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Using Geographical Data Analysis to Combat Impaired Driving Collisions in Marion County

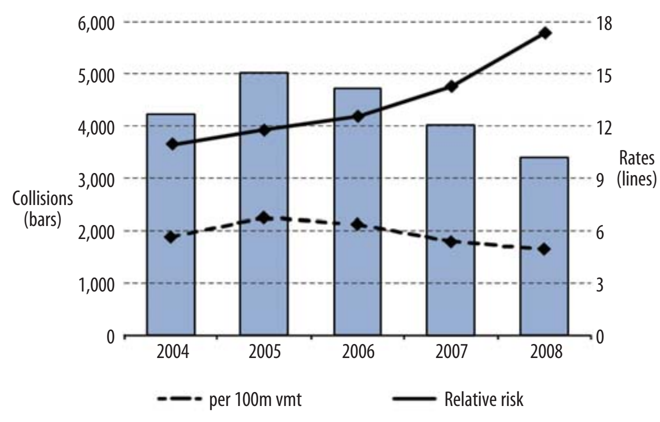
The role of alcohol in violent death and injury is widely recognized (Razvodovsky, 2003; Felson, Burchfield, & Teasdale, 2007). In particular, alcohol-impaired driving is a major—and often lethal—contributing factor in motor vehicle crashes (Williams, 2006). For example, in Indiana in 2008, the likelihood of being killed for vehicle occupants and non-motorists in collisions involving at least one driver or motorcycle rider with a blood alcohol concentration (BAC) of 0.08 grams per deciliter (g/dL) or more was 17 times greater than persons in collisions with no alcohol involvement (Figure 1).

Because alcohol is a major risk factor in traffic collisions, state and national traffic safety policies often focus on interventions to reduce the incidence of alcohol-impaired driving. One such intervention—sobriety checkpoints—has been shown to be "effective in preventing alcohol-impaired driving, alcohol-related crashes, and associated fatal and nonfatal injuries" (Shults et al., 2001: 789). A recent meta-analysis found that sobriety checkpoints reduced the number of collisions by 14 percent and alcohol-related collisions by 17 percent (Erke, Goldenbeld, and Vaa, 2009). In addition, criminal justice literature on *what works* to reduce crime and violence also deems sobriety checkpoints a viable method of decreasing violent injury or death and, indirectly, other types of crime (Sherman, et al., 2002: 314).

Indiana has been identified nationally as a frequent user of sobriety checkpoints (Fell et al., 2003), and among jurisdictions within the state, Marion County has implemented sobriety checkpoints as well as roving patrols to reduce alcohol-impaired driving. These interventions have been implemented under the auspices of the Marion County Traffic Safety Partnership (MCTSP), a group comprised of members from seven law enforcement agencies. MCTSP is dedicated to traffic safety education and enforcement efforts, focused primarily on alcohol-impaired driving and high-risk intersections within the county.

In 2007, MCTSP approached the Center for Criminal Justice Research (CCJR) of the Indiana University Public Policy Institute for assistance in locating high concentrations of alcohol-impaired collisions within the county. Since 2006, CCJR has provided analytical services to the Indiana Criminal Justice Institute for production of traffic safety reports and analysis. In response to MCTSP's request, CCJR completed two sets of analyses for sobriety checkpoint site selection, one set in 2007 and another in 2009. The 2007 analyses served as the basis for site selection for 22 sobriety checkpoints conducted by MCTSP between October 2008 and September 2009. Nearly 900 vehicles passed through these checkpoints, producing 127 standard field sobriety tests, 68 portable breath tests, 43 driving while intoxicated arrests, and another 256 vehicle stops by associated roving patrols.

Figure 1: : Indiana alcohol-impaired collisions, rate per 100 million (m) vehicle miles travelled (VMT), and relative risk of fatality



Source: Indiana State Police Automated Reporting Information Exchange System (ARIES), as of March 1, 2009

Notes:
Alcohol-impaired defined as collisions that involve at least one driver or motorcycle rider with a BAC of 0.08 g/dL or higher.
Relative risk defined as proportion of individuals in alcohol-impaired collisions fatally injured divided by proportion of individuals in non alcohol-impaired collisions fatally injured.

Impaired driving collisions in Indiana and collision data reporting by ARIES

Alcohol impairment in motor vehicle collisions is down in recent years, but continues to be a priority for traffic safety officials and law enforcement. Since 2004 in Indiana, alcohol-impaired motor vehicle collisions have decreased an average of four percent each year and fell 15 percent from 2007 to 2008 (4,000 to 3,394) (Figure 1). From 2007 to 2008, both alcohol-impaired fatal collisions (i.e., those with at least one fatality) and fatalities in alcohol-impaired collisions decreased, continuing downward trends since 2005. After increasing from 2004 to 2005, alcohol-impaired collisions per 100 million vehicle miles travelled (VMT) decreased each year from 6.8 in 2005 to 4.9 in 2008. Notwithstanding these improvements, for individuals in alcohol-related collisions from 2004 to 2008 the relative risk of being killed has grown from 11 to more than 17 times that of being killed in non-alcohol collisions. Further, alcohol-impaired collisions cost Hoosiers an estimated $263 million in 2008 (Nagle, 2009).

Responding to this public safety issue from an enforcement standpoint is challenging due to the unpredictability of collision occurrence: it is difficult for law enforcement personnel to determine which drivers are impaired to stop them before a collision occurs, or to prevent impaired drivers from ever getting behind the wheel. However, Indiana traffic safety and law enforcement officials do have a valuable data source at their disposal in ARIES—historical information about when and where alcohol-impaired collisions occur.

Annually from 2004 to 2008, there were approximately 204,000 motor vehicle collisions in Indiana. Each time a motor vehicle collision with death, injury, or at least $1,000 in property damage occurs, the responding officer is required by Indiana code to complete an *Indiana Officer's Standard Crash Report* and submit it to the Indiana State Police within 24 hours (Indiana Code 9-26-2). Crash reports provide extensive detail on collision circumstances and the characteristics of vehicles, vehicle occupants, and non-motorists involved. These data are stored in ARIES, which utilizes 136 base variables (excluding record identifiers) and 39 derived variables. Altogether, these 175 substantive variables can be used to describe various aspects of motor vehicle collisions. Data include when and where collisions occurred; the number of vehicles, drivers, injured occupants and non-motorists involved; primary cause of and circumstances that contributed to the collision; and ambient environmental and road conditions. Collisions and vehicles are assigned a yes/no indicator of alcohol involvement and impairment. The base variables used to assess alcohol involvement include alcohol tests given and results from those tests (blood alcohol content, or BAC).

Using ARIES data to select sites for Marion County sobriety checkpoints

In Indiana, as elsewhere in the United States, sobriety checkpoints must satisfy legal and constitutional guidelines that prescribe the permissible locations and procedural requirements for legally defensible checkpoints (National Highway Traffic Safety Administration, 2002). As a result, before sobriety checkpoints can be implemented in the state of Indiana, careful consideration must be given to several key elements. In a benchmark case on sobriety checkpoints in Indiana, *State of Indiana v. Gerschoffer* (2002), the Indiana Supreme Court identified location and timing as significant factors in weighing the "reasonableness" of sobriety checkpoints, and ultimately ruled to suppress evidence collected from the checkpoint in question (in Mishawaka, IN, in 1999) because the procedures followed "did not satisfy the requirements of Section 11, a part of Indiana's Bill of Rights." The *Gerschoffer* case established a six-pronged test for sobriety checkpoints:

1. Sites selected for checkpoints must be implemented on the basis of a neutral plan developed and approved by local officials, and publicized in advance.
2. The objective, location, and timing of the checkpoint must be closely tied to apprehending impaired drivers.
3. Officer discretion at checkpoints should be minimized with sufficiently explicit guidance to avoid arbitrary or inconsistent actions by checkpoint officers.
4. The degree of intrusion to drivers (e.g., time spent at the checkpoint) should be minimized.
5. The spatial arrangement of the checkpoint should be safe.
6. The checkpoint should be effective (e.g., there should be a deterrent effect).

In its checkpoint guide, the National Highway Traffic Safety Administration (2002: 5) places similar emphasis on site selection, advising administrators to choose sites "with a high incidence of impaired driving related crashes or fatalities" to maximize effectiveness.

From October 2008 to September 2009, MCTSP used a geographic information system (GIS) analysis of impaired driving collisions within Marion County to target areas for sobriety checkpoints. MCTSP recognized that to be consis-

Methods summary

This analysis examines alcohol-impaired collision rates near nine sobriety checkpoint locations in Marion County, Indiana, before and after implementation of 22 checkpoints, using collision data from the Indiana Automated Reporting Information Exchange System (ARIES) between October 11, 2007 and November 16, 2009, and checkpoint location data from the Marion County Traffic Safety Partnership (MCTSP) for checkpoints conducted between October 11, 2008 and September 5, 2009, in Marion County. Collision latitude and longitude values and checkpoint addresses were used to map the locations of these points.

Areas of interest included areas within two miles of nine unique checkpoint locations and two control group locations that did not have checkpoints. Using a Geographic Information System (GIS) program, a two-mile band was created around each checkpoint and control site and collisions located inside the band were selected. This was done separately for each checkpoint and comparison site resulting in some collisions being identified in more than one checkpoint/comparison site.

Counts of collisions were aggregated for each checkpoint and comparison site in 30-day increments before and after checkpoint dates resulting in 26-28 pre/post observations for each site. Counts of alcohol-impaired collisions were divided by counts of non-alcohol-impaired collisions and multiplied by 100 to arrive at a rate of alcohol-impaired collisions per 100 non-alcohol-impaired collisions. Because checkpoints were implemented at different times, the number of pre and post observations varies between checkpoints. In addition, to facilitate comparisons between checkpoints and comparison sites, comparison site dates were matched to each checkpoint date so that pre/post observations could be synchronized.

tent with the *Gerschoffer* decision, checkpoint locations should be in areas where impaired driving, as measured by concentrations of impaired driving collisions, has historically been more common (see #2 above). Therefore, to strengthen the empirical basis for identifying checkpoint sites, MCTSP started with a basic question: where do alcohol-impaired collisions occur most frequently in Marion County? MCTSP narrowed this inquiry to only include collisions where a vehicle driver involved:

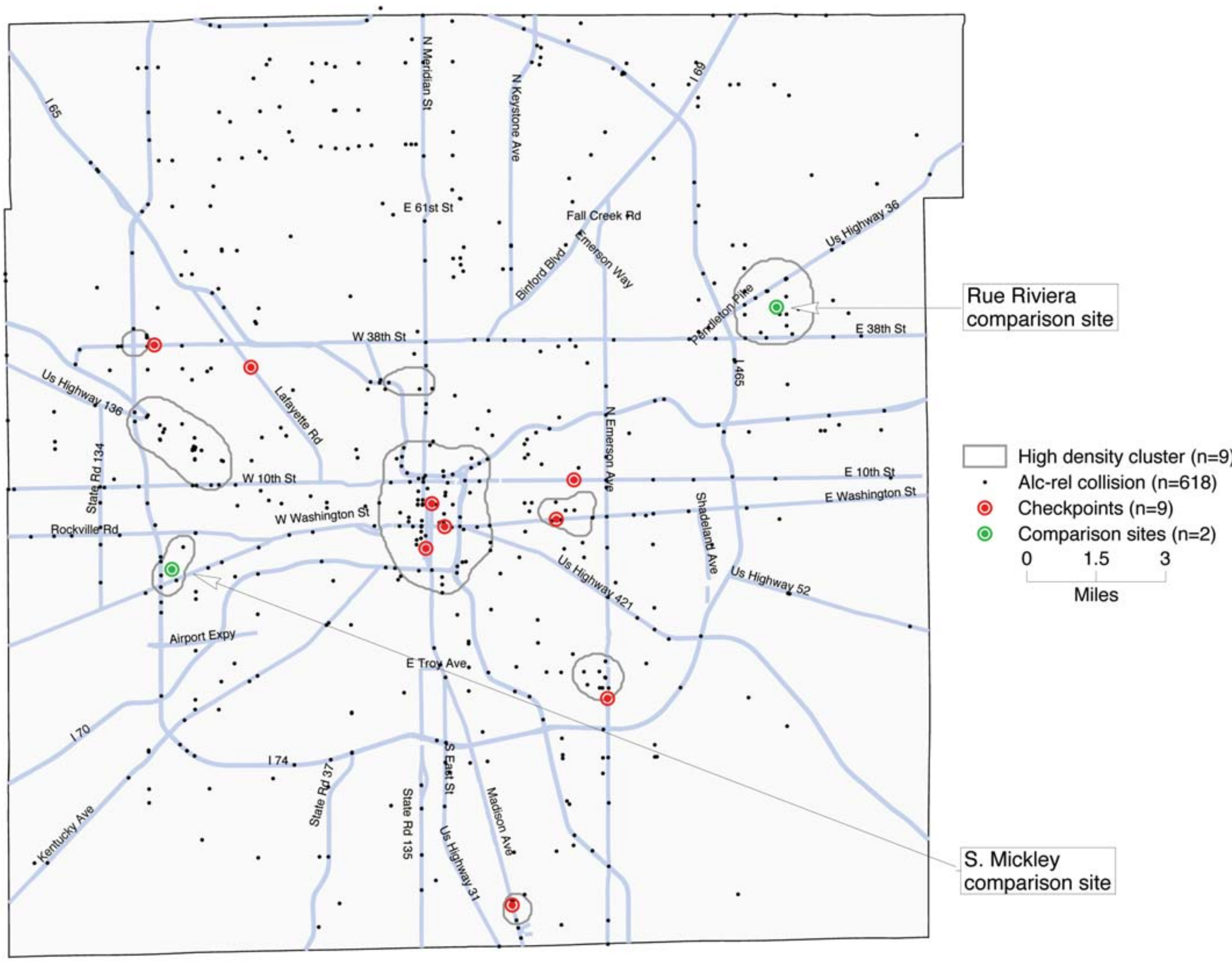
1. Refused an alcohol test;
2. Had a BAC test result of 0.05 g/dL or higher; or
3. Received a citation for violation of one of six alcohol-related Indiana codes.

Using these parameters to filter the ARIES database, CCJR identified collisions meeting the criteria and extracted location coordinates for mapping. Data were imported into the ArcMap GIS to identify high-density clusters of impaired driving collisions in Marion County (see Methods Summary Box, page 2). Nine high-density alcohol-related crash clusters were identified using kernel density cluster analysis of 618 alcohol-related collisions meeting the above criteria that occurred in calendar year 2006. These are shown in Map 1 (on page 4).

Areas within the clusters would be candidate locations for sobriety checkpoints, and as shown in Map 1, it appears clear that checkpoint locations were influenced by the geographical boundaries of high-density clusters. Beginning in October 2008, nine checkpoint locations were established.[1] Eight of the nine checkpoint locations were either directly within or closely adjacent to five of the nine high density clusters. Three checkpoints (N. Delaware, S. Pennsylvania, and East/Washington) were inside the largest high density cluster surrounding downtown Indianapolis. There were single checkpoint locations in three other clusters (W. 38th, S. Emerson, and Madison), and two locations in one cluster (E. 10th Street). The E. 10th Street checkpoint lies just outside a high density cluster. The 3400 Lafayette checkpoint is the farthest from any high density clusters, but is still within three miles of three high density clusters from 2006. Four of the 2006 high density clusters did not host a MCTSP checkpoint during this period.

[1]The MCTSP actually used 12 discrete locations. However, three of those locations (4400 E. 10th, South/Pennsylvania, and 500 E. Washington) were in very close proximity to other checkpoints (i.e., within about 1000 feet or so). For purposes of the checkpoint assessment in this issue brief, it was decided to combine these into nine locations.

Map 1: High density clusters of 2006 alcohol-related collisions and 2008-2009 MCTSP checkpoint locations



Points represent collisions in Marion County in 2006 where a driver refused an alcohol test, had a test result of 0.05 or greater, or received a citation for violation of one of six alcohol-related Indiana codes.

Effects of checkpoints on rates of impaired driving collisions

Between October 2008 and November 2009, the MCTSP implemented 22 sobriety checkpoints among the nine locations. Did these checkpoints affect the rate of impaired driving collisions in and around the checkpoint locations? Or, in the language of the *Gerschoffer* decision, were they effective—did they show evidence of a deterrent effect on impaired driving collisions? Answering this question for each checkpoint location is complicated by the sequential nature of checkpoint dates, the different number of checkpoints conducted during the period at each location, and the relatively close proximity of some checkpoints.

To examine the possible impacts of the sobriety checkpoints on the incidence of impaired driver collisions, we used a pre-post/control area evaluation model, in which we compare the mean pre-checkpoint impairment rates (pre-mean) to the mean post-checkpoint impairment rates (post-mean) in the nine MCTSP checkpoint locations, and relative to control areas that did not host checkpoints. In the language of quasi-experimental design, this is known as an "interrupted time series with a non-equivalent no-treatment control group time series" (Cook and Campbell, 1979).[2] Two control areas were used to measure changes occurring in areas without checkpoint applications. One was in the southwestern quadrant of the county (S. Mickley), and one was in the northeastern quadrant (Rue Riviera). As shown in Map 1, the control sites are located within high alcohol-related collision density areas in 2006, but had no MCTSP checkpoints during the 2008-2009 period. These two areas can serve as control sites because, in comparison to the checkpoint areas, they had roughly equivalent impaired collision densities in 2006. The basic objective was to assess whether areas around checkpoints (checkpoint zones) showed any evidence of better or worse impaired collision rate changes than the zones around comparison sites.[3]

Since 2004 in Indiana, alcohol-impaired motor vehicle collisions have decreased an average of four percent each year and fell 15 percent from 2007 to 2008.

We analyzed the change in checkpoint- and control-zone impairment rates, measured as

Impairment rate = (Count of impaired collisions / Count of non-impaired collisions) x 100.

It is interpreted as the rate of impaired collisions per 100 non-impaired collisions (i.e., the re-scaled odds that given a collision occurred, it would be alcohol-related). Average monthly impairment rates in checkpoint zones at least 12 months before checkpoint dates were compared to monthly impairment rates after checkpoint dates. For the two control sites and each of the 22 checkpoint dates, the pre-checkpoint period for each date began on October 11, 2007. The post-checkpoint period started the day after a checkpoint and extended through November 16, 2009. For these time periods, counts of impaired and non-impaired collisions were obtained within a two-mile buffer zone around each checkpoint and comparison site. To obtain the same time periods in the comparison sites (i.e., to develop time-matched control zones), collisions within the two control zones were re-grouped to match the pre- and post-time frames of each checkpoint zone location/date. For the checkpoint locations and the comparison sites, mean monthly changes in impairment rates during the pre- and post-checkpoint periods were examined (i.e., the pre-mean and the post-mean) and tested for significant

[2]The analyses actually consist of two models: a simple interrupted time series (where only a single checkpoint occurred in a zone), and an interrupted time series with multiple replications (where various numbers of checkpoint "treatments" were applied at the same location using from two to five replications).

[3]Because this was not a randomized experiment, we were unable to control whether during these same periods other types of anti-impaired driving programs were operating within either the checkpoint or control areas. The MCTSP implemented numerous roving sobriety patrols across the county—they reported 582 impaired driving patrols (>2800 hours of activity) in FY 2008, and 721 patrols (>3200 hours) in FY2009. These are both more than ten times the hours devoted to sobriety checkpoints (211 hours in FY 2008, and 246 hours in FY 2009). If it is assumed that other programs such as roving sobriety patrols are spatially distributed more or less evenly within the county, then this is not a serious problem. If sobriety patrols were focused in particular areas, however, e.g., the high density clusters from 2006, this means any change linked to checkpoints might also be due to non-measured aspects of other programs. In any event, differences between checkpoint areas and the control sites should be interpreted carefully.

statistical changes. This allowed three types of comparisons:

1. The difference in the pre- and post-checkpoint rates within checkpoint zones (if sobriety checkpoints have a deterrent effect, we should see decreases in post-checkpoint impairment rate means)
2. How checkpoint zone post-mean changes compare to the control sites (if sobriety checkpoints have a deterrent effect, impairment rate changes in the checkpoint zones should be comparatively lower than the control sites)
3. Whether pre-to-post changes in means were better or worse in the checkpoint zone versus its two control zones (if sobriety checkpoints have a deterrent effect, pre-to-post changes in the impairment rate mean would be comparatively better than those of the control sites)

Table 1: Mean rate of impaired collisions before and after checkpoints, by checkpoint and compared to control sites, October 11, 2007 to November 16, 2009

				Control sites, same time as checkpoint					
	Checkpoints			Rue Riviera			S. Mickley		
Checkpoint location/date	Mean pre	Mean post	Improved?	Mean pre	Mean post	Improved?	Mean pre	Mean post	Improved?
Not downtown sites (11 dates, 6 locations)									
1. 3400 Lafayette Rd: 24-Apr-09	3.93	5.38	0	4.29	6.19	0	2.96	3.32	0
2. 8100 Madison Ave: 8-Aug-09	2.82	7.08	0	4.36	8.55	0	2.90	4.81	0
3. 3600 S. Emerson Rd:			2			0			0
7-Aug-09	4.49	1.17*	1	4.41	8.20*	0	2.88	4.54	0
21-Aug-09	4.65	1.97*	1	4.42	7.98	0	2.95	3.79	0
4. 3700 E. Washington St:			2			0			0
10-Jul-09	4.78	3.54	1	4.36	8.07	0	2.74	3.69	0
4-Sep-09	4.79	3.01*	1	4.60	9.00*	0	2.80	5.04	0
5. 6102 W. 38th St:			2			0			0
25-Apr-09	4.03	3.78	1	4.30	6.26	0	2.93	3.36	0
1-Sep-09	3.84	2.74	1	4.25	7.74	0	2.76	4.65	0
6. 4100 E. 10th St:			2			1			0
11-Oct-08	4.50	4.01	1	5.04	4.92	1	2.80	3.46	0
29-Nov-08	4.33	4.20	1	4.76	4.94	0	2.84	3.31	0
17-Apr-09 (4400 E. 10th St)	4.70	6.16	0	4.37	5.20	0	2.94	2.94	0
Downtown sites (11 dates, 3 locations)									
1. 500 N. Delaware St:			1			0			0
17-Mar-09	1.94	3.55	0	4.54	5.47	0	2.96	3.24	0
27-Mar-09	2.01	2.62	0	4.54	5.47	0	2.96	3.24	0
13-Jun-09	2.19	2.16	1	4.41	5.34	0	2.81	3.35	0
2. 600 S. Pennsylvania St:			2			0			0
27-Jun-09 (South & Pennsylvania)	2.34	2.29	1	4.33	6.82	0	2.84	4.00	0
11-Jul-09	2.33	2.30	1	4.37	5.70	0	2.74	3.73	0
21-Aug-09	2.33	2.48	0	4.42	7.98	0	2.95	3.79	0
3. East St & Washington St:			0			2			0
24-Oct-08	1.88	2.86*	0	4.82	4.74	1	2.92	3.17	0
21-Nov-08	1.95	2.81	0	4.83	4.80	1	2.88	3.23	0
31-Dec-08	2.01	2.91*	0	4.52	5.22	0	2.80	3.44	0
12-Jun-09	2.34	2.79	0	4.42	5.27	0	2.73	3.42	0
4-Sep-09	2.36	2.53	0	4.60	9.00*	0	2.80	5.04	0
Count of post-mean improvements			**11**			**3**			**0**

*Post mean impairment rate is statistically different from pre-mean, $p < 0.05$.

Sources:
Checkpoint data: Marion County Traffic Safety Partnership.
Collision data: Indiana Automated Reporting and Information Exchange System, as of May 5, 2009.

Notes:
1. Rates are monthly and per 100 non-impaired collisions. Rates are based on counts of collisions within two miles of checkpoints/comparison sites.
2. Comparison site start dates were matched to checkpoint start dates to synchronize timing and allow comparisons.
3. Comparison sites are inside areas previously identified as high density clusters of 2006 alcohol-related collisions for which MCTSP did not conduct checkpoints.
4. Collisions occurring the day of the checkpoint are excluded from rate calculations.
5. Downtown checkpoints are those within a mile of the intersection of N31 (Meridian St.) and Washington St.

Pre-to-post differences in checkpoint zones and control zones

As shown in Table 1, among all 22 checkpoint dates, 11 experienced decreases in their post-checkpoint mean, and 6 of the 9 checkpoint locations had at least one improvement in the post-checkpoint mean. Because monthly impairment rates improved after half of the checkpoints, these changes suggest that checkpoints had a deterrent effect in some cases. The effects seem to be linked to checkpoint location—there were post-mean impairment rate improvements half the time overall (11 of 22), about three-quarters of the time in non-downtown sobriety checkpoint zones (8 of 11), but less than one-fourth of the time in downtown checkpoint zones (3 of 11). Although this suggests some improvement (decreased rates of impaired collisions) in checkpoint zones, most of the post-means are not significantly different in a statistical sense from pre-means. In this regard, only 5 of 22 checkpoint dates experienced statistically significant changes in their mean impaired collision rate. Three checkpoint-date combinations had significant decreases: both August 2009 dates at 3600 S. Emerson, and the September 2009 checkpoint at 3700 E. Washington; these combinations had the shortest post-checkpoint time frames (three to four months), and suggest short-term reductions in impairment rates within those checkpoint zones. In contrast, the October and December 2008 checkpoints at East/Washington experienced significant increases; these combinations had comparatively longer post-checkpoint time series (11 to 13 months), and suggest a regression back to long-term trends in monthly impaired collision rates.

However, Table 1 also suggests that some level of overall deterrence from checkpoints was supported in contrast to the control zones, where mean monthly impairment rates rarely improved in the time-matched comparisons. One control site (S. Mickley) never experienced a post-mean decrease, and the other (Rue Riviera) experienced only three (Table 1). None of the post-mean decreases in the Rue Riviera control site were statistically significant. Further, the Rue Riviera control site experienced three statistically significant increases in the post-mean impairment rate—two of those occurred during the same periods that the S. Emerson and E. Washington checkpoint zones experienced statistically significant decreases in post-means.

Post-mean change in checkpoint zones and control zones

Table 2 examines the magnitude of change from pre-to-post means for the checkpoint and comparison zones. The idea here is to see whether the impairment rate changes in checkpoint zones are better or worse than changes in the control zones during the matched time periods. That is, even if there was an increase in the post-checkpoint mean, it might have been less (or more) than the change in control zones. Overall, out of 44 possible comparisons between

Table 2: Change in the mean rate of impaired collisions before and after checkpoints, by checkpoint and compared to control sites, October 11, 2007 - November 16, 2009

	Change in pre- to post-mean			Mean-post change better than control sites?	
		Control sites			
	Checkpoint	Rue Riviera	S. Mickley	Count	Percent (by location)
Not downtown sites (11 dates, 6 locations)					
1. 3400 Lafayette Rd: 24-Apr-09	1.44	1.90	0.36	1	50%
2. 8100 Madison Ave: 8-Aug-09	4.26	4.18	1.90	0	0%
3. 3600 S. Emerson Rd:				4	100%
7-Aug-09	-3.31	3.79	1.66	2	
21-Aug-09	-2.68	3.56	0.84	2	
4. 3700 E. Washington St:				4	100%
10-Jul-09	-1.24	3.72	0.95	2	
4-Sep-09	-1.77	4.40	2.24	2	
5. 6102 W. 38th St:				4	100%
25-Apr-09	-0.25	1.96	0.42	2	
1-Sep-09	-1.10	3.48	1.89	2	
6. 4100 E. 10th St:				4	67%
11-Oct-08	-0.49	-0.12	0.66	2	
29-Nov-08	-0.13	0.18	0.47	2	
17-Apr-09 (4400 E. 10th St)	1.47	0.84	0.00	0	
Downtown sites (11 dates, 3 locations)					
1. 500 N. Delaware St:				3	50%
17-Mar-09	1.61	0.93	0.29	0	
27-Mar-09	0.61	0.93	0.29	1	
13-Jun-09	-0.03	0.93	0.55	2	
2. 600 S. Pennsylvania St:				6	100%
27-Jun-09 (South & Pennsylvania)	-0.05	2.50	1.16	2	
11-Jul-09	-0.03	1.34	0.99	2	
21-Aug-09	0.15	3.56	0.84	2	
3. East St & Washington St:				4	40%
24-Oct-08	0.99	-0.08	0.26	0	
21-Nov-08	0.85	-0.03	0.35	0	
31-Dec-08	0.90	0.70	0.64	0	
12-Jun-09	0.46	0.85	0.70	2	
4-Sep-09	0.17	4.40	2.24	2	
Average change	**0.08**	**2.00**	**0.89**		
Count of comparative change improvements				**30**	**68%**

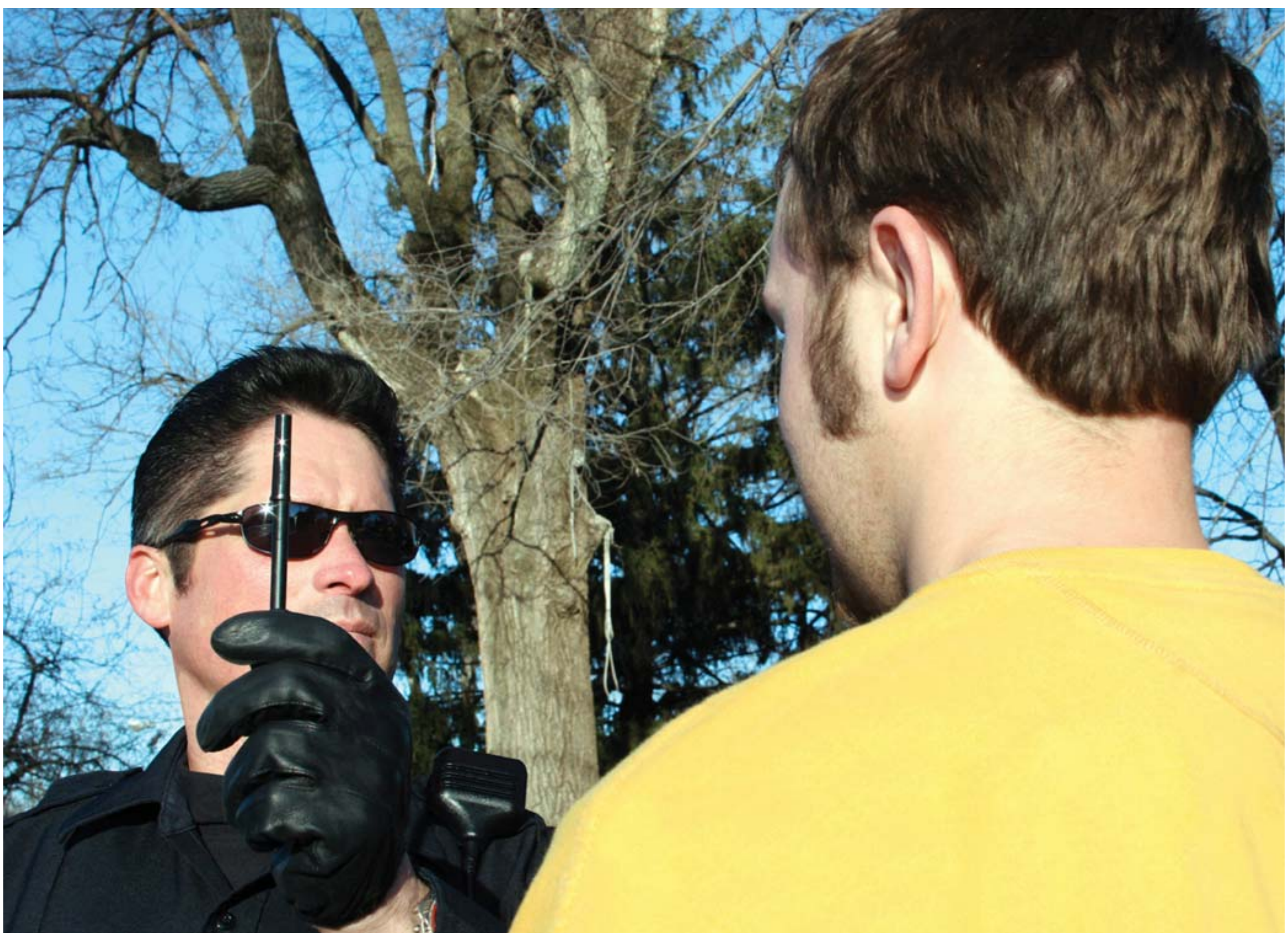
Sources:
Checkpoint data: Marion County Traffic Safety Partnership.
Collision data: Indiana Automated Reporting and Information Exchange System, as of May 5, 2009.

Notes:
1. Rates are monthly and per 100 non-impaired collisions. Rates are based on counts of collisions within two miles of checkpoints/comparison sites.
2. Comparison site start dates were matched to checkpoint start dates to synchronize timing and allow comparisons.
3. Comparison sites are inside areas previously identified as high density clusters of 2006 alcohol-related collisions for which MCTSP did not conduct checkpoints.
4. Collisions occurring the day of the checkpoint are excluded from rate calculations.
5. Downtown checkpoints are those within a mile of the intersection of N31 (Meridian St.) and Washington St.

checkpoint zones and control zones, the checkpoint zones had more desirable post-mean change 68.1 percent of the time (30 of 44). In other words, more than two-thirds of the time either post-mean decreases in checkpoint zones were greater than control zones decreases, or post-mean increases in checkpoint zones were less than control zone increases. In this context, the downtown checkpoint sites appeared considerably more successful compared to the control zones that had no checkpoints. In 22 comparisons with the control sites, downtown locations had a more desirable rate of change 59 percent of the time (13 of 22). The outlying non-downtown checkpoint zones performed even better, comparing favorably to control sites 77.2 percent of the time (17 of 22). In four checkpoint locations (S. Emerson, E. Washington, W. 38th, and S. Pennsylvania), pre-to-post changes were always better than the comparison sites. Only the Madison Avenue checkpoint location had no favorable comparison to control sites in post-mean changes.

Analyzing multiple replications of sobriety checkpoints

The biggest challenge to a pre/post test analysis in the MCTSP case is that because seven of the nine locations had several checkpoint dates (i.e., multiple replications), the post-checkpoint period for early dates included new (later) checkpoints at the same location; similarly, for later checkpoint dates, the pre-checkpoint period included post periods of earlier checkpoints. Considering all nine checkpoint locations in this context, two had only one application of a checkpoint; three had two replications; three had three replications; and one had five replications. Thus, sorting out the impacts of any single checkpoint for seven of these locations is complicated by the overlapping timing of checkpoint applications at the different locations.



In general, our analysis suggests a slight relationship between the number of checkpoint replications and the strength of their deterrence effect. In the single application Lafayette and Madison checkpoint locations, there were not obvious improvements in the rate of impaired collisions after the checkpoint dates, nor were the checkpoint zone increases generally more favorable in comparison to the control zones. The S. Emerson Road, E. Washington Street, and W. 38th Street checkpoint zones that had two replications each show some evidence of improved collision impairment rates after checkpoints were applied, on their own and in comparison to the control sites. The three-replication locations had mixed evidence of deterrence. The 4100 E. 10th checkpoint in 2008 showed some deterrent effects, but this evidence was not sustained by the latter 2009 checkpoint. The 500 N. Delaware location showed few signs of deterring future impaired driving collisions within the checkpoint zone, and there was virtually no measurable deterrence associated with the 600 S. Pennsylvania checkpoint locations, even if the location did have more desirable post-mean change than the control zones. Finally, the only five replication location, East/Washington, showed little evidence of deterrence.

Implications for sobriety checkpoints and impaired driving in Marion County

It seems clear that site selection is a critical decision in the checkpoint planning process, not only from the standpoint of rational public safety policies, but also from the perspective of the *Gerschoffer* decision on sobriety checkpoints. Careful, objective, data-driven site selection can yield many benefits for law enforcement and checkpoint organizers, most notably reducing potential legal challenges associated with checkpoint implementation and execution, as well as increasing checkpoint effectiveness through a hypothesized increased likelihood of impaired driving detection. Additionally, it can save law enforcement and checkpoint organizers time and money by quickly narrowing the vast number of site options and reducing time spent investigating these options.

Based on existing research and the findings of this exploratory analysis, sobriety checkpoints are an effective strategy for reducing alcohol-impaired driving, and thus, alcohol-impaired collisions.

Findings from this exploratory analysis suggest differences between checkpoint locations in the downtown area (i.e., within a one-mile radius of the intersection of Meridian and Washington streets) and those located outside the downtown area. Using the metrics examined here, the three downtown checkpoint locations were generally not as successful as the six outlying non-downtown locations. Outlying checkpoints had post-mean decreases after eight of the 11 checkpoint dates, nearly three times (2.7) the rate of downtown checkpoints (three of 11 dates). This raises the question of why differences existed between downtown and outlying locations, and there are several plausible hypotheses.

One possibility is that the intensity of checkpoint activity per location (treatments per location or *replications* in Cook and Campbell terms) might play a part. Among the three downtown locations, each had an average of 3.7 checkpoint replications, which was twice the rate of the six non-downtown locations (1.8 replications per site). The location with the largest number of checkpoint replications (five), at roughly East and Washington streets, exhibited in some respects the poorest or least desirable changes in impairment rates. The series of checkpoint dates at East/Washington not only did not reflect a decrease in post-means, it showed increases in post-means across all dates (two significant statistically). Also, the pre-means for the five dates increased sequentially, suggesting the rate of impaired collisions was drifting upward even in the midst of five replications of checkpoint treatment.

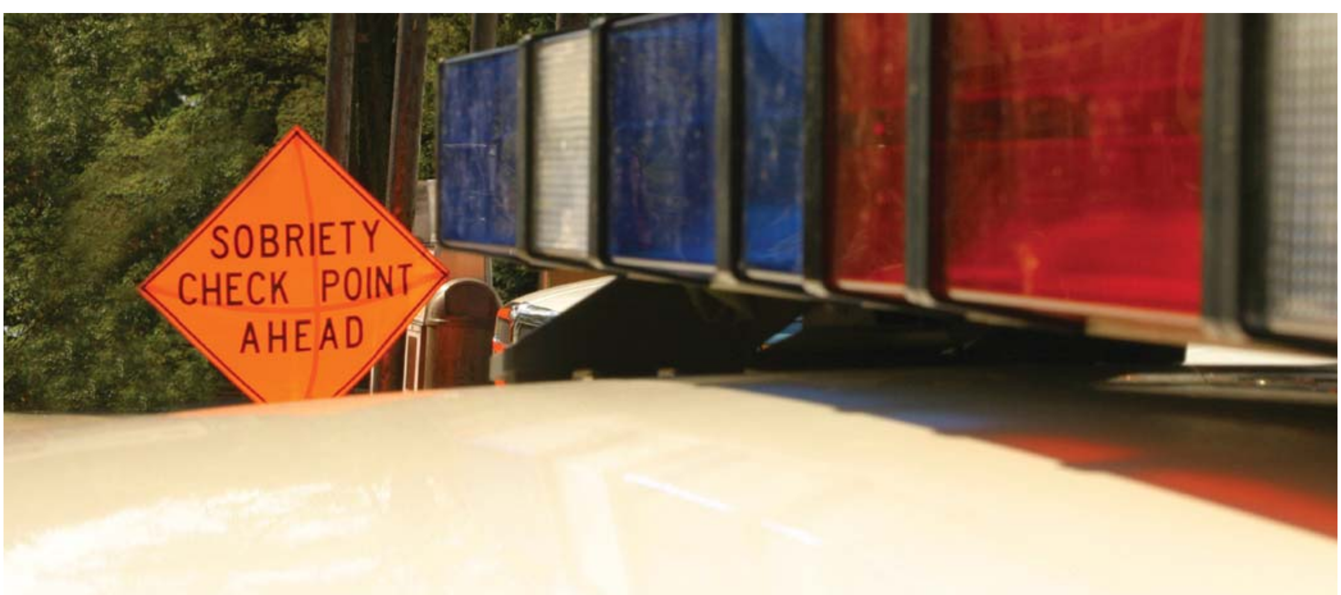
Secondly, the traffic environment in the downtown differs somewhat from outlying areas, and it is possible that these differences affect the impairment rate. The rates of impaired driving overall are less in the downtown than the outlying sites. There are higher overall traffic volumes, higher concentrations of business traffic, and higher overall collision rates around the downtown sites due to the presence of two major interstates (I-70 and I-65) and major state roads (US 31 and US 40) that converge downtown. This would likely lead to higher numbers of collisions during daytime hours, when alcohol is less likely to be a factor. Third, because downtown Indianapolis is the location for a variety of major nighttime entertainment events (e.g., Colts and Pacers games, concerts, festivals, plays, etc.), decisions to drive downtown are less likely to be foregone, and in addition such events would attract many non-Marion County residents who might be otherwise unaware of sobriety checkpoint locations and dates.

In summary, the findings from this analysis are more suggestive than definitive. Different results might be obtained by re-defining checkpoint zones (as bigger or smaller areas) or changing the time periods before and after checkpoint dates. In addition, the incidence of impaired driving collisions is comparatively rare, and as a result some of the monthly counts of impaired collisions will be low, thus limiting the power of statistical tests. Nonetheless, within the parameters of this analysis, several checkpoints appeared to have desirable effects, and the number and timing of checkpoint replications at a single location could have some effect on short-term deterrence of impaired driving collisions. Based on checkpoints implemented at these nine sites from October 2008 through September 2009, those locations with two or three replications appeared to show the most evidence of deterrent effects.

Conclusion

The Marion County Traffic Safety Partnership, working with the Center for Criminal Justice Research, serves as an example of how law enforcement and checkpoint organizers can utilize Indiana's collision data set, ARIES, to optimize site selection for sobriety checkpoints and enhance their efforts to respond to the public safety issue of impaired driving collisions. The CCJR analysis provided the MCTSP with a countywide overview of alcohol-impaired collision clustering and a detailed view of individual clusters so the partnership could make informed, objective decisions about the placement of checkpoints in Marion County. In addition to overlays of streets, alcohol-impaired collisions, and aerial photos, each high-density cluster was further profiled with statistics such as cluster size and total length of road segments (in miles) in the cluster. The 2006 high density maps were included in the MCTSP sobriety checkpoint handbook to guide checkpoint operations in 2008-2009. In 2010, new locations based on 2008 impaired collision patterns are likely to be developed by MCTSP.

Based on existing research and the findings of this exploratory analysis, sobriety checkpoints are an effective strategy for reducing alcohol-impaired driving, and thus, alcohol-impaired collisions. Traffic safety officials responsible for implementing traffic safety programs and disbursing traffic safety funds might want to consider supporting the standardization of sobriety checkpoint site selection methods, such as those described here, to normalize and consolidate sobriety enforcement efforts across the state. Doing so could protect law enforcement and checkpoint organizers from legal challenges ensuing from site selection decisions, enhance the effectiveness of checkpoints by making use of a valuable resource (ARIES), and save law enforcement and checkpoint organizers time and money by simplifying the site selection process.



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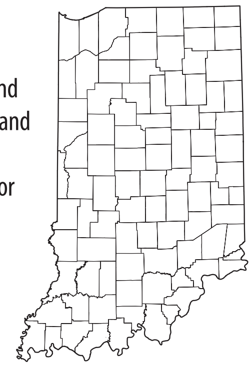

The Indiana University Center for Criminal Justice Research is a nonpartisan applied research organization in the School of Public and Environmental Affairs at Indiana University–Purdue University Indianapolis. Researchers at CCJR work with public safety agencies and social services organizations to provide impartial applied research on criminal justice and public safety issues. CCJR is one of three applied research centers currently affiliated with the Indiana University Public Policy Institute. The partner centers are the Center for Urban Policy and the Environment and the Center for Health Policy.

This issue brief describes how Indiana collision data were used to help direct traffic safety resources and ultimately respond to alcohol-impaired collisions in Marion County, Indiana. The brief provides an overview of impaired driving collisions in Indiana, and a description of collision data contained in the Indiana Automated Reporting Information Exchange System (ARIES). Also included is a synopsis of how the data were used to assist Marion County law enforcement agencies in conducting sobriety checkpoints.

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Authors: William Newby, Program Analyst and **Samuel Nunn,** Director, Center for Criminal Justice Research, and Professor, School of Public and Environmental Affairs
Technical review: Matt Nagle, Program Analyst; **Kenna Quinet,** Faculty Fellow, Indiana University Public Policy Institute, and Associate Professor, School of Public and Environmental Affairs; and **Thomas D. Stucky,** Interim Director, Center for Criminal Justice Research, and Associate Professor, School of Public and Environmental Affairs

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