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Amrita Goswamy*, Shauna Hallmark, Omar Smadi, Institute for Transportation, Iowa State University.

* Presenter

Identification of Work-Zones from SHRP 2 Naturalistic Driving Study (NDS) Database and the Roadway Information (RID) Database for Future Analysis of Work-Zone Safety.

Problem Statement

Work-zones provide challenging and hazardous conditions not only for vehicle drivers, but also for highway workers who are injured or killed by errant vehicles. About **116 fatal occupational injuries** at the road construction sites were recorded in 2014 (*1*). Overall, about **579 people were killed in work-zones** all over the country in 2013 which equates to one work-zone fatality every 15 hours and to 1.8% of all roadway fatalities nationally. **About 47,758 injuries** were estimated to have occurred in work-zones during 2013. This equates to about 131 work-zone injuries per day (*2*). **Previous studies showed that work-zone crashes were more severe than other crashes (*3, 4, and 5*).**

The second Strategic Highway Research Program **SHRP2 Work-Zone Phase-I** study conducted by the Center for Transportation Research and Education (CTRE) at Iowa State University **demonstrated the feasibility of assessing work-zone safety using the (SHRP2) Naturalistic Driving Study (NDS) and Roadway Information Database (RID) (*8*).**

Methodology

The RID, developed in the SHRP 2 NDS project served as the main source of data for finding out construction and maintenance events. The RID was collected by instrumented mobile van, driving at posted speed limits, and maintained by CTRE at Iowa State University (*6*). The RID combined data from several sources including the NDS states Department of Transportation (DOT), Highway Performance Monitoring System (HPMS), and other supplemental data covering most roadways for each study state.

Primarily, the 511 data (*7*), included as a supplementary RID database and used to identify work-zones. The 511 data sometimes represented point and other times line features. An attribute query was conducted using **ArcGIS** to select the work-zones. This query was different for different states due to disparity in 511 data. **Table-1** provides the information of the 511 files and the attributes for identifying work-zones for the five **NDS States (WA, FL, NC, NY, and PA)**. 511 data for the state of Indiana was unavailable.

Once the work-zones were identified, **the study was intersected in finding out the total number of trips traversed by the participating drivers in the entire NDS study period on the identified work-zones.** In order to locate the **NDS links that directly intersected with the identified work-zones, dynamic segmentation method** was utilized, this ensured accurate selection of links over conducting a **"near-table"** join. **"Overlay Route Events" tool** was utilized in ArcGIS, that overlays two event tables to create an output event table that represents the union or intersection of the input.

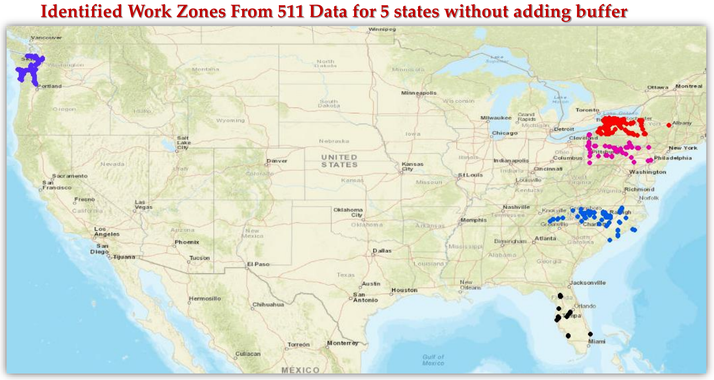
Table-1 Information of the 511 files and the available attribute fields for identifying work-zones.

NDS States	RID 511 Files used:	Attribute query for Work-Zones in ArcGIS	Text search attribute for Work-Zone Configuration
Washington (WA)	Point features: Events511_Points_2011, Events511_Points_2012, Events511_Points_2013 Line features: Events511_Lines_2011, Events511_Lines_2012, Events511_Lines_2013	EVENTCATEG = 'Construction' OR 'Lane Closure' OR 'Maintenance'.	"HEADLINEDE"
Florida (FL)	Point features: ATMSIncidents2011to2013	FDOT_EVENT_TYPE = 'Construction'.	"EVENT_NM"
North Carolina (NC)	Line features: TIMS_NC.	No field available to create attribute query	"REASON"
New York (NY)	Point features: Events511_2010, Events511_2011, Events511_2012, Events511_2013	EVENT_TYPE = 'Construction' OR 'Lane Closure' OR 'Maintenance'.	"EVENT_DESC"
Pennsylvania (PA)	Line features: Events511_Lines_2011-2013	CAUSE= "ROADWORK"	"STATUS"

Table 2a	Total No. of Work Zones	Trip Counts			Participants		
		Mean	Min	Max	Mean	Min	Max
North Carolina	90	500.9	32	7715	91.37	11	410
Florida	39	1026.13	34	9056	124.5	17	579
New York	1748	2033.86	31	23187	127.4	11	665
Washington	6984	2267.99	31	13097	193.1	11	665
Pennsylvania	429	307.25	31	11836	58.14	11	224

Table 2b	Through Lane	Left Turn Lane	Right Turn Lane	Center Turn Lane	Accele-ration Lane	Decele-ration Lane	Accel-Decel Lane	Median Type	If Urban
North Carolina	34	34	34	34	34	34	34	46	90
Florida	16	16	16	16	16	16	16	15	39
New York	475	475	475	475	475	475	475	339	858
Washington	4386	4386	4386	4386	4386	4386	4386	3506	6495
Pennsylvania	429	193	193	193	193	193	193	193	171

Identified Work Zones From 511 Data for 5 states without adding buffer



Results

"Line-on-line" and "point-on-line" event-overlay was performed depending upon the type of 511 events data. The input and overlay events was based on the same route reference. "Point-on-line" overlay selected only one NDS link for each of the points. This link can lie anywhere within the work-zone. **Thus a buffer of a mile or two upstream and downstream of the link will be added so that a greater part of the actual work-zone can be captured.**

There can be many events associated to a single link identity, as multiple work-zones can be set up on the same roadway segments in different time periods. "Line-on-line" overlay on the other hand, selected many adjacent link ids. The output table can be displayed in ArcMap using **"display-route-event"** layer. **Next using the start and end dates, work-zones that existed in-situ for more than three days were selected.**

The extensive 511 data rows is narrowed down to the reasonable number of rows of three or more day's work-zones. For example, there were about **1,022,354** total number of 511 events recorded in Florida in the years 2011 to 2013. The final number of work-zones of three or more days in Florida were **568**. **A total of 9290 three or more days of work-zones were identified for all the five states.** Table-2a provides the distribution of work-zones for each of the NDS states, and the descriptive statistics of the total NDS trip counts and participants.

To identify whether a SHRP2 participant traversed the link of interest during the work zone period, the work-zones that indicated higher number of trip counts and participants on them will signify that the probability of one or more NDS drivers having driven the work-zone is high. Table-2b provides the available number of observations among the total number of work-zones where the RID mobile data was collected.

Conclusions

- **RID 511 Events files for each state were located.** An appropriate field that specified any kind of construction, roadwork or maintenance was identified.
- Duration of work zones from start and end dates were calculated. **Work-zones of three or more days were used in the study.**
- The next step involves spatial overlay of the selected work-zone events with NDS trip density maps. This step is performed using **dynamic segmentation method in ArcGIS**.
- **At the end of this process, the work-zone events was associated with NDS Links**, which in turn provided information of **number of trips and number of participants** that traversed the work-zones in the entire NDS study period. **The work-zones that indicated higher number of trip counts and number of participants on them signified that the probability of one or more NDS drivers having driven the work-zone is high.**

Summary

Work-zone crashes are a serious concern for both drivers and highway workers who are injured or killed every year. This study identified the long term work-zones that existed in the NDS states during the three year study period of 2011 to 2013 to conduct useful future research on driver behavior, speed-change and safety critical events on work-zones. The study provided a step by step approach towards the process identifying the work-zones from the supplementary RID 511 data. 511 events data from Indiana was not obtained, so the study was conducted on the remaining five NDS states (PA, WA, NC, NY and FL). The study was successful in narrowing down the extensive 511 data to 9290 total number of three or more day's work-zones. In order to locate the NDS links that directly intersect with the 511 features, dynamic segmentation method was utilized. All work-zone types were evaluated based on trip density information to find out work-zones with high probability of subject drivers being present which will be used in future studies to evaluate driver behavior in work-zones. The study finally generated a list of work-zones with total trip counts and participants to request Virginia Tech Transportation Institute (VTTI) with the actual number of traces (a trace is 1 trip for 1 participant driver through a roadway segment) for the specified work periods on the identified work-zones (8).

References

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4) Pigman, J. G., and K. R. Agent. Highway Accidents in Construction and Maintenance Work Zones. In Transportation Research Record 1270, TRB, National Research Council, Washington, D.C., 1990, pp. 12–21.

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6) Smadi, O. (2015). SHRP2 Roadway Information Database. Institute for Transportation. Ames, IA.

7) http://www.511.org/developer-resources_traffic-data-feed.asp.

8) Hallmark, S., Smadi, O., and Sharma, A. Evaluation of Work Zone Safety Using the SHRP 2 Naturalistic Driving Study Data. Phase I Final Report and Phase II Proposal SHRP 2 Implementation Assistance Program. Center for Transportation Research and Education at Iowa State University's Institute for Transportation, 2711 South Loop Drive, Suite 4700, Ames, Iowa 50010 (515) 294-8103. September 30, 2015.