

Harsh Braking as a Surrogate for Crash Risk: A Segment-Level Analysis with Connected Vehicle Telematics

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Introduction

- Harsh Braking (HB) events refer to sudden and forceful stops captured by connected vehicle (CV) telematics.
- NJ highways have heavy traffic, toll plazas, and complex interchanges that result in higher crash risk and conditions for sudden stops.
- If HB patterns can reliably identify crash-prone segments, action can be taken before crashes happen (proactive approach).
- Goal:** to determine whether HB pattern associated with crash frequency.

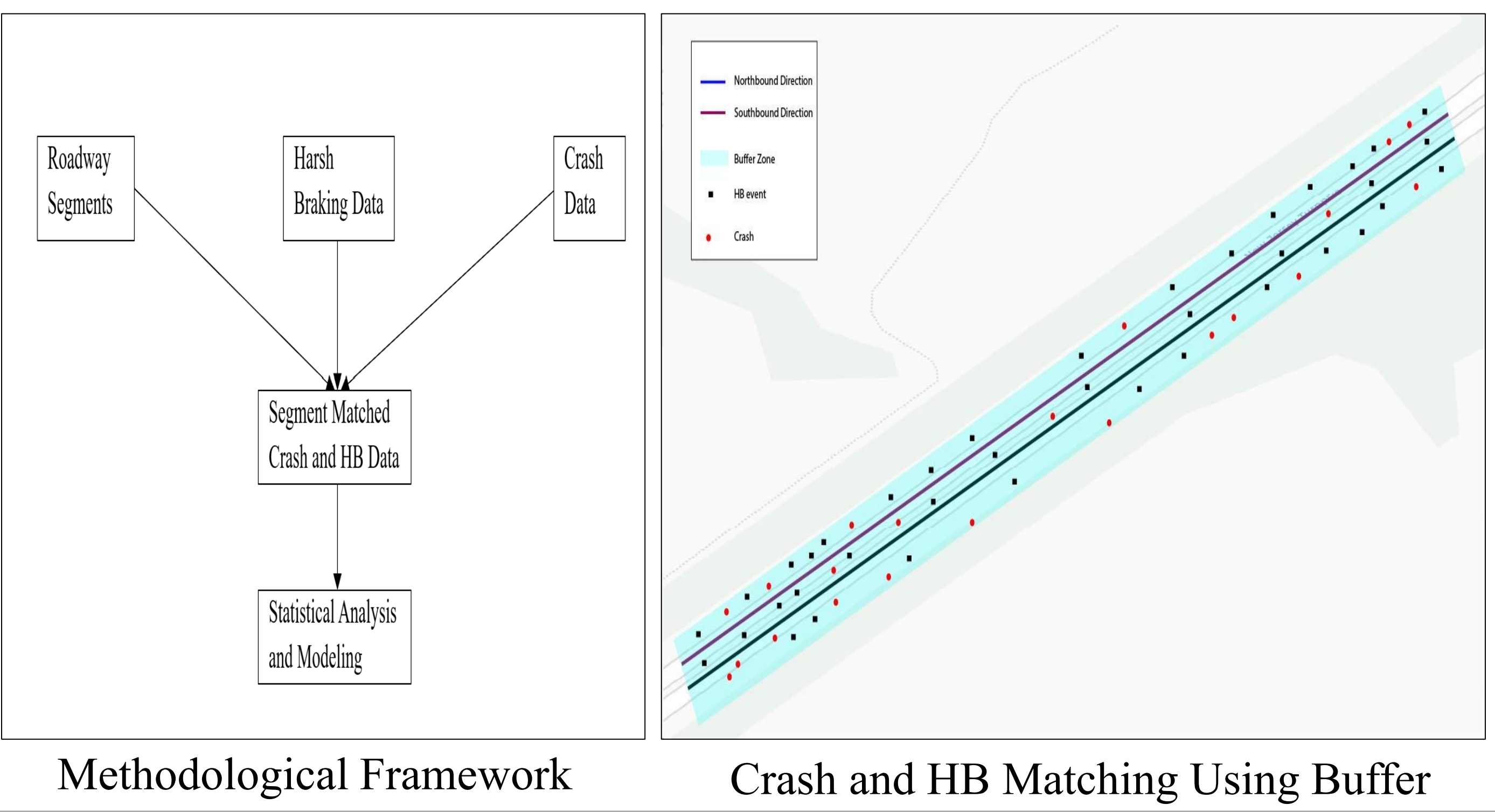
Methodology

Data

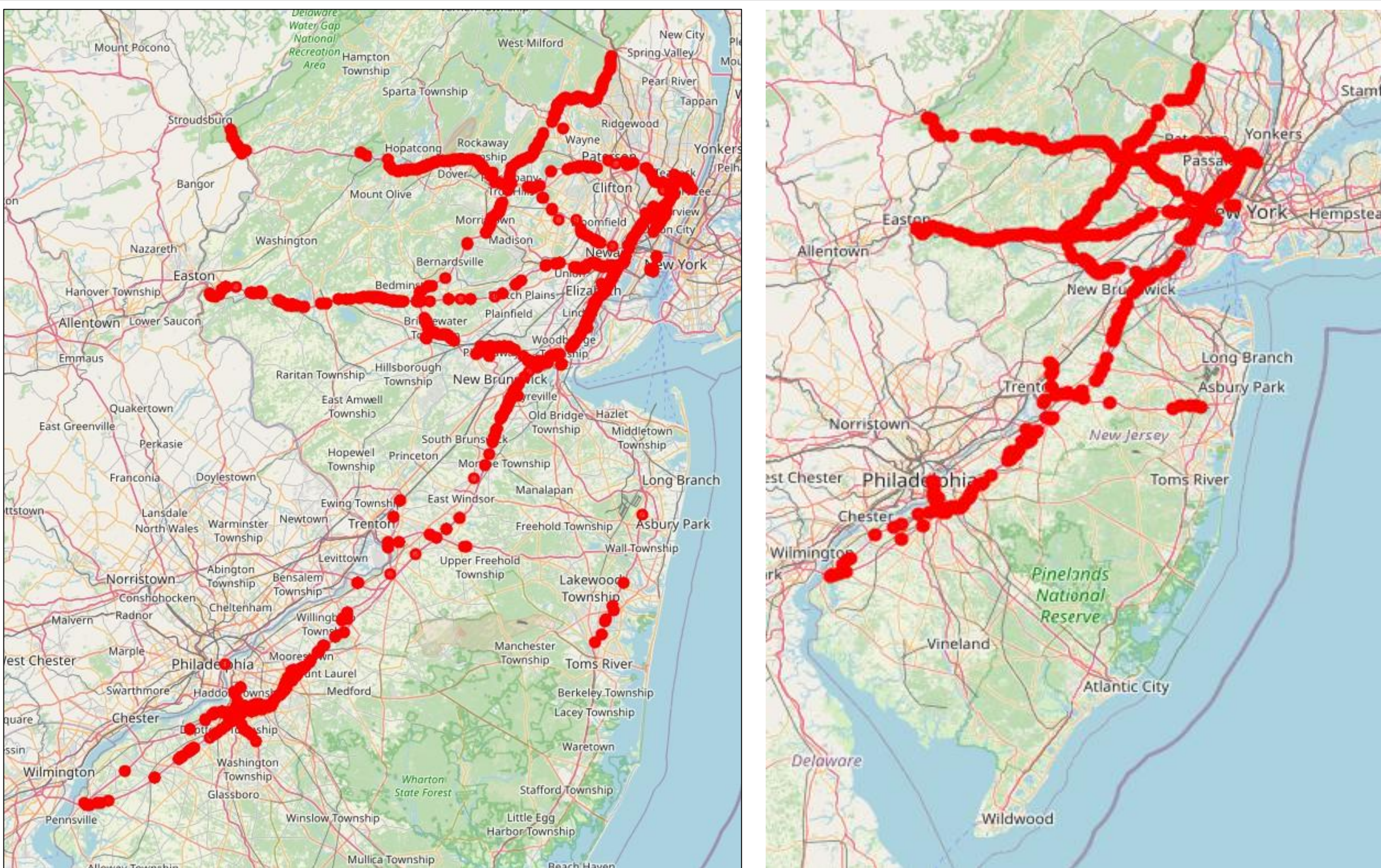
- About 8.5 million Drivewyze truck telemetry records (July–Dec 2024).
 - ✓ Define HB if deceleration $\geq 6 \text{ fts}^{(-2)}$ (approximately 0.2g).
- 45,000 NJ police crash reports, known as NJTR-1 reports, (same period)

Framework

- Segmentation:** NJ interstate highways split into 1-mile segments. Identified 1,023 segments.
- Matching:** Crashes and HB events linked to the same segments using GIS buffers.
- Modeling:** Statistical models, Negative Binomial (NB) and Zero-Inflated Negative Binomial (ZINB) tested if more HB results in more crashes.

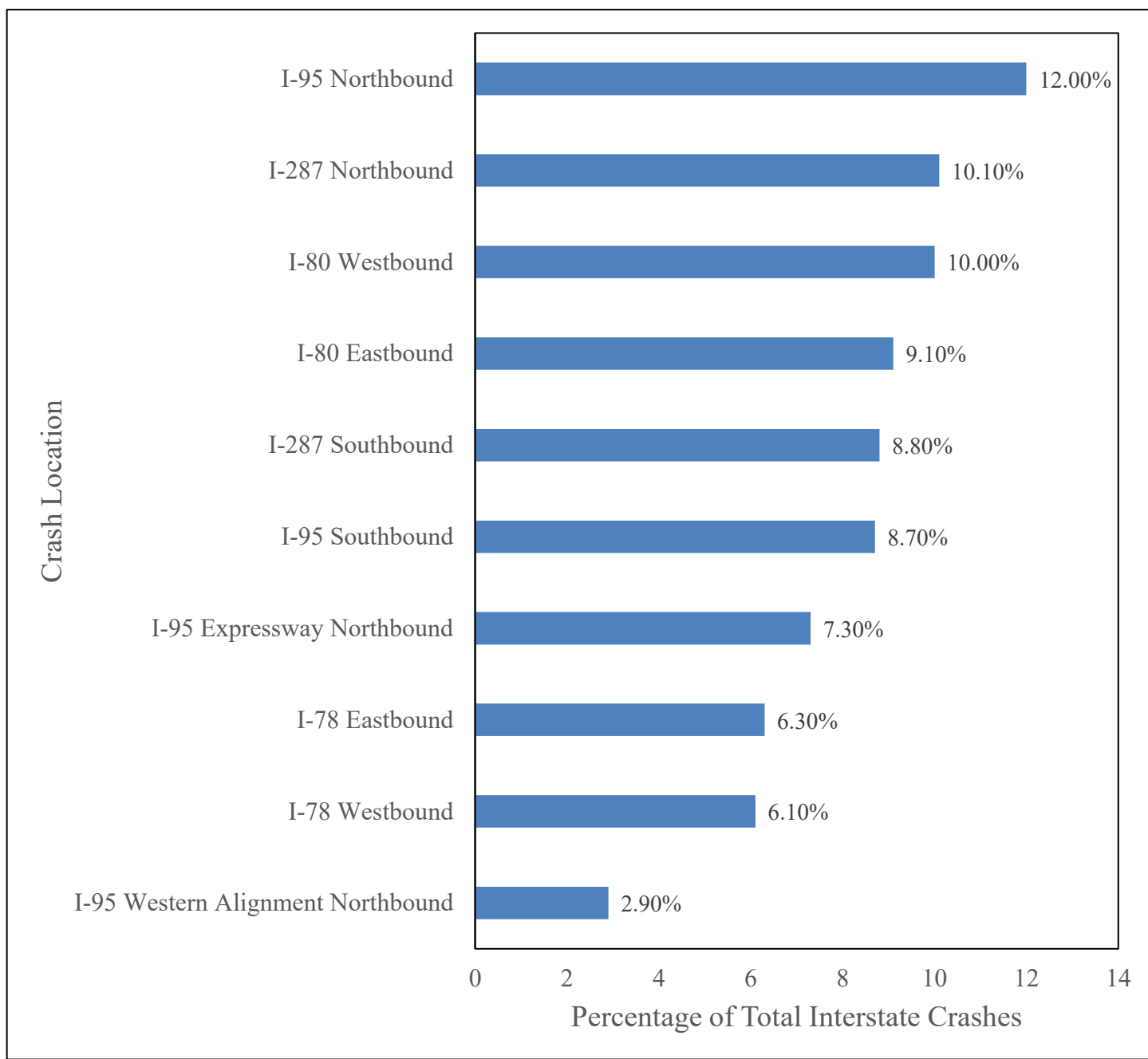


Descriptive Analysis

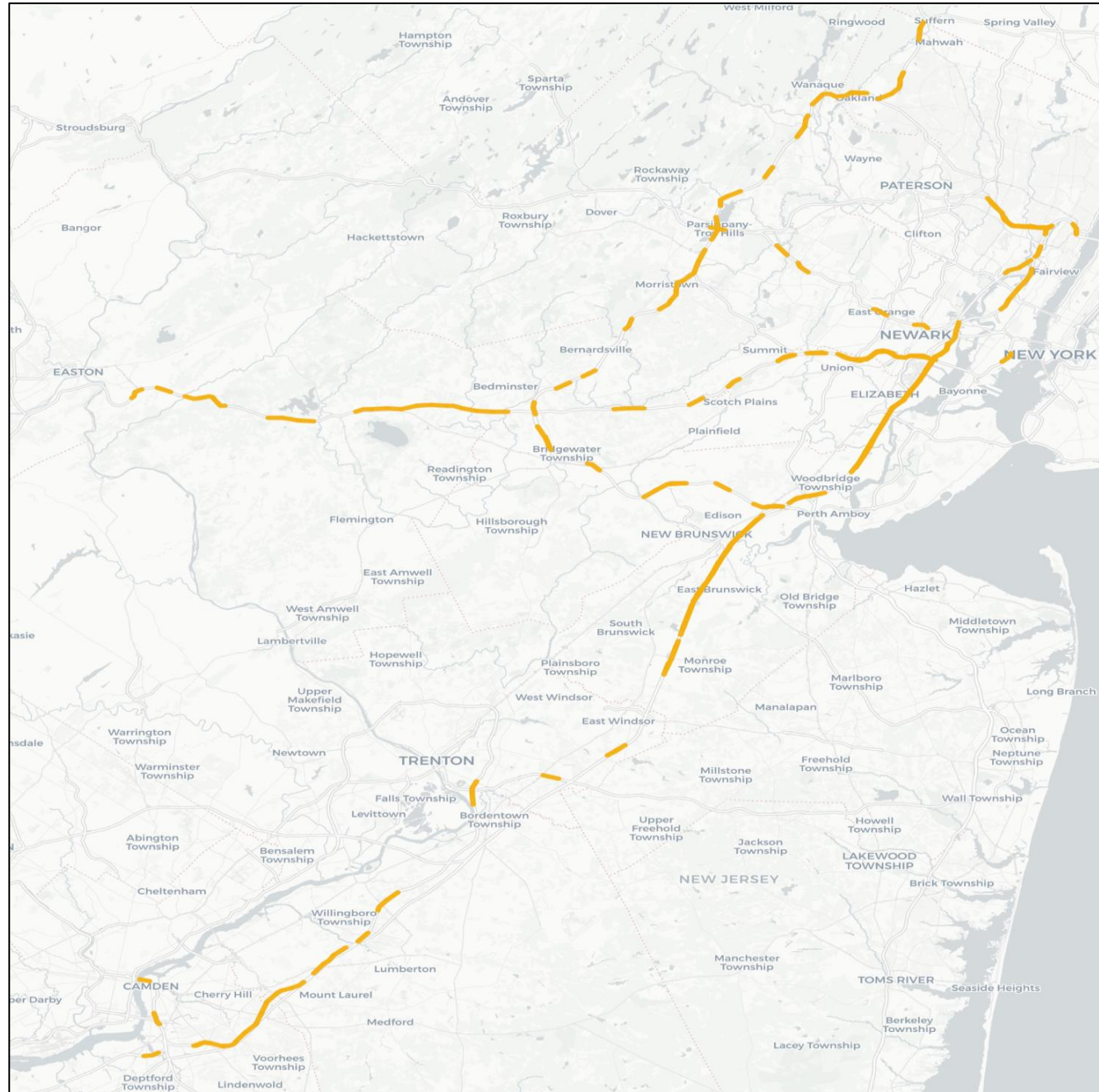


Harsh Braking (HB) Locations

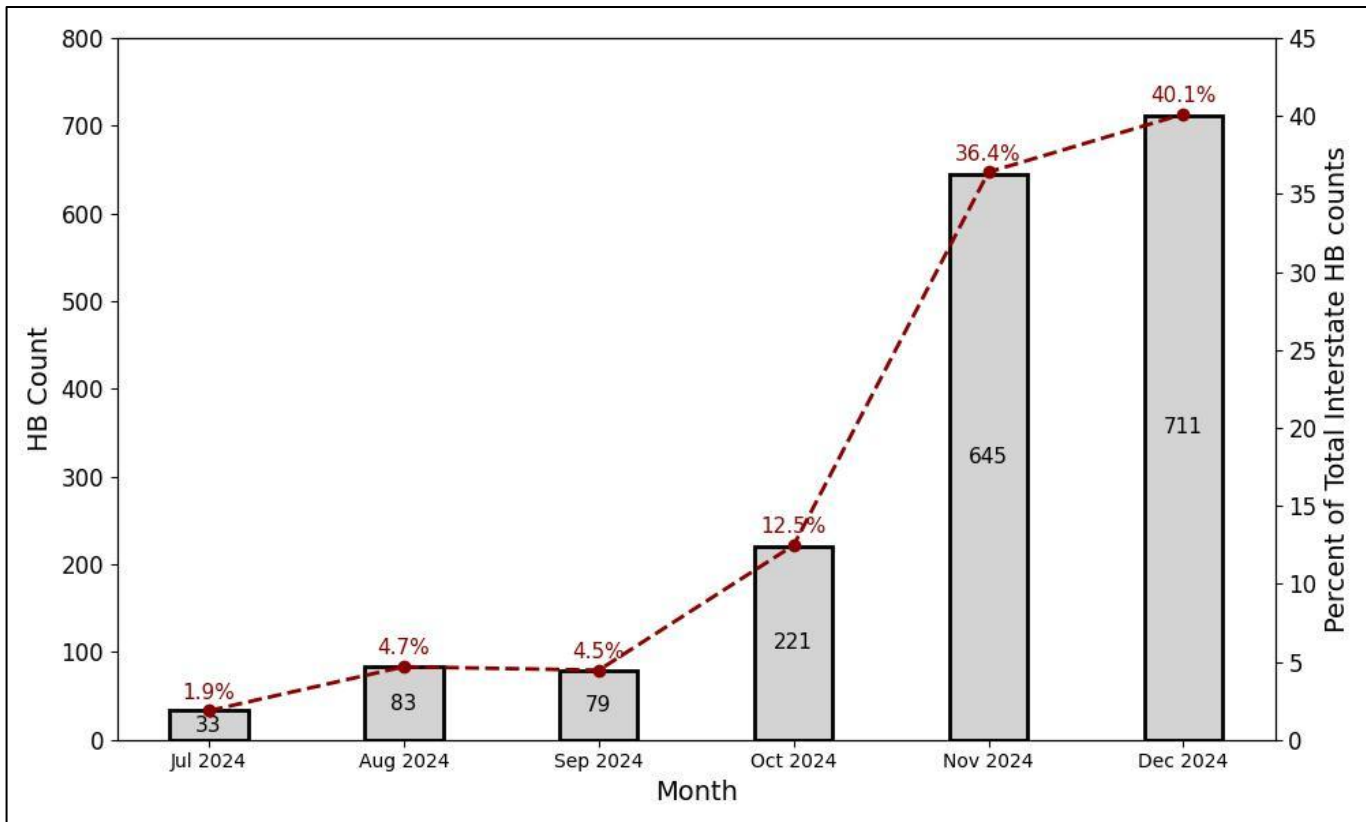
August-2024 Crash Locations



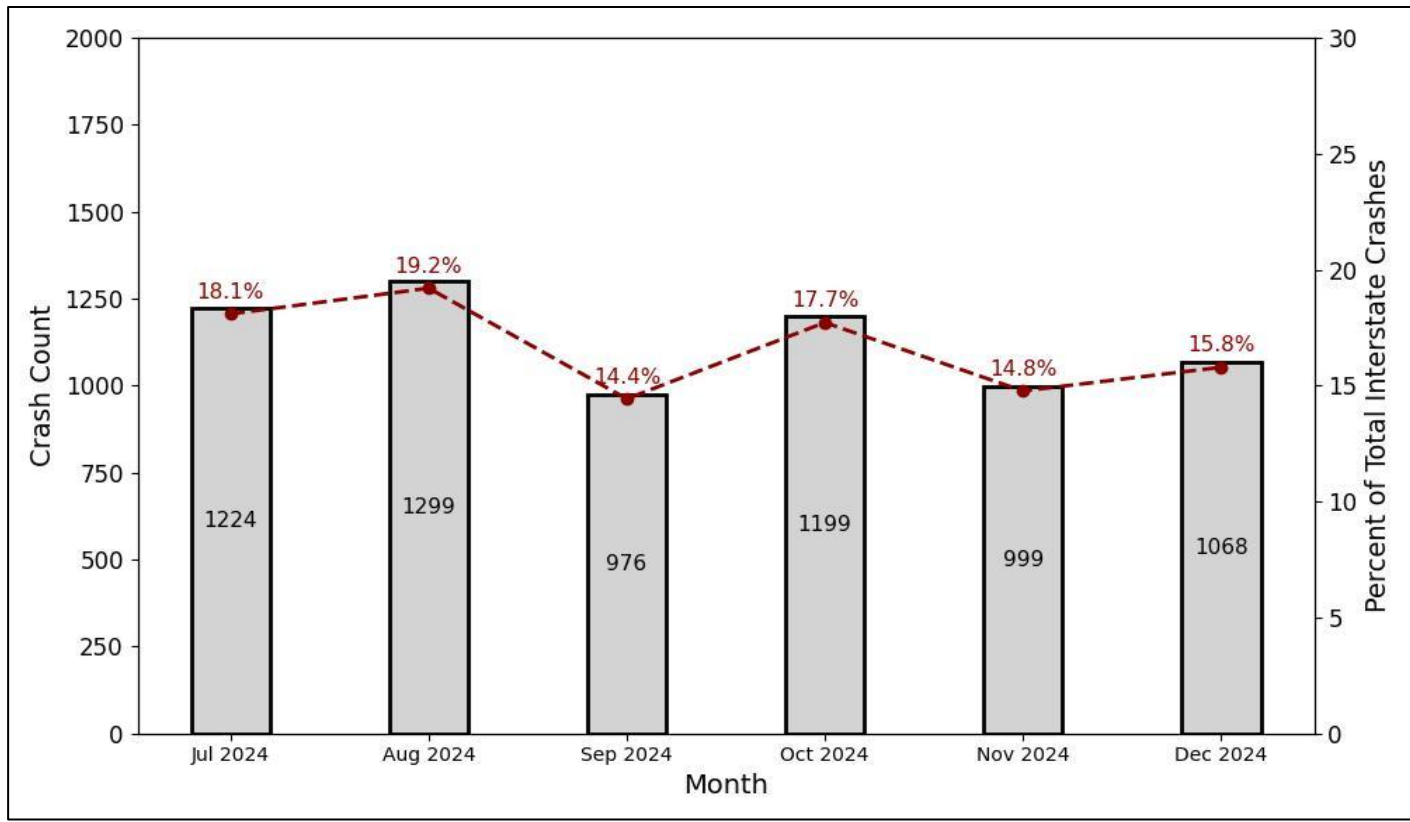
Top 10 Interstate Crash Locations in NJ



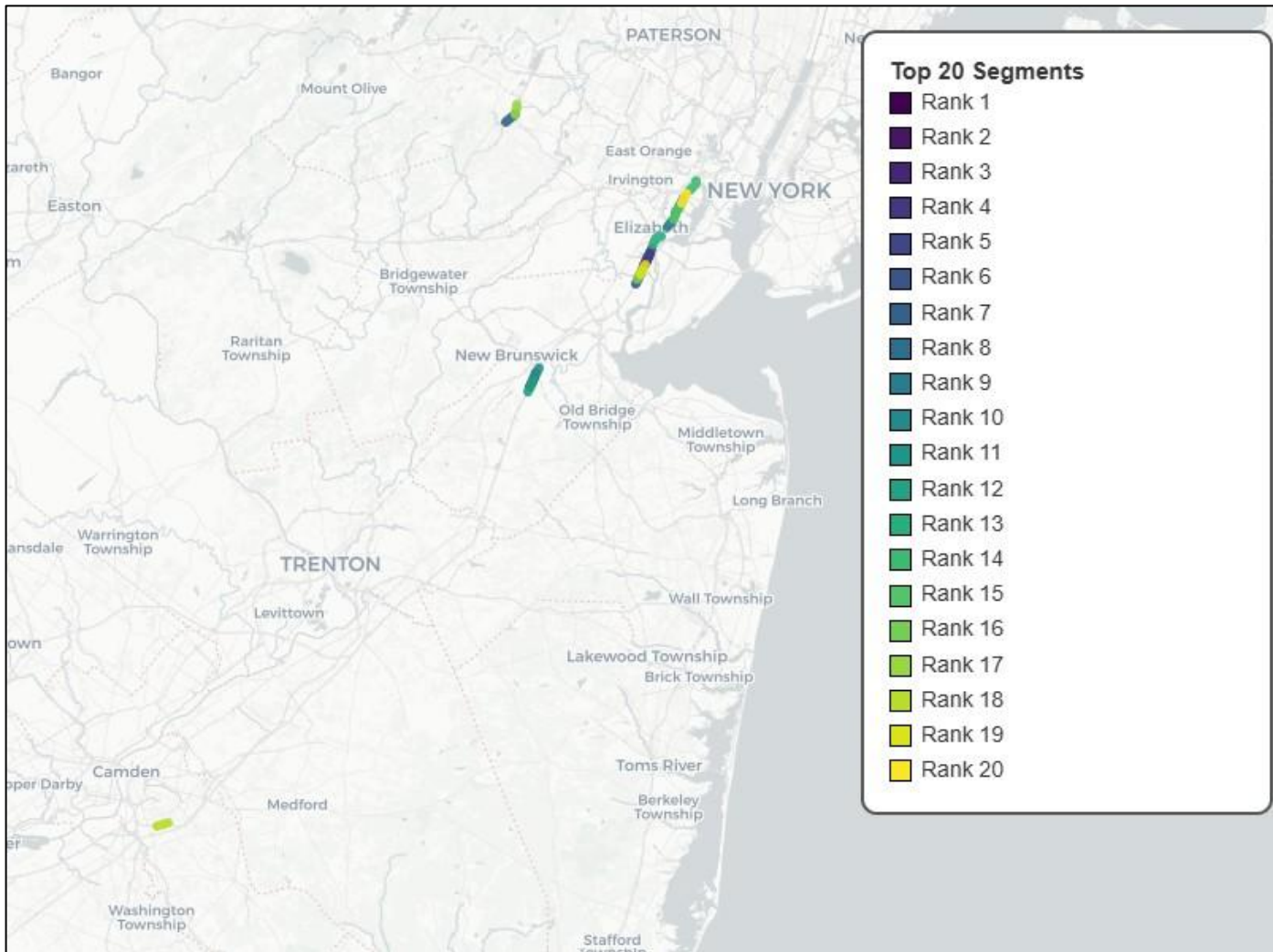
Segments with both HB & Crashes



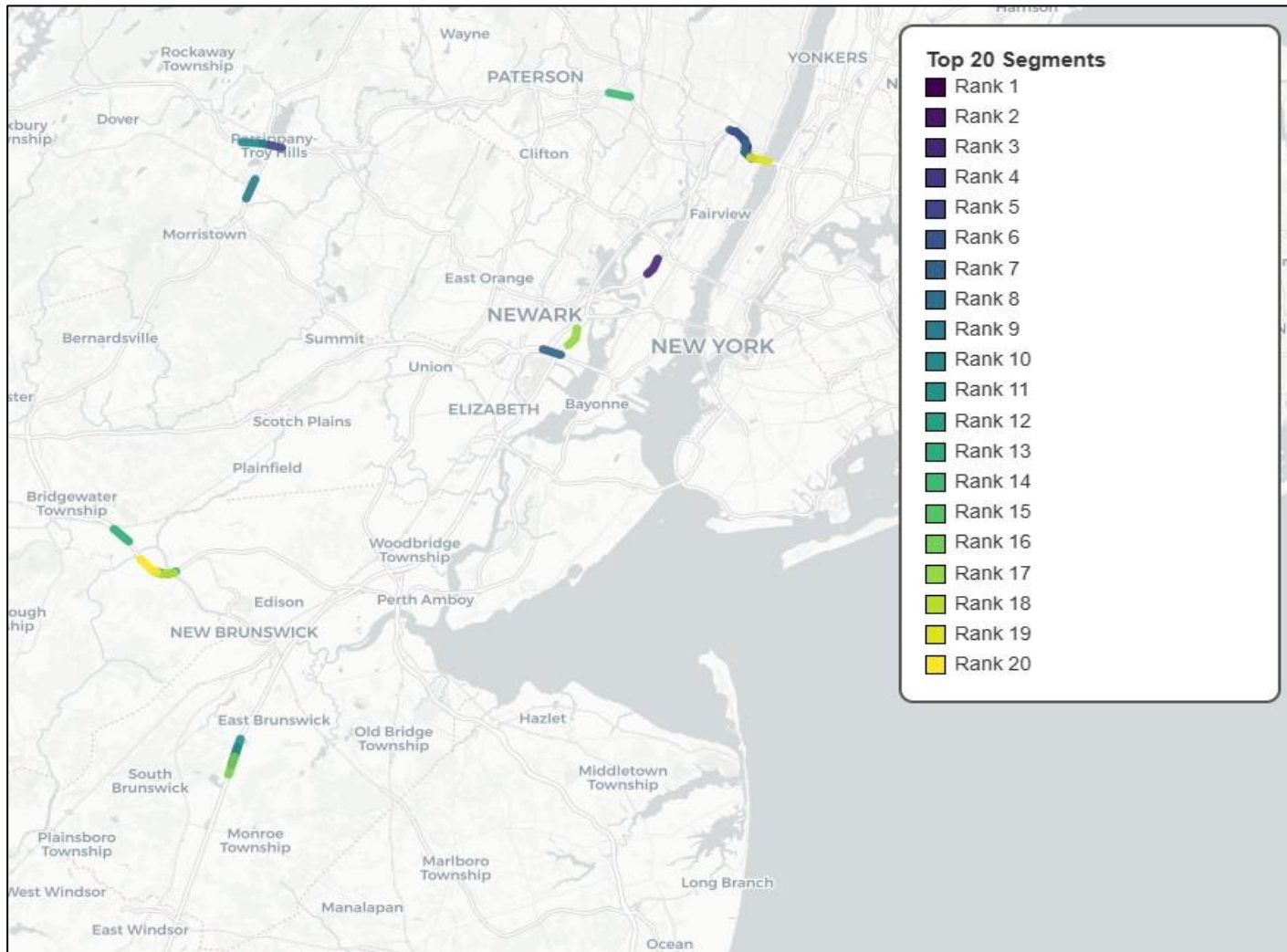
Interstate HB counts by Month



Interstate Crashes by Month



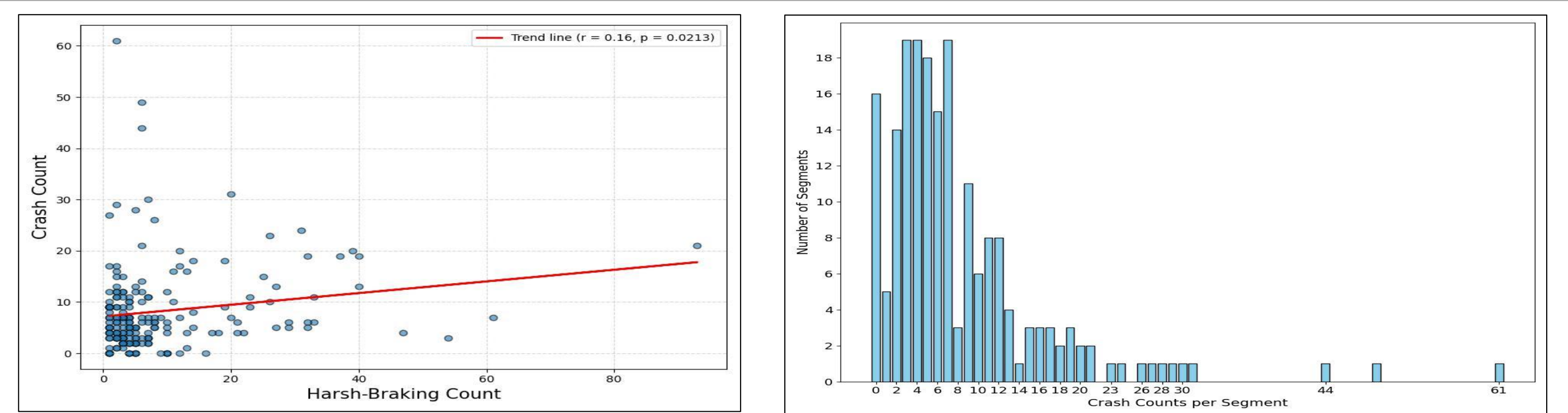
Top 20 Segments for HB events



Top 20 Segments for crash events

Model Result

- Zero-Inflated Negative Binomial (ZINB) model fits best.
- Each extra HB event contributes to a 1% increase in expected crashes per segment.
- Example: An increase of 10 HB events corresponds to an expected crash frequency of about 10 % higher.
- The result confirms that HB can events can serve as an early warning indicator of potential crashes.

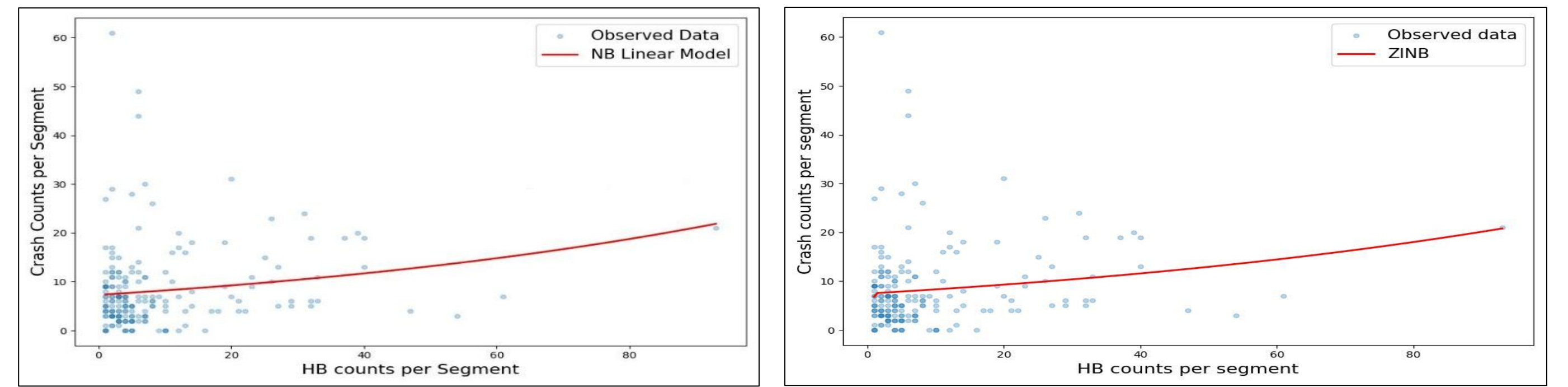


Correlation Between HB and Crashes

Segment-wise Distribution of Crashes

Table: NB and ZINB Regression of Crash Counts on HB Counts

Model	Variables	Coefficient	Std. Error	Z	P> Z	AIC	Alpha
NB	Intercept/Constant	1.99	0.10	20.98	0.00	1234.49	1.00
	HB Counts	0.01	0.01	1.92	0.06		
ZINB	Inflated constant	12.77	1097.32	0.01	0.99	1228.63	0.65
	Inflated HB counts	-15.03	1097.32	-0.01	0.99		
	Constant	2.01	0.08	24.88	0.00		
	HB Counts	0.01	0.01	2.12	0.03		



Conclusion & Recommendations

- This study demonstrates that harsh braking (HB) activity, derived from connected-vehicle telematics, provides a meaningful surrogate for identifying crash risk on large-scale interstate highway systems.

Recommendations

- Agencies should integrate HB monitoring into safety dashboards to identify danger zones in real time.
- Segments with frequent HB events should be prioritized for countermeasures such as better signage, enforcement, lane guidance, and ramp metering.
- Combining HB data with crash, weather, and traffic information enables faster, proactive crash prevention.