

# A Data Driven Approach to Quantify Truck Rest Area Safety Performance based on the Associated Fatigue-related Crashes

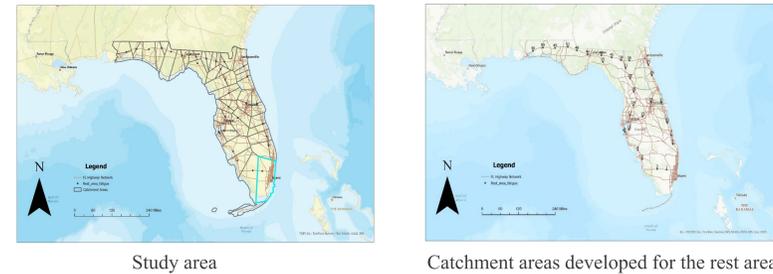
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## Introduction

- The increase in commercial motor vehicle traffic, stricter delivery schedules, and federally regulated driving time limits (Hours of Service rules) have collectively increased the demand for truck parking.
- The lack of adequate parking facilities leads to the unauthorized parking on ramps and shoulders or driving in fatigue.
- Driving in fatigue estimated to cause 20% of truck involved crashes. It was also observed that fatigue impairs driving performance by diminishing attention and focus, slowing reaction time, and leading to poor decision-making, among other effects.
- There is a lack of research in quantifying rest area performance based on fatigue related crashes.

## Methods

- A deficiency metric is introduced for rest areas on the National Highway system (State Highway, US Highway, Interstates) based on the fatigue related crashes that occurred between 2019 and 2023. The developed metric is developed using selection, assignment and assessment process to score each rest area considering relevant crashes.
- In the selection process, relevant fatigue related crashes is identified. Crashes that occurred within 40 m to the highway network and in the vicinity of rest areas (250 m) are selected. Crashes that occurred in urban areas are excluded to prevent urban aggregation problem.
- In the assignment process, each crash is assigned to the nearest rest area facility based on the trucking network distance from the truck to the closest rest area, by the assumption that the driver with fatigue was trying to go to the nearest rest area before the crash. Based on this assumption, the closest rest area to the truck driver was assumed to be influencing that crash due to its inability to provide the required service.
- In the scoring process, rest areas were evaluated heuristically based on their performance in mitigating crashes. Rest areas is scored considering various factors such as proximity, severity and their catchment area.



Distance Weight (W)	Distance x (mile)	Severity Scale (S)	Crash Severity
1	x <= 10	1	No Injury
0.9	10 < x <= 20	1	Non-Traffic Fatality
0.8	20 < x <=30	10	Possible Injury
0.7	20 < x <=30	20	Non-Incapacitating Injury
0.6	40 < x <=50	50	Incapacitating Injury
0.5	50 < x	100	Fatal (within 30 days)

### Proposed Deficiency Score

$$\text{Crash Index } j = \sum_{i=1}^n S_i * W_{ij}$$

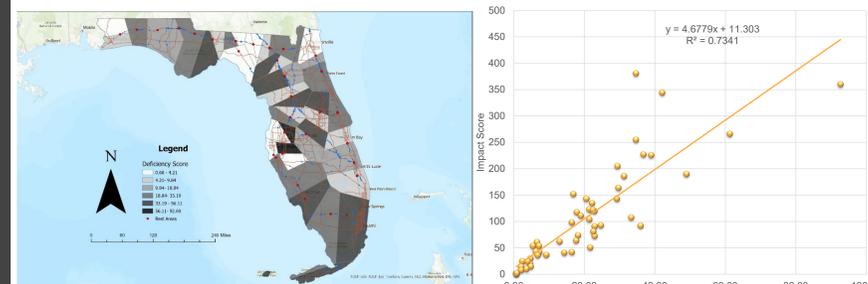
$$\text{Correction factor } j = \text{Sum of length in catchment area}_j^{0.3}$$

$$\text{Deficiency Score } j = \frac{\text{Crash Index } j}{\text{Correction factor } j}$$

$$\text{Impact Score}_j = \sum_{i=1}^n S_i$$

## Results

- Spatial distribution of catchment areas and relationship between impact score and deficiency score:



DS of rest areas in Florida overlaid by fatigue-related crash hotspots

Relation between Impact and Deficiency Score

- Ranked deficiency score of facilities from worst to the best:

Fac_ID	Impact Score	Crash Index	Sum of Length (mile)	Crash Frequency	Deficiency Score
18	360	304.8	52.8826	40	92.69
12	266	237.5	91.58735	31	61.25
25	190	188.5	89.35723	14	48.97
16	344	246.1	359.9504	40	42.1
27	226	210.3	276.301	13	38.94
24	227	187.2	228.3007	24	36.71
44	92	90.8	21.96203	6	35.94
3	255	184.5	263.4856	25	34.66
1	381	295.8	1274.951	43	34.62
32	108	106.4	47.9555	15	33.32
4	186	147.6	176.3276	13	31.27
19	164	143.9	193.2681	11	29.66
9	205	174.2	376.7073	20	29.39
30	143	131.7	150.9733	7	29.24
42	93	81.9	54.27589	6	24.71
50	120	97	121.9727	3	22.96
48	73	68.8	38.95651	5	22.93
38	91	81.9	70.24444	4	22.87
51	81	74	52.77835	4	22.52
53	122	110	202.4757	4	22.36
21	135	108.5	198.9874	8	22.17
36	51	46	12.33394	2	21.65
2	123	102.2	182.5935	5	21.43
37	104	82.2	88.34883	9	21.43
23	143	92	147.8561	7	20.55
29	111	88.7	170.0824	7	19
49	74	57.4	46.27286	8	18.17
15	118	80.7	153.7151	13	17.82
28	64	58.8	55.10895	17	17.66
7	152	100.5	383.5676	8	16.87
13	42	39.9	19.06396	4	16.48
52	98	77	170.9853	12	16.47
33	41	37.3	24.2165	13	14.34
8	62	46.6	71.31473	6	12.95
20	37	36.4	97.90562	9	9.2
14	42	35.7	203.8073	5	7.24
22	54	48.3	597.645	5	7.1
46	36	31	162.739	8	6.73
6	61	39.4	384.243	15	6.61
45	43	32.7	249.4417	6	6.24
5	54	27.6	232.3026	5	5.38
39	15	14.2	37.55905	6	4.78
26	30	26.4	307.7266	12	4.73
31	20	18	93.89285	1	4.61
35	24	15.9	110.9278	6	3.87
41	10	8	14.56285	1	3.58
34	25	14.9	443.7869	7	2.39
10	12	10.7	176.6219	3	2.27
40	8	6.7	52.76524	8	2.04
17	14	12.6	438.0584	5	2.03
47	2	1.8	14.91437	2	0.8
43	2	1.9	20.9478	2	0.76
11	1	1	3.546754	1	0.68

## Conclusion

- The developed performance metric offers a systematic approach to evaluate the effectiveness of rest areas, considering factors such as proximity to crashes, and severity of crashes.
- Rest areas with high value of Deficiency Score can be investigated further to detect the root cause and targeted safety measures can be introduced to solve location specific challenges.
- This score can also be related to the service in designated catchment area. Therefore, this method can be used to finalize site selection process for the new rest areas.