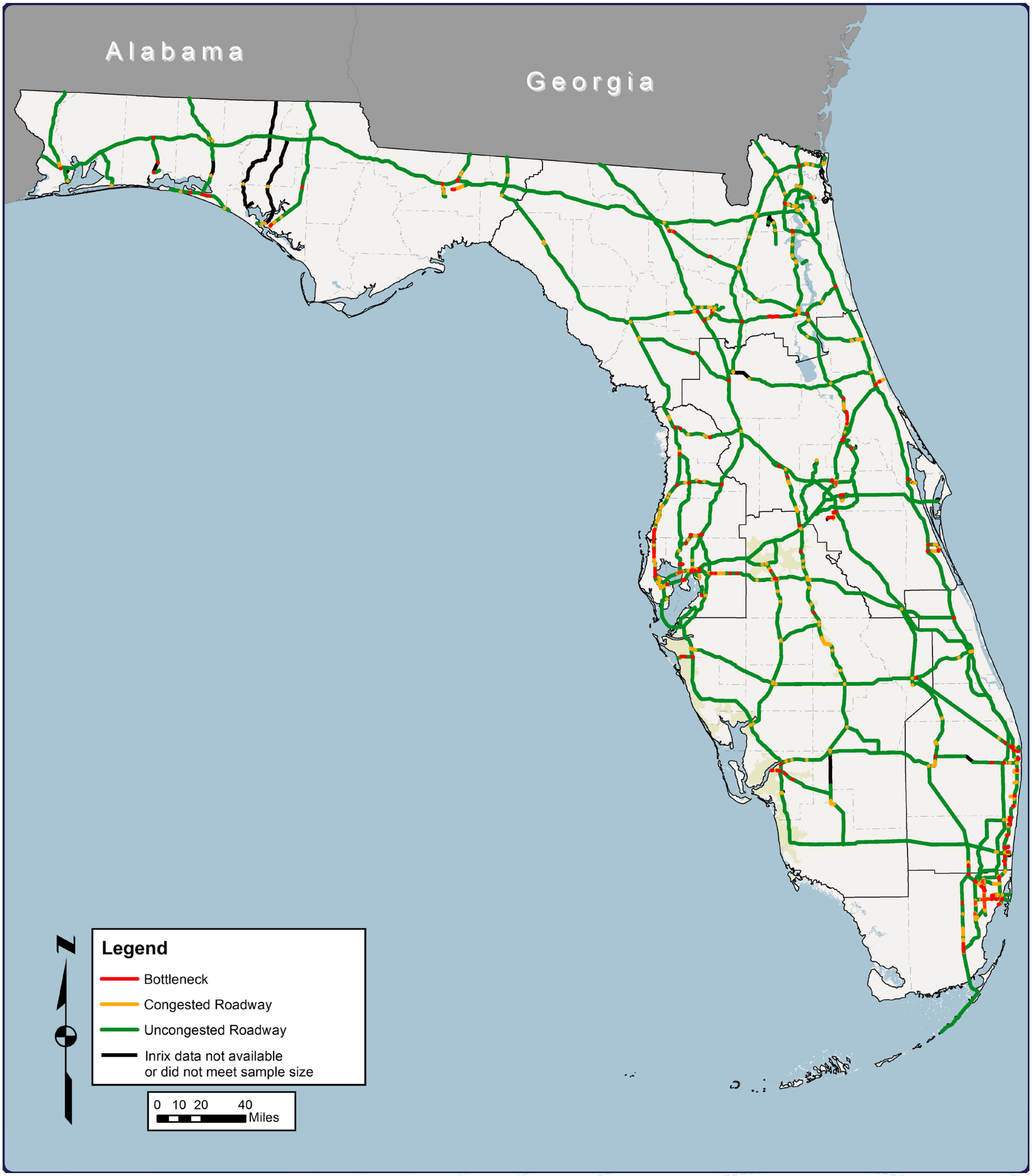
Top 20 Statewide SIS Bottlenecks





Florida Rank 2011	County	District	Road	Segment	Length
1	Miami-Dade	6	FL Turnpike NB	at Kendall Drive	0.86 miles
2	Hillsborough	7	I-275 NB	Floribraska Avenue to 26th Avenue	0.23 miles
3	Miami-Dade	6	FL Turnpike SB	FL 836 to Coral Way	1.86 miles
4	Miami-Dade	6	FL 826 NB	Coral Way to FL 836	2.14 miles
5	Hillsborough	7	I-4 WB	15th Street to I-275	0.86 miles
6	Miami-Dade	6	FL 826 SB	at Miami Lakes Drive	0.47 miles
7	Miami-Dade	6	FL 836 WB	at 17th Avenue	0.52 miles
8	Hillsborough	7	I-275 NB	Howard Frankland Bridge to West Shore Boulevard	2.63 miles
9	Hillsborough	7	I-275 SB	I-4 to N Tampa Street	0.55 miles
10	Orange	5	I-4 NB	Michigan Street to Robinson Street	2.61 miles
11	Miami-Dade	6	FL 826 SB	NW 58th Street to NW 25th Street	1.82 miles
12	Miami-Dade	6	FL 836 WB	I-95 to NW 12th Avenue	0.20 miles
13	Miami-Dade	6	FL 826 SB	at SW 24th Street	0.23 miles
14	Miami-Dade	6	FL Turnpike SB	at I-95	0.77 miles
15	Miami-Dade	6	Airport Expressway WB	Unity Boulevard to North River Drive	0.99 miles
16	Miami-Dade	6	I-95 SB	at FL Turnpike	0.15 miles
17	Miami-Dade	6	I-75 EB	at Palmetto Expressway	0.51 miles
18	Miami-Dade	6	FL 826 SB	at W 68th Street	0.61 miles
19	Miami-Dade	6	FL 836 EB	at NW 72nd Avenue	0.25 miles
20	Miami-Dade	6	FL 826 SB	SW 24th Street to SW 40th Street	0.88 miles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Congested Roadway
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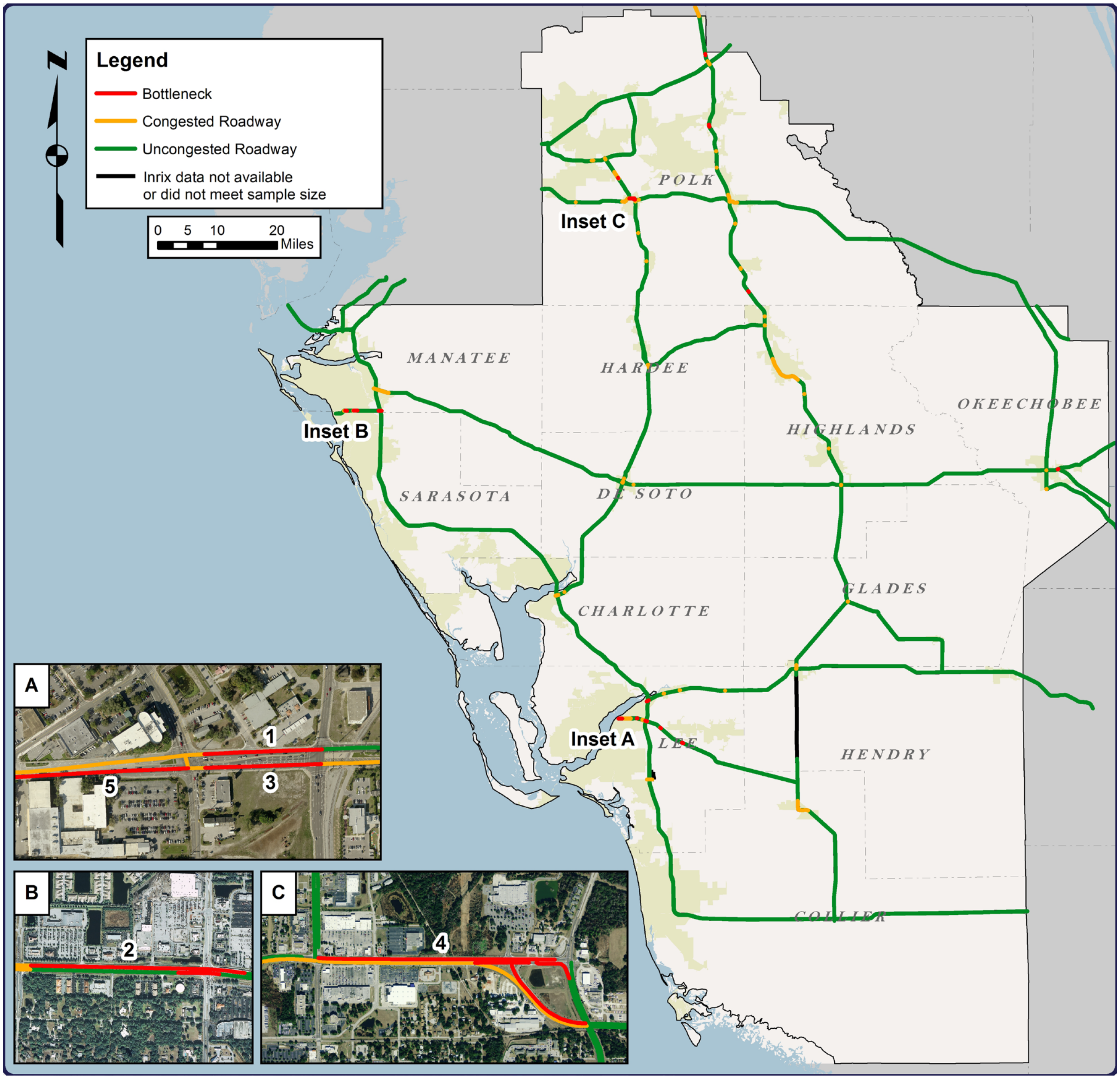
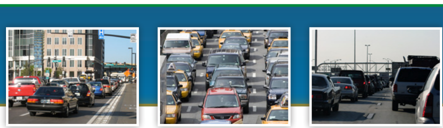
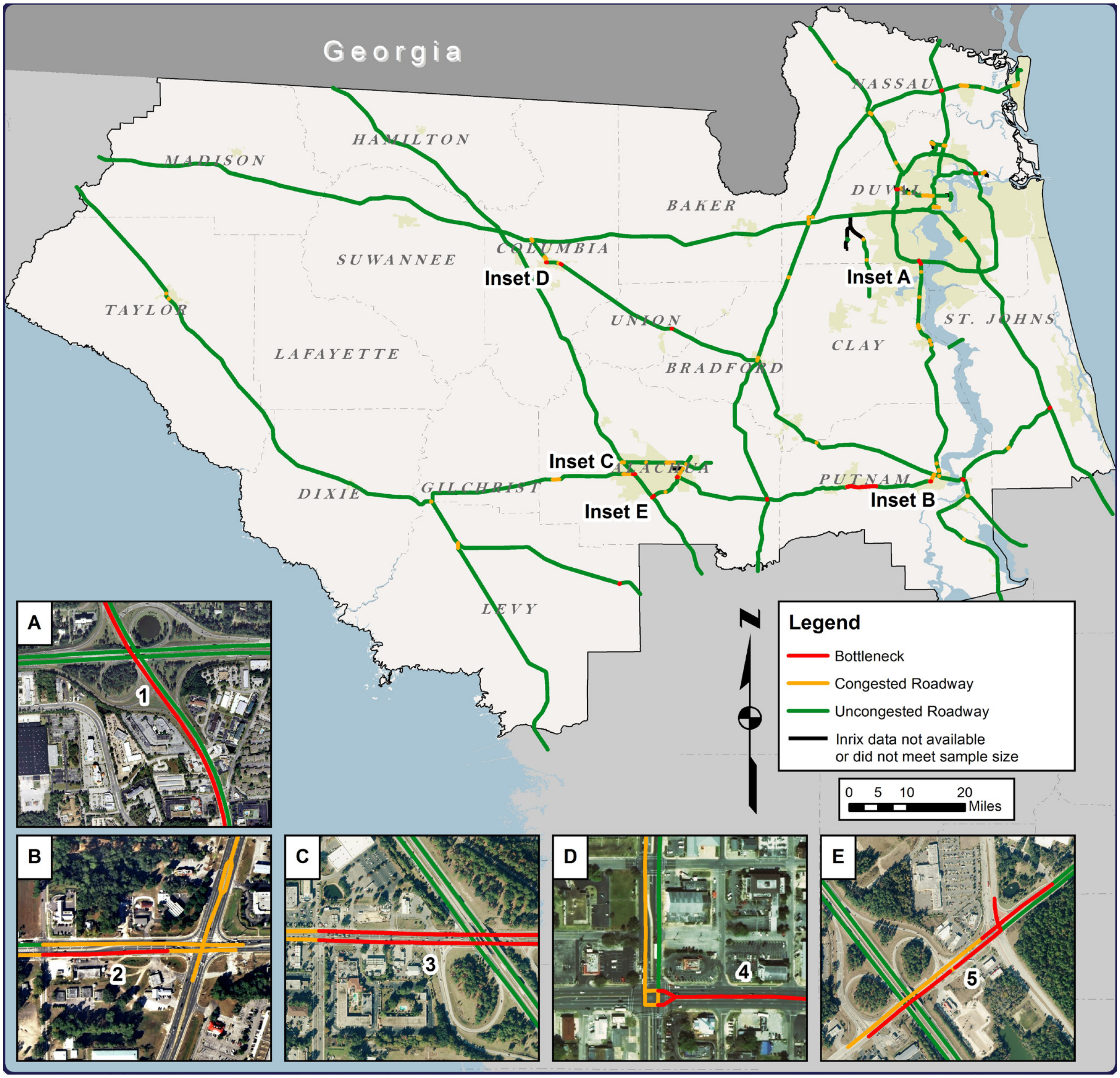


Top Bottlenecks

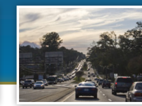
ID	Road	Segment	County	Length
1	Martin Luther King Jr. Boulevard WB	Evans Avenue to Fowler Street	Lee	0.11 miles
2	University Parkway WB	Lockwood Ridge Road to Tuttle Avenue	Sarasota	0.45 miles
3	Martin Luther King Jr. Boulevard EB	Fowler Street to Evans Avenue	Lee	0.11 miles
4	E Van Fleet Drive WB	SR 60 to Broadway Avenue	Polk	0.60 miles
5	Martin Luther King Jr. Boulevard EB	Monroe Street to Fowler Street	Lee	0.44 miles

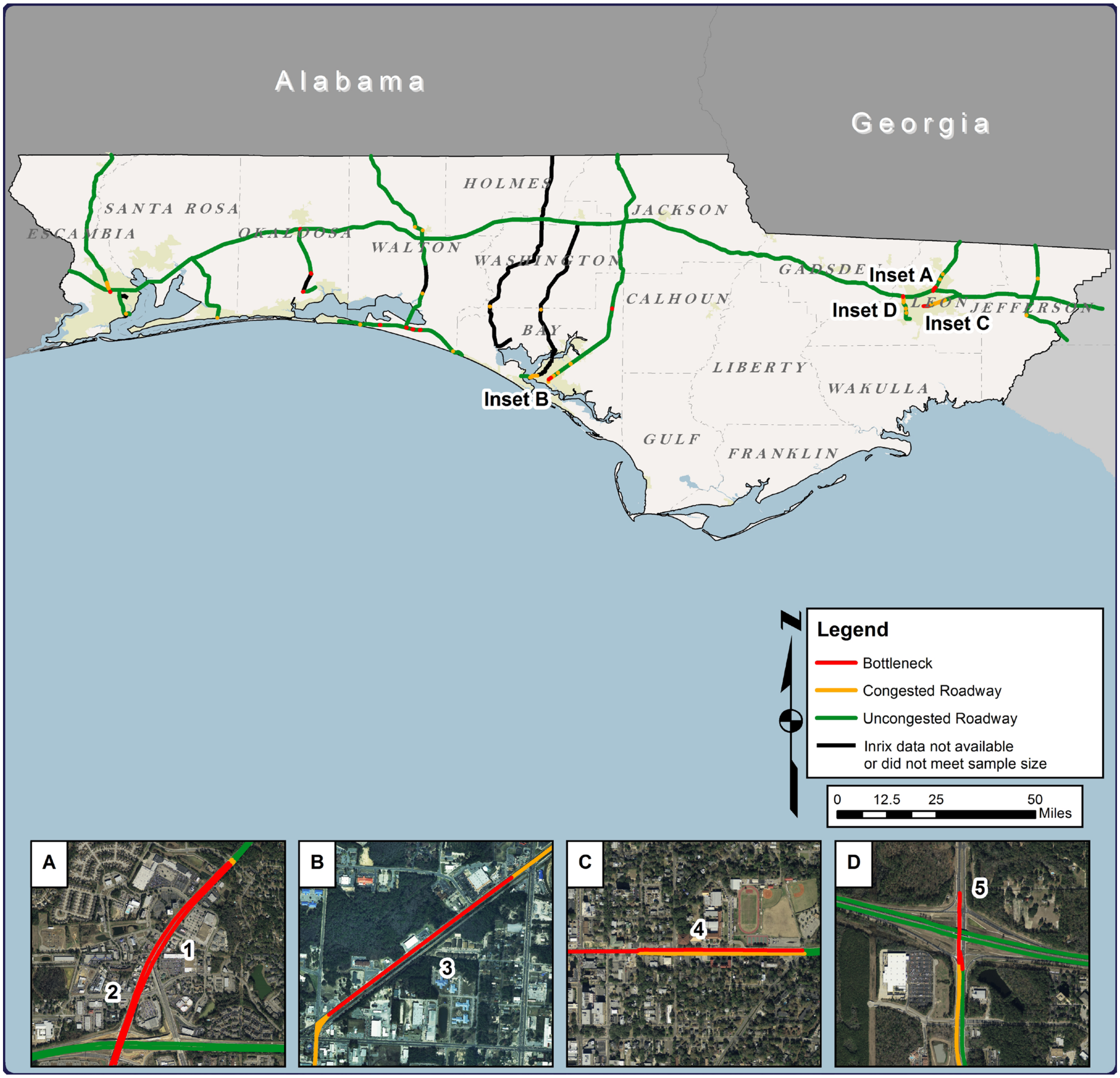




Top Bottlenecks

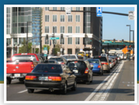
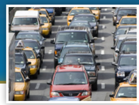
ID	Road	Segment	County	Length
1	Roosevelt Boulevard SB	I-295 to Wells Road	Duval	0.65 miles
2	Crill Avenue EB	Moody Road to SR 19	Putnam	0.13 miles
3	SR 26	NW 75th Street to I-75	Alachua	0.62 miles
4	Duval Street	NW Main Boulevard to Marion Avenue	Columbia	0.14 miles
5	SR 121 EB	I-75 to SW 34th Street	Alachua	0.32 miles

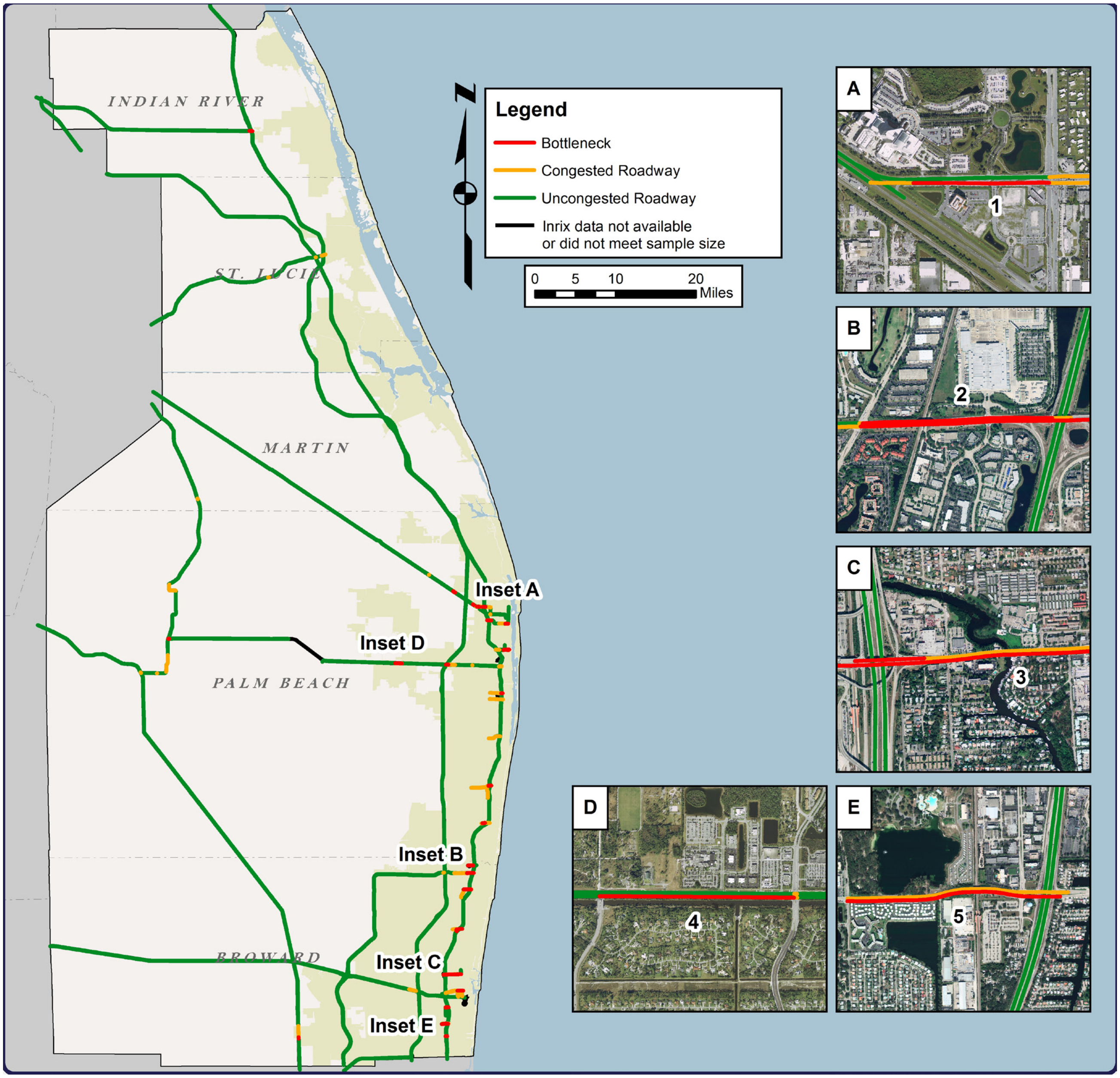




Top Bottlenecks

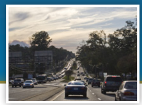
ID	Road	Segment	County	Length
1	Thomasville Road NB	Raymond Diehl Road to Maclay Road	Leon	0.94 miles
2	Thomasville Road SB	Maclay Road to Raymond Diehl Road	Leon	0.99 miles
3	US 231	Harrison Avenue to Cove Boulevard	Bay	0.66 miles
4	Tennessee Street	Macomb Street to Franklin Boulevard	Leon	0.97 miles
5	Capital Circle NW	at I-10	Leon	0.21 miles

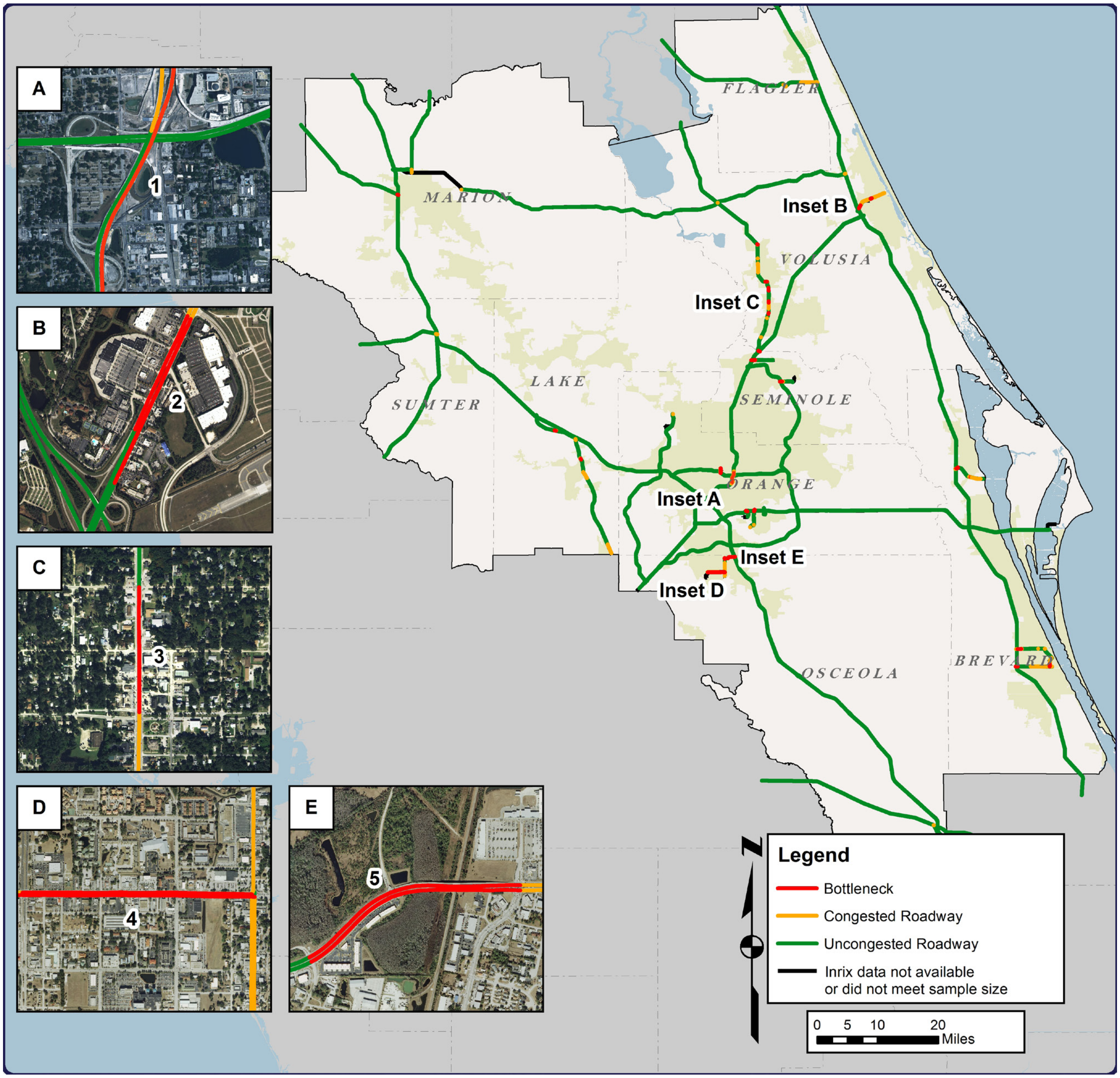



Top Bottlenecks

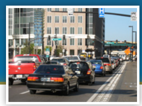
ID	Road	Segment	County	Length
1	Blue Heron Boulevard EB	Beeline Highway to Military Trail	Palm Beach	0.28 miles
2	SW 10th Street	I-95 to Military Trail	Broward	0.58 miles
3	Broward Boulevard EB	I-95 to 3rd Avenue	Broward	1.96 miles
4	US 441 EB	Big Blue Trace to Forest Hill Boulevard	Palm Beach	0.72 miles
5	Sheridan Street	Park Road to I-95	Broward	0.74 miles

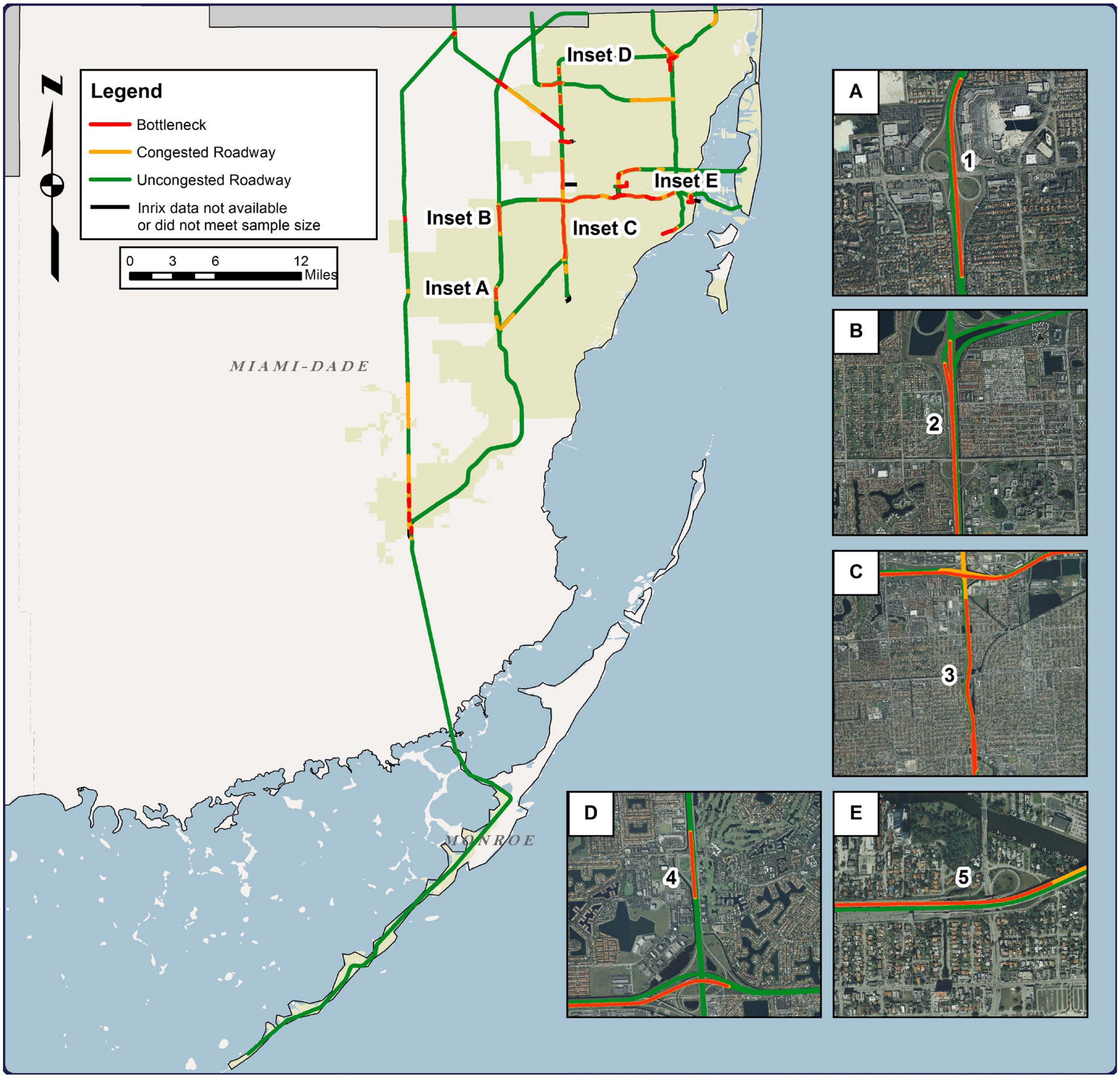




Top Bottlenecks

ID	Road	Segment	County	Length
1	I-4 NB	Michigan Street to Robinson Street	Orange	2.61 miles
2	International Speedway Boulevard	Williamson Boulevard to I-95	Volusia	0.98 miles
3	US 17	Graves Avenue to French Avenue	Volusia	0.24 miles
4	Vine Street	Hoagland Boulevard to Main Street	Osceola	3.24 miles
5	Osceola Parkway	Old Dixie Highway to Michigan Avenue	Osceola	1.26 miles

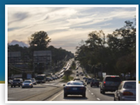


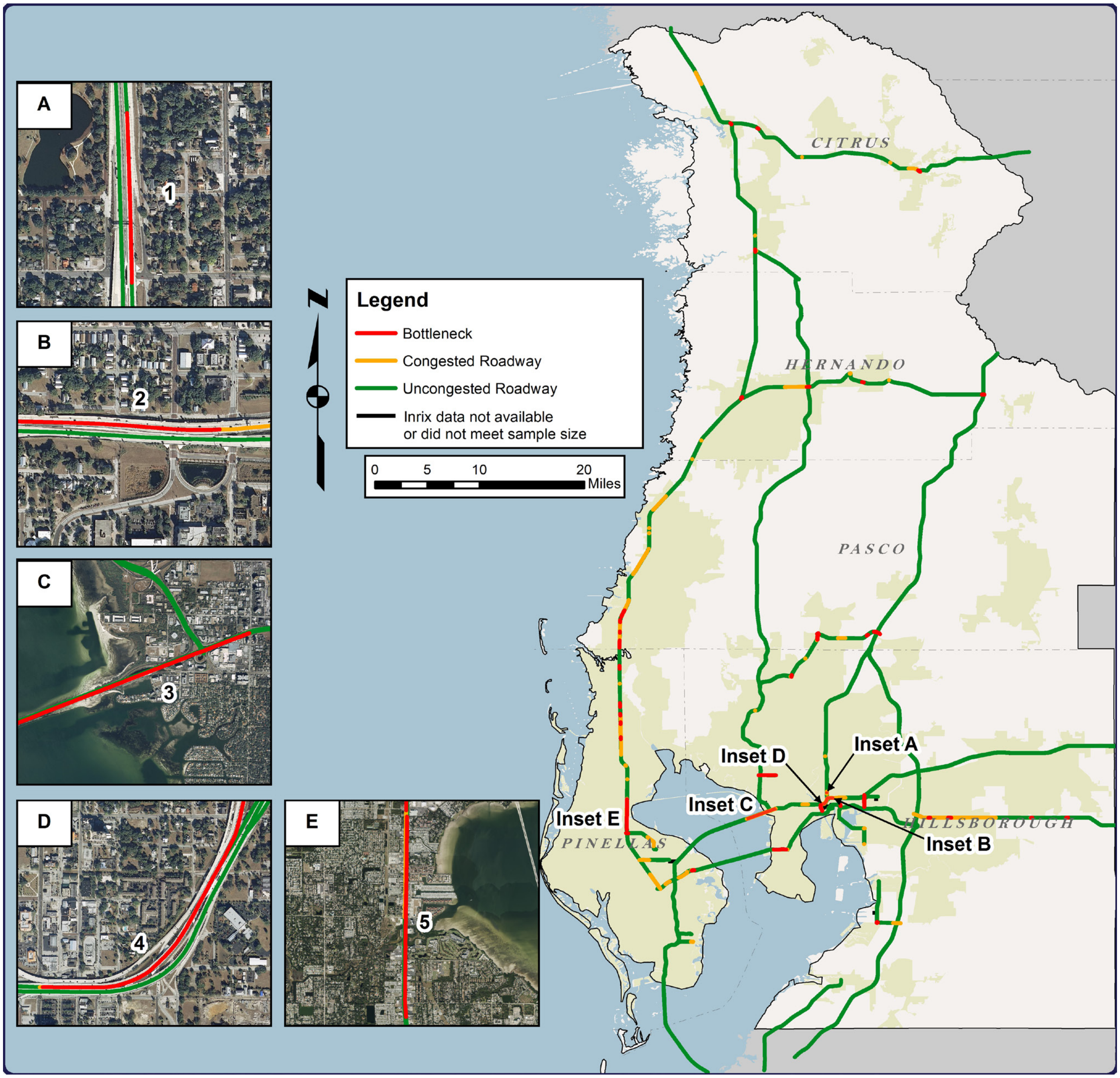


Top Bottlenecks

ID	Road	Segment	County	Length
1	FL Turnpike NB	at Kendall Drive	Miami-Dade	0.86 miles
2	FL Turnpike SB	FL 836 to Coral Way	Miami-Dade	1.86 miles
3	FL 826 NB	Coral Way to FL 836	Miami-Dade	2.14 miles
4	FL 826 SB	at Miami Lakes Drive	Miami-Dade	0.47 miles
5	FL 836 WB	at 17th Avenue	Miami-Dade	0.52 miles

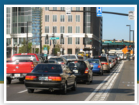
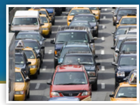






Top Bottlenecks

ID	Road	Segment	County	Length
1	I-275 NB	Floribraska Avenue to 26th Avenue	Hillsborough	0.23 miles
2	I-4 WB	15th Street to I-275	Hillsborough	0.86 miles
3	I-275 NB	Howard Frankland Bridge to West Shore Boulevard	Hillsborough	2.63 miles
4	I-275 SB	I-4 to N Tampa Street	Hillsborough	0.55 miles
5	US 19 NB	Whitney Road to FL 60	Pinellas	2.35 miles


INRIX historical traffic flow data is delivered in CSV (comma separated value) format, with all the data for the state of Florida. Data provided by INRIX contains the following information: TMC ID, year, month, day, hour, minute and speed. Traffic Message Channel (TMC) is the basic spatial unit used by INRIX to report the traffic flow data. TMC is a specific application of the FM Radio Data System (RDS) used for broadcasting real-time traffic and weather information. INRIX uses a 9-digit TMC ID to define a unique segment and direction of roadway in North America.

This section provides details on INRIX data processing for determining the traffic bottlenecks on Florida's SIS.

Step 1: Initial Processing

The following three steps were performed before conducting detailed analysis.

- The original raw file from INRIX for the whole state of Florida contained 711,351,697 vehicle probe data records. Data for the SIS study area was identified and extracted from the statewide data which resulted in 293,372,069 vehicle probe data for further processing.
- The original vehicle probe data from INRIX was provided in Coordinated Universal Time (UTC) standard. These universal times were converted to Florida local time including the adjustment for the daylight savings time.
- Next, the data was formatted to a format convenient for conducting analysis using Oracle.

Step 2: Calculate Performance Measures

In order to calculate the performance measures, the following parameters are defined:

- **Valid weekday –** Defined as any weekday excluding holidays (listed below)
- **Daytime –** Defined as the time from 6 am to 7 pm
- **Overnight hours –** Defined as the time from 10 pm to 5 am
- **Holidays –** The following days are considered as holidays: Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day, Thanksgiving Friday, Christmas Day, New Year's Day, Martin Luther King Jr. Day, Washington's Birthday, Memorial Day.

The processed data obtained from step 1 was analyzed using Oracle software and the following measures were calculated.

- **Number of Observations –** this measures the number of data records for each TMC segment for the whole year.
- **Daytime 10^{th} Percentile Speed –** this measures the 10^{th} percentile speed for valid weekdays during daytime for each TMC segment for the whole year. This is also equivalent to the 90^{th} percentile travel time.
- **Free-flow Speed –** this measures the 85^{th} percentile speed for all 365 days during overnight hours for each TMC.
- **Daytime Planning Time Index –** this measure is calculated for each TMC segment for the whole year using the following formula. For example, a planning time index of 1.60 means that, for a 15-minute trip in light traffic, the total time that should be planned for the trip is 24 minutes. If the calculated value is less than 1, then it is assumed as 1.0
  - $$\text{Planning Time Index} = \frac{\text{Free-flow Speed}}{10^{th}\ \text{Percentile Speed}}$$
- **Frequency of Congestion –** this measures the percent of time that the travel speeds are less than 75 percent of the free-flow speed. This measure is calculated for valid weekdays during daytime hours.

Step 3: Statistical Validation of Performance Measures

Since the INRIX data included a large sampling of the vehicle speeds on Florida's SIS, a statistical validation of the calculated performance measures is essential. The margin of error is a statistic expressing the amount of random sampling error in a survey's results. For the INRIX vehicle probe data, margin of error for two performance measures—free-flow speed and daytime 10^{th} percentile speed—are calculated. The TMC segments for which the margin of error is greater than 10 percent are not accounted for in the estimation of traffic bottlenecks.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

Strategic Intermodal System