Crime Mapping News

A Quarterly Newsletter for Crime Mapping, GIS, Problem Analysis, and Policing

POLICE FOUNDATION

Volume 6 Issue 2
Spring 2004

The topic of this issue of *Crime Mapping News* is the use of global positioning systems (GPS) and geographic information systems (GIS) in law enforcement. The first article in this issue is about the use of GPS and GIS in the state of North Carolina and focuses on truck crashes and commercial vehicle enforcement. The second article is about the use of GPS-enabled digital cameras to analyze gang-related graffiti incidents in Santa Monica, CA. Finally, the third article is a recap of the recent International Crime Mapping Research Conference that took place on March 2004 in Boston, MA.

North Carolina's Experimental Use of GPS to Provide an "Integrated" GIS Analysis for Truck-Involved Crashes and Commercial Vehicle Enforcement Activities

by Ronald G. Hughes, Ph.D., Highway Safety Research Center, University of North Carolina at Chapel Hill, and Marc Stanard, North Carolina State University, Institute for Transportation Research and Education

Background

North Carolina consistently ranks in the top ten states in the U.S. in terms of fatal truck-involved crashes. The state organization with the primary enforcement responsibility for truck safety is the Motor Carrier (i.e., commercial vehicle) section of the N.C. State Highway Patrol (NCSHP). Each year, the section conducts approximately 60,000 enforcement actions (i.e., driver and vehicle inspections conducted both at the roadside and at the sixteen fixed weigh station facilities operated by the section, citations or serious CDL (commercial driver license) traffic violations, as well as mobile and fixed scale weight compliance activities).

The section is presently experimenting with the use of an inexpensive global positioning system (GPS) and "event capture" capability to document enforcement presence (through generation of a vehicle "track" file) and the location of specific enforcement actions (typically roadside inspections of drivers and vehicles, portable scale operations, commercial vehicle traffic citations, etc.).

GPS is being used in order to provide an integrated GIS data analysis environment whereby the spatial attributes of truck-involved crashes and commercial vehicle enforcement activity can be analyzed with the same set of GIS analysis tools. Since 2000, all truck-involved crashes in North Carolina have been entered into a GIS crash database using standard off-the-shelf ESRI software (e.g., ArcGIS, ArcInfo, ArcIMS, etc.). With three years of crash data now in the system, it is possible to evaluate trends over time in the spatial attributes of truck-involved crashes. Figure 1 maps changes in the density of truck-involved crashes in the twelve-county, Troop C area from 2000 through 2002.

Only when one can relate the spatial attributes of crashes (the problem) and the spatial attributes of those (enforcement) activities undertaken, in part, to reduce those crashes (the solution) can one begin to effectively target limited enforcement resources, both spatially and temporally. However, "mile-posting" events, such as crashes and

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Inside this Issue

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How to Analyze and Battle Incidents of Graffiti: CGrAS - Citywide Graffiti Abatement System

by Safa Egilmez, Crime Analyst
Santa Monica Police Department

Introduction

Santa Monica is a Southern California beach city of 85,000 residents adjacent to the City of Los Angeles. Graffiti abatement is a priority established by the community-oriented-policing initiative. To expedite the abatement, four years ago the Santa Monica Police Department shifted the initial responsibility for responding to community reporting from the police department to the city's Facilities Management Department, and a graffiti hotline was subsequently established. Before this transfer occurred (and the hotline was initiated), SMPD had customarily been receiving eight to ten graffiti calls per week. A recent evaluation by SMPD Crime Analysis personnel discovered that the Facilities Management Department. has been receiving one hundred to 120 calls for graffiti removal per week, whereas only approximately eight to ten of them are still being reported to the police department. In the last six months of 2002, the city responded to and cleaned 2,157 incidents of graffiti, and in 2003, they abated 5,222 incidents of graffiti (14.3 per day). In order to capture all of the graffiti incidents and the nature and sources of the tagging, a solution had to be formulated.

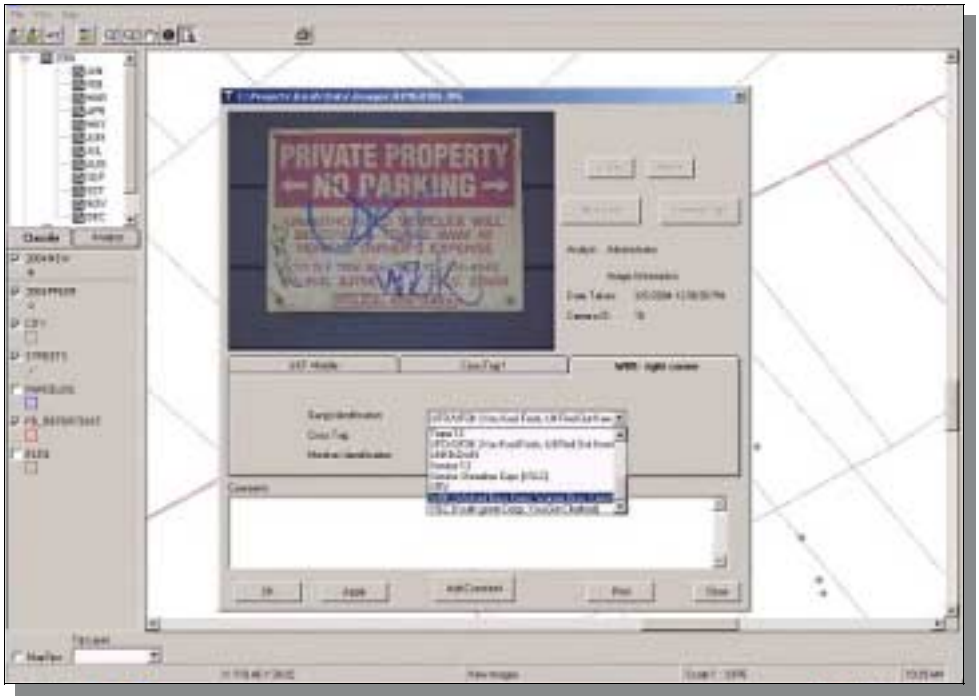
Development of CGrAS

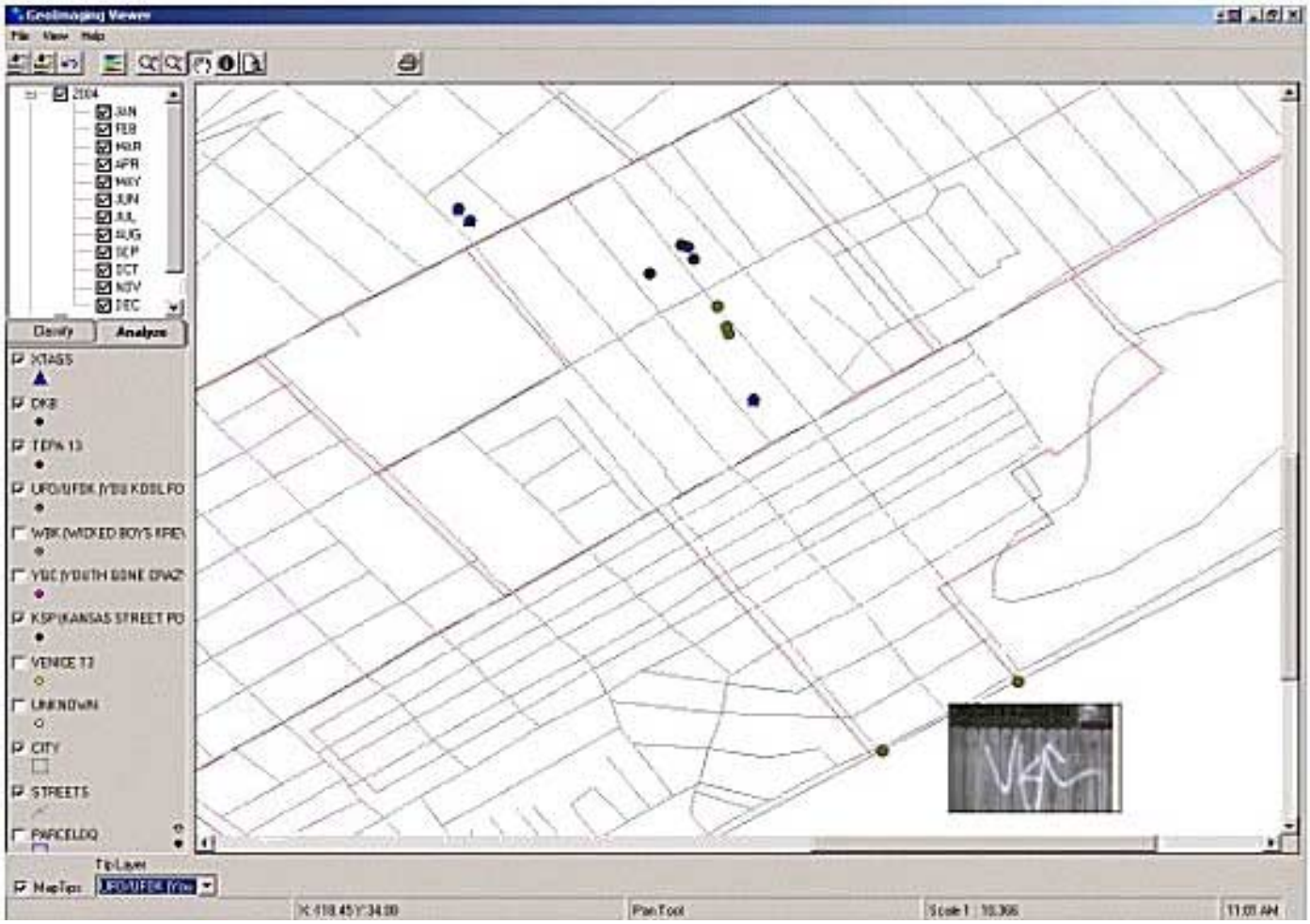
The department's crime analysis personnel came across a solution involving GPS and wireless-enabled digital cameras, further utilizing ArcSDE to enhance the performance. The department contacted RICOH© Digital Camera Company for this solution. After a needs assessment and a capabilities evaluation, it teamed with RICOH© and Farragut Systems© in order to develop the system. Farragut Systems© developed the Graffiti Abatement Visualization System named CGrAS - Citywide Graffiti Abatement System for the agency. The system is based on ESRI© ArcObjects platform and is highly scalable. The department's crime analysts actively participated in the development and testing stages of the product in order to maximize the efficiency and usability from the standpoint of crime analysts.

The digital cameras have a unique, drop down menu that can be programmed beforehand with varying information. This information can be selected by the user very easily and is then embedded inside the image file, thereby preserving the chain of custody and effectively dealing with authentication issues. If any of the images are manipulated, the complete file becomes unusable and will not open. The camera has a 3.2 megapixel resolution and is equipped with an SD card slot. It also has a rechargeable lithium-ion battery, as well as an emergency function, so that when in the field, should the battery lose power and discharge, two AA size batteries can be placed in the same battery slot to power up the camera. The camera is equipped with a GPS unit that transfers the location information into the same image file that also becomes embedded in the header file. A user can acquire and check the GPS signal and then take one step towards the object of interest and capture it. The travel direction will be captured in order for the visualization component to correctly orient the camera's direction. As an additional bonus feature, the camera lets the user make voice notes and attach them to the image. All of this information can then be sent wireless using either a Wi-Fi connection or a GPRS connection to the central ftp server.

Implementation and How it Works

In the first phase of development, the department has selected to utilize the direct download option that requires the camera to be connected to any city LAN location. The information stored in the camera is then sent to the central server via ftp to the specific folders based on the header tags that the user selects. If the user tags it for a graffiti incident, it will download the images to the specific graffiti folder. If they are tagged with traffic accident information, they will be downloaded automatically to the traffic accidents folder.





The files are then selected according to the information tags and populated to the ArcSDE database. The current development version is utilizing an SQL server to directly download the images via ftp. The ArcSDE solution will be installed by the end of May 2004. The installation was delayed because the city had technical issues with the ArcSDE server. The software automatically converts the GPS locations to the GIS basemap projection that the department is using and displays the new locations when the application is launched. Crime analysis personnel then select the new images for review. The user can choose not to classify the images, or to classify them according to the gang affiliation. The user has the ability to make notes and other comments in the fields that are provided. All of the gang names have been loaded as drop-down choices along with the associated gang monikers. These tables are easy to modify for the administrator and have dependencies built in. The crime analyst then can finish the analysis of the images and close the application. Analysts can choose to share the photos with different departmental personnel by forwarding the image location along with the data information to the department of interest. The images and the information reside in the centralized server, and only the link to the image folder is sent, thereby providing a central repository and minimizing the amount of the data transfer.

Multiple city agencies will have administrator-allowed access to the central repository. While the police department is evaluating the gang monikers, the Facilities Management Department will evaluate the manpower needs to remove the graffiti and make cost recovery calculations. This has proved a valuable and cost-effective approach to implementing the sharing of information among different city agencies.

Impact and Summary

CGrAS has been well received by police department personnel, as well as the city's graffiti-abatement crews and the GIS department, as a valuable tool to access, map, and analyze incidents of graffiti. This new approach provides a fast, graffiti-abatement capability as well as providing detailed information about sources of graffiti, perpetrator target locations, and the nature of the graffiti. It has also improved the communications between different departments and allowed a more comprehensive approach for graffiti abatement. In the next phase of the project, the wireless, data-send approach will be utilized along with evaluation of this tool by traffic-accident and gang-enforcement units.

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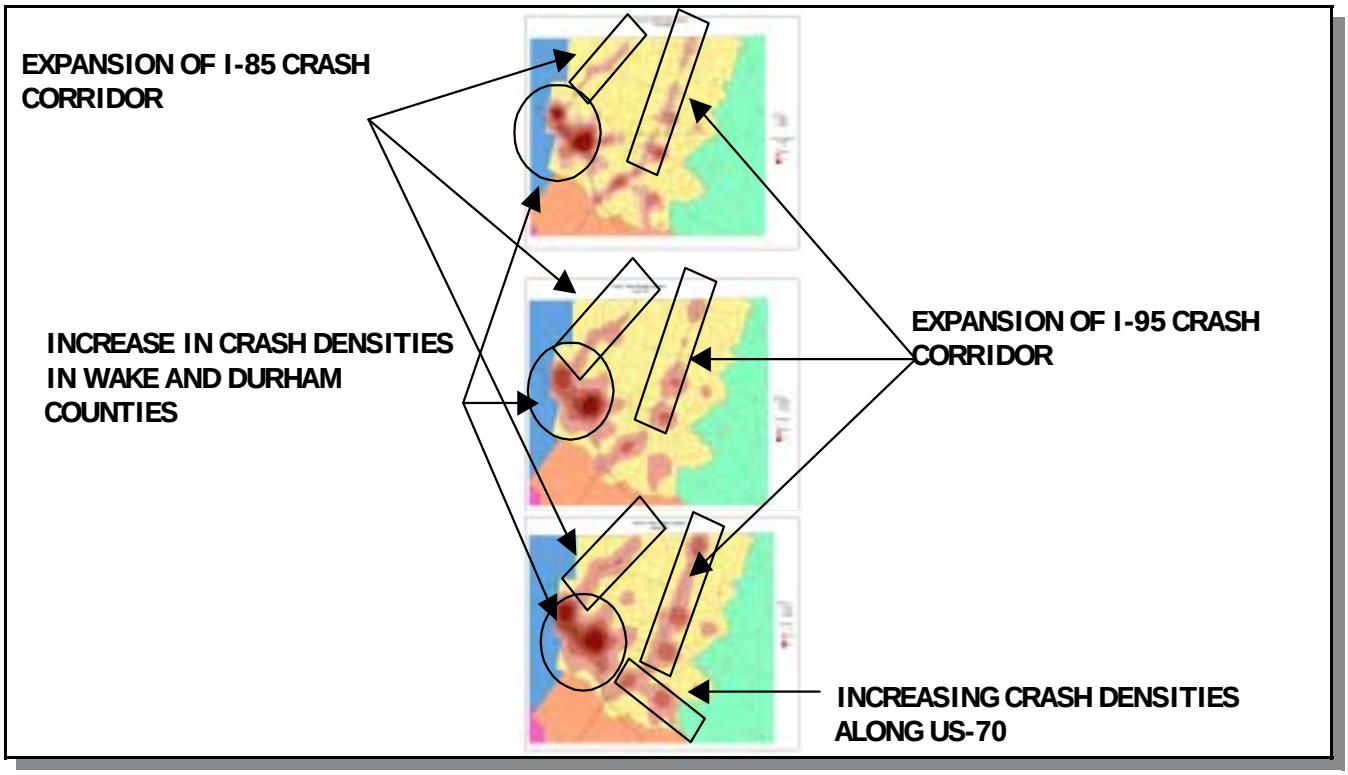

Figure 1. Use of GIS to Evaluate Trends Over Time in Truck-Involved Crashes in a Twelve-County Area in North Carolina

(Continued from page 1)

enforcement activity that occur along linear features (i.e., roads), can be a labor-intensive operation in the absence of good location data. This is especially true at the level of 8,000-9,000 truck-involved crashes statewide each year and at enforcement levels that exceed 60,000 actions each year.

North Carolina's Experimental Use of Inexpensive GPS Hardware

The current experimental effort in North Carolina is being conducted in the twelve-county area of the state comprising NCSHP Troop C. Troop C includes the Raleigh-Durham area and much of the area served by I-95, I-40, and I-85 in the eastern portion of the state. The approach is to equip fifty motor-carrier enforcement vehicles with low cost (approximately $100 each) GPS receivers that are integrated with the vehicle's laptop computing environment. Commercially available Garmin eTrex receivers are being used for the test. The in-vehicle installation is shown in Figure 2.

The vehicle-powered receiver provides continuous x,y,z coordinate data. Positional accuracy is generally in the range of + or – 10 meters (considered sufficient for this application). Location data can be sampled at a user-specified rate to establish vehicle location (enforcement presence) and time when officers enter their record of the enforcement activity via a laptop. The prototype application includes a special data event capture page (see Figure 3) that the officer accesses via the touch-sensitive screen of the

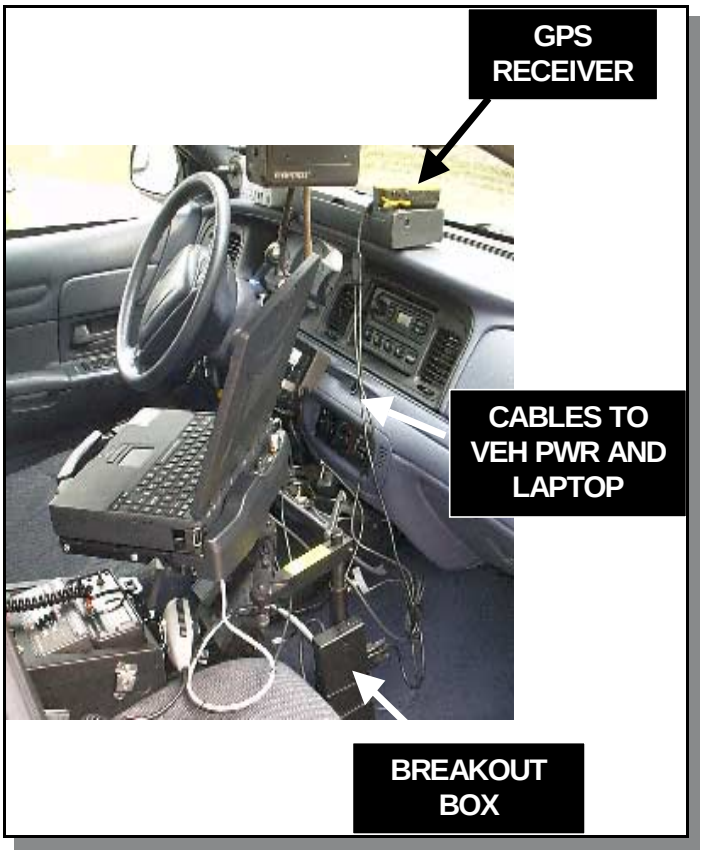

Figure 2. In-Vehicle Configuration of GPS Receiver

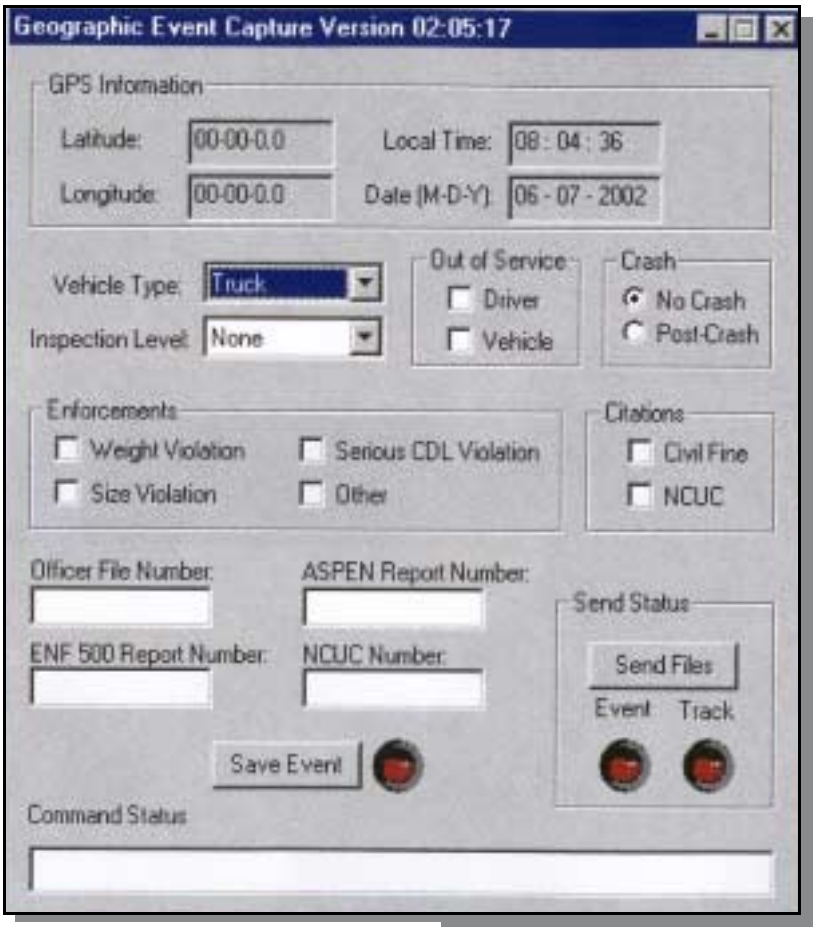

Figure 3. GPS Event Capture Page

in-vehicle documentation. In a typical scenario, an officer hits save; the x,y,z coordinate information is sampled, and a record of the event is saved to the officer's laptop.

Figure 4a shows the enforcement event data of twelve individual officers over a finite period of time. The event data are stored as a "layer" in the GIS crash data file. Here the event data are displayed against a background of county boundaries and those routes included as part of the state truck network. Each point can be accessed by officer ID, by type and level of event (e.g., Level I, II, or III inspection; traffic stop; etc.), by type of vehicle (CMV or non-CMV), time of event, whether driver and/or vehicle was placed out of service, whether a citation was issued, etc. Figure 4b shows the density of enforcement events (radius set at three miles). Figure 4c shows enforcement event density in relationship to the locations of fatal, truck-involved crashes. Figure 4d is an effort to quantify enforcement presence in terms of a measure of the density of vehicle-track (location) events. In this case, a track event has been generated every three seconds. The white square (black square in Figure 4a) indicates the location of a truck weigh-station facility.

These data are for illustrative purposes only. They do not represent the total, motor-carrier enforcement activity for this period for the entire troop assigned to this area. Thus, for example, it should not be inferred from this subset of the total, motor-carrier enforcement activity in the troop that there was no enforcement presence or activity in geographic areas where fatal crashes had been reported (e.g., in the lower right quadrant of the image).

Relating the Spatial Attributes of Crashes and the Spatial Attributes of Enforcement

The geographic relationship between enforcement presence and crashes can be illustrated another way. Consider the data shown in Figure 5. The top part of the figure shows each of the eight NCSHP troop areas across the state. Areas have been shaded in relation to the percentage of total, statewide, truck-involved crashes in that troop (the darker the shading the higher the percentage of statewide crashes). Note that the relative number of crashes reported in the areas indicated by the arrow is exceeded by only one other troop area in the state. The two lower portions of the figure show the ratio of percent of crashes to either (a) percent of inspections conducted and (b) percent of serious CDL (traffic) citations issued. In both instances, the darker the shading, the more the problem (relative crashes) exceeds the relative levels of enforcement activity being applied to it. Simply stated, these data indicate that while the area in question is identified as having a high percentage of truck-involved crashes statewide, it is characterized by a low percentage of CMV enforcement statewide (i.e., a discrepancy). Such discrepancies, where they have been noted, have been used by the Motor Carrier enforcement section to reevaluate the spatial distribution of motor-carrier enforcement personnel statewide, as well as to examine more closely the observed levels of enforcement performance.

We should point out that while this proportionality principle works well for matching enforcement levels with the attributes of crashes overall. It does not effectively target enforcement, however, to that subset of truck-involved crashes that are most likely to involve fatalities. This is because non-fatal crashes tend to occur as a result of exposure, while fatal crashes reflect other factors, such as class of road. Thus, while a spatial analysis of truck-involved crashes and enforcement activity/presence can be useful for general manpower/personnel assignment purposes (e.g., at the

Note from the Editors: *The opinions expressed in the articles of this newsletter are those of the authors and do not necessarily reflect the views of the Police Foundation or the COPS Office. In addition, only light editing has been made to the articles in order to keep each author's voice and tone.*

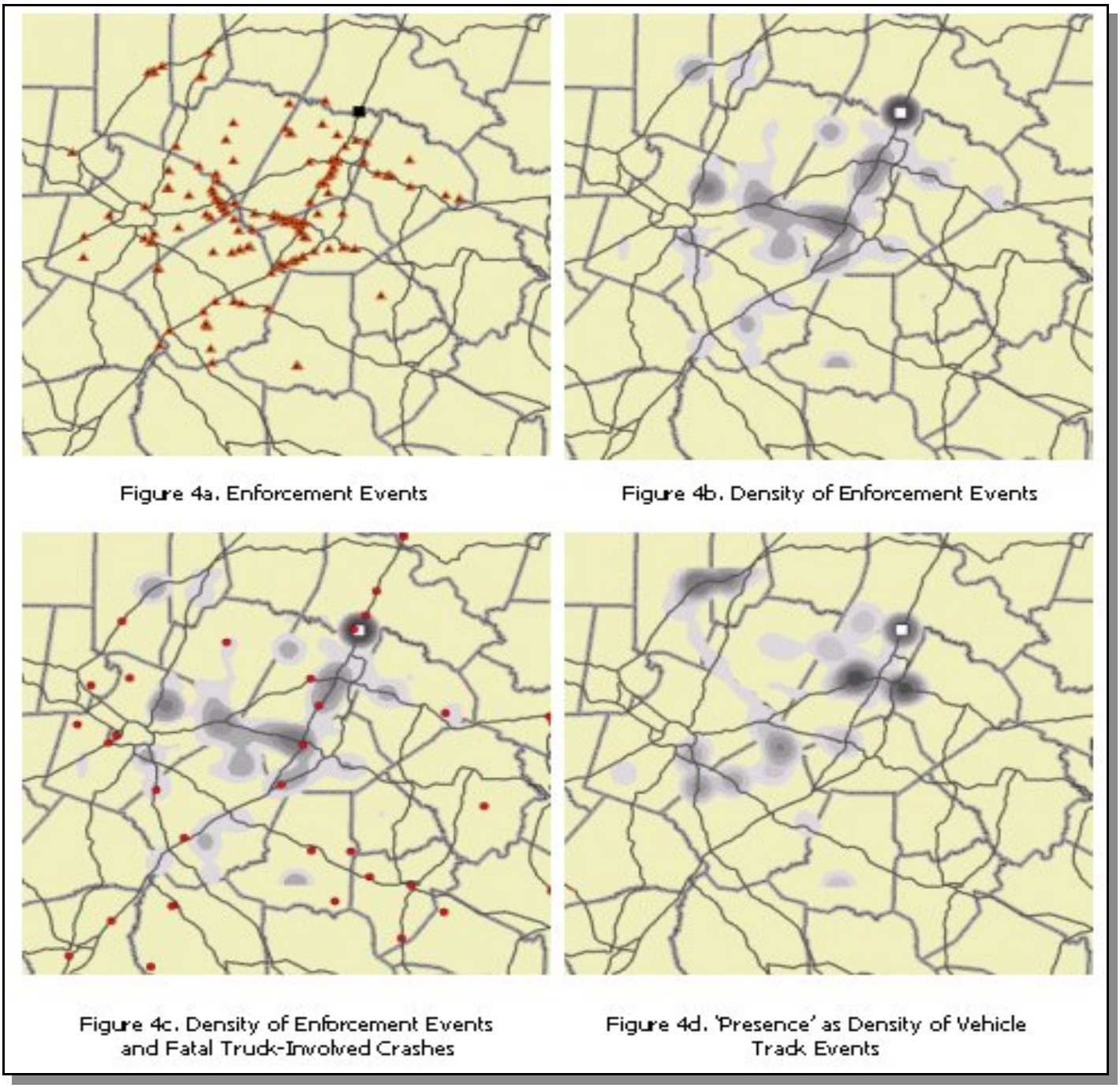

Figure 4a. Enforcement Events

Figure 4b. Density of Enforcement Events

Figure 4c. Density of Enforcement Events and Fatal Truck-Involved Crashes

Figure 4d. 'Presence' as Density of Vehicle Track Events

Figure 4a-d. GPS Used to Locate Enforcement Activity and Enforcement Presence

overall troop level), an analysis of other factors must be used in targeting those areas with the highest likelihood of fatal crashes within the troop.

Part of Overall Strategic Plan

The development of more effective procedures for "mile-posting" safety/enforcement related events is part of a broader NCSHP approach to the integration of wireless e-crash, e-ticketing, and e-reporting capabilities intended to improve the overall timeliness and accuracy of critical data.

This longer-term strategy includes the continued use of GIS and GPS methodologies and a broader application of web-based methods for data access. Within the NCSHP, the January 2003 merger of motor carrier enforcement personnel (formerly part of the N.C. Division of Motor Vehicles) with the State Highway Patrol (SHP) also will result, over time, with the move toward a more "distributed" (laptop versus mobile data, or dumb, terminal) in-vehicle computing environment that will ultimately function in a totally wireless communication environment. As these capabilities mature, GPS capabilities will migrate from the current use of external receivers to internal hardware/software capabilities that

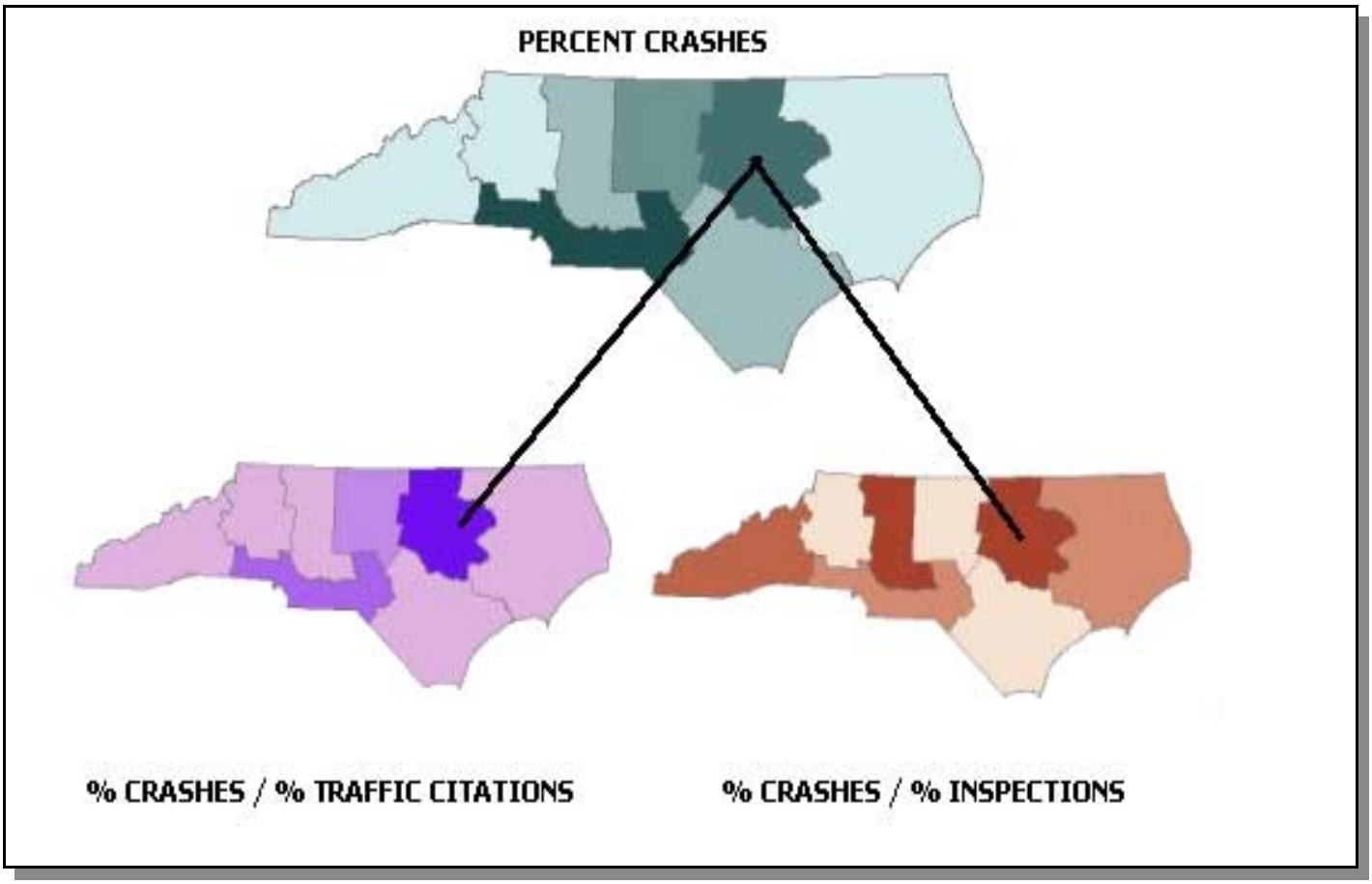

Figure 5. Proportionality Between Crashes and Enforcement

provide commanders with real-time, situation-awareness capabilities of all key personnel. In North Carolina where the NCSHP is part of the N.C. Department of Crime Control and Public Safety, we anticipate that these basic applications and system architectures will have even broader application as time goes on.

HSRC and NCSU/ITRE are currently working with the N.C. State Highway Patrol and the N.C. Governor's Highway Safety Program (GHSP) to extend the GIS truck-crash, database experience to a comprehensive GIS crash data base application for all vehicle crashes. Doing so means being able to establish a cost effective method for mile-posting over 221,000 reported vehicle crashes each year (i.e., a number well in excess of that dealt with thus far by the truck-involved, crash/enforcement work). It is at this level that we feel the adoption of GPS as a primary source of crash-location information represents an extremely cost-effective alternative to the continued use of narrative location descriptions and the associated labor-intensiveness involved in "mile-posting" such information for use in GIS.

Acknowledgement: The GPS Event Capture software application was developed by David Alford of the Engineering Applications Branch of the North Carolina Department of Transportation (NCDOT).

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Mark Stanard is currently a Computer Consultant for the N.C. Department of Environment and Natural Resources. He can be contacted via e-mail at mstan55@hotmail.com.

Conference Summary: Seventh Annual International Crime Mapping Research Conference March 31- April 3, 2004

The Seventh Annual International Crime Mapping Research Conference, sponsored by the Mapping and Analysis for Public Safety Program at the National Institute of Justice (NIJ), was held in Boston, MA, from March 31 through April 3, 2004. The conference included over 400 individuals representing law enforcement agencies from the United States and abroad, federal agencies, universities, nonprofit organizations, and software vendors. More specifically, there were approximately 130 presenters, 49 panels, 22 workshops, and 18 vendors. Many attended in order to learn new and/or refined techniques and ideas about crime mapping and crime analysis; to have the opportunity to network with professionals from across the United States and other countries; and to experience first hand the application of current crime mapping and crime analysis software programs and technologies.

The conference commenced on Wednesday, March 31 with vendor exhibits and a welcome by Sarah V. Hart, Director of the NIJ. The keynote address was delivered by Edward Flynn, Secretary of Public Safety for the Commonwealth of Massachusetts, who spoke about his life's work and the importance of crime mapping and analysis to policing. Some of the afternoon workshops included building a great Compstat meeting, problem analysis and crime mapping, maximizing maps with color, spatial data analysis with GeoDa, and an overview of GIS.

On Thursday, April 1, the topics of the morning workshops included introduction to CrimeStat III, techniques of spatial regression, and basics of cartography. The concurrent panels designed to structure the conference agenda and various presentations consisted of the following:

- Spatial Technology Showcase Session
- Corrections, Probation, and Parole
- Geographic Profiling and Forecasting
- GIS for Public Safety
- Local, Regional, and Federal Mapping
- Spatial Analysis and Research
- GIS Applications

Some specific examples of presentations given were:

- Neighborhood Structural Determinants of Recidivism: A Multilevel Study of Parolees in Their Neighborhoods
- The Role of GIS and the Crime Analyst in Homeland Security Preparedness and Emergency Operations
- Reentry Mapping Network: Using Spatial Data to Inform Local Prisoner Reentry Efforts
- Crime Mapping and S.A.R.A in the Buenos Aires Province of Argentina

The day concluded with an international roundtable whose

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Also, feel free to contact individual Crime Mapping and Problem Analysis Laboratory staff with questions or comments.

Joe Ryan
Director

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Kevin Cozzolino
Graduate Research Associate

participants discussed common concerns and compared the successes and challenges of ongoing, crime mapping efforts being implemented in developing countries were discussed.

On Friday, April 2, the conference began with vendor exhibits and the concurrent panels followed thereafter. Some of the morning panel presentations were:

- Comprehensive Approach to County-wide Public Safety Data Sharing and Mapping Partnerships
- Routine Arrest Space of Drug Offenders,
- Seattle COMPASS Experience: Using GIS to Support Community Building
- Systematic Social Observation for Public Safety: Combining GIS, Aerial Photographs, and Video Mapping Systems (VMS) for Neighborhood Crime Analyses and Interventions

Tom Casady, Chief of the Lincoln, Nebraska, Police Department delivered the keynote luncheon address where he discussed the future of Compstat and how it has affected police departments across the country. A research and theory development panel, which was substituted for the corrections, probation and parole panel, involved several presentations including, Exploring the Use of Geographic Information for Identifying Breakdowns in Community Cohesion to Support Effective Police Responses. Other panels that were substituted in the agenda that day included:

- GIS for Policy and Program Evaluation
- GIS, Crime, and Community Organization
- Offender Travel Behavior

Examples of presentation topics in these panels were:

- Beat Redistricting for the City of Wichita
- Theory and Practice: Assessing the Capacity of Community Organizations
- Modeling Metropolitan Criminal Travel Behavior

The day concluded with a roundtable discussion about development issues in spatial crime analysis software.

On Saturday, April 3 only morning panels were scheduled, and they included two different panels than before:

- Concentrating GIS Applications at the University Level
- GRASP – A Geospatial Repository for Analysis and Safety Planning

Topics presented by the panels included:

- Challenging Place-based Theories and Methods: The Example of the Spatial Relationship between Street-level Drug Activity and Crime
- Criminal Investigative Failures
- Traffic Safety
- The Metropolitan Area Planning Council's GIS Center
- Robust Spatial Analysis of Rare Crimes

Following the morning panels, there were workshops on topics such as small unit spatial analysis, writing grant proposals, applications of census data in crime, and principles of thematic mapping. The conference ended at noon following closing remarks.

In addition to the many presentations and workshops, two pre-conference labs were held at Suffolk University on Monday and Tuesday, March 29 and 30. The labs were entitled "Crime Mapping with ArcGIS 8.x" and "Crime Mapping Tips and Tricks," and they offered training on topics such as selecting queries, tricks for cleaning data, regional data sharing, and hot spot techniques.

For further information about this conference go to the NIJ website at www.ojp.usdoj.gov/nij/maps/conferences.html.

This article was written by Greg Jones, research associate, Police Foundation Crime Mapping and Problem Analysis Laboratory. He can be contacted via e-mail at gjones@policefoundation.org.

NEXT ISSUE

The next issue of *Crime Mapping News* will be on the value of crime mapping and analysis involving gang enforcement and a summary of findings from our recent training needs assessment survey.

If you are interested in contributing to the next issue or any future issue, please contact the Crime Mapping and Problem Analysis Laboratory at:

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or
jryan@policefoundation.org

Upcoming Conferences and Training

MAY

Massachusetts Association of Crime Analysts Conference
May 17- 20
Barnstable, MA
www.macrimeanalysts.com

JUNE

CMAP Introductory Training (MapInfo)
June 7 - June 11, 2004
Denver, CO
Contact: Danielle DiGiosio
cmap@du.edu or (800) 416-8086
www.nlectc.org/cmap/CMAPApplication.html

CMAP Advanced Training
June 28 - July 2, 2004
NCTC, PA
Contact: Danielle DiGiosio
cmap@du.edu or (800) 416-8086
www.nlectc.org/cmap/cmapadvanced.html

JULY

CMAP Introductory Training (ArcGIS 8.x)
July 19 - July 23, 2004
Denver, CO
Contact: Danielle DiGiosio
cmap@du.edu or (800) 416-8086
www.nlectc.org/cmap/CMAPApplication.html

National Gang Violence Conference (CGIA/ATF)
July 20 - 23, 2004
Anaheim, CA
www.cgiaonline.org

GENERAL WEB RESOURCES FOR TRAINING SEMINARS AND CONFERENCES

http://giscenter.isu.edu/training/training.htm
http://msdisweb.missouri.edu
www.actnowinc.org
www.alphagroupcenter.com
www.cicp.org/gis.html
www.cops.usdoj.gov
www.esri.com/events
www.iaca.net/Certification/training.html
www.ialeia.org
www.ialep.org
www.mapinfo.com/events
www.nijpcs.org/upcoming.htm
www.nlectc.org/nlectcrm
www.nsgic.org NEW
www.tri-statercpi.org
www.urisa.org/meetings.htm

Early Reminder!

ESRI International User Conference
August 9 - 13, 2004
San Diego, CA
www.esri.com

Looking Ahead in 2004!!

International Association of Crime Analysts
September 8 - 11, 2004
Seattle, WA
www.iaca.org

California Crime & Intelligence Analysts Conference
September 15 - 17, 2004
Sacramento, CA
www.crimeanalyst.org

American Society of Criminology
November 17 - 20, 2004
Nashville, TN
www.asc41.com

MapInfo's MapWorld Road Show in Select Cities: Baltimore, Dallas, Chicago & San Francisco
www.mapinfo.com

International Association of Law Enforcement Planners
September 19 - 24, 2004
Chicago, IL
www.ialep.org

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The Police Foundation is a private, independent, not-for-profit organization dedicated to supporting innovation and improvement in policing through its research, technical assistance, communication, and professional services programs. Established in 1970, the foundation has conducted seminal research in police behavior, policy, and procedure, and works to transfer to local agencies the best new information about practices for dealing effectively with a range of important police operational and administrative concerns. Motivating all of the foundation's efforts is the goal of efficient, humane policing that operates within the framework of democratic principles and the highest ideals of the nation.

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This project was supported by cooperative agreement #2004-CK-WX-K003 awarded by the Office of Community Oriented Policing Services, US Department of Justice. Points of view or opinions contained in this document are those of the authors and do not necessarily represent the official position or policies of the US Department of Justice.