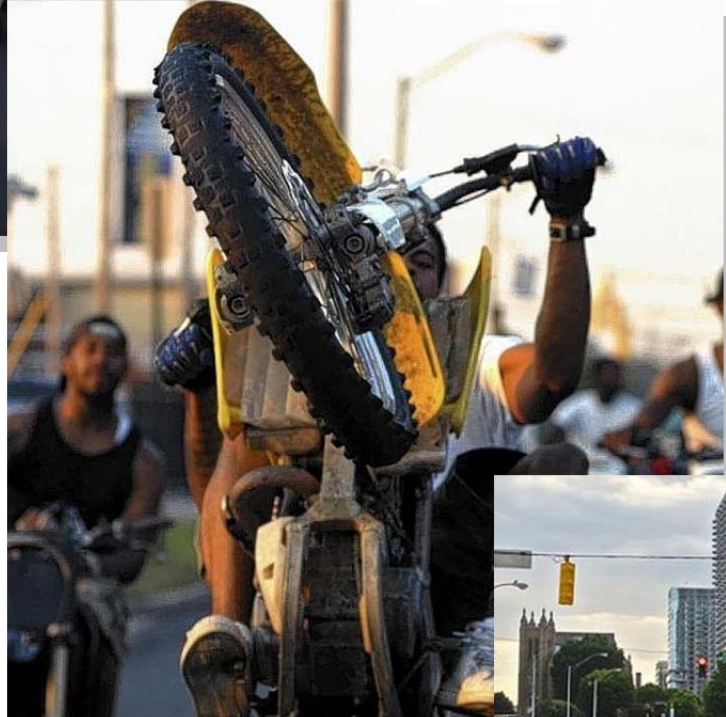


Hartford, CT



Baltimore, MD



Atlanta, GA



UConn Report on Urban Dirt Biking

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Front Cover: Hartford, CT (Rob, 2013); Baltimore, MD (Nathan et. al, 2014); Atlanta, GA (Sigala, 2014)

1. Introduction

In recent years, many cities across the U.S. have experienced problems with unlicensed all-terrain vehicles (ATVs) and dirt bikes converging on neighborhoods and staging large group rides that have overwhelmed many city streets. These group rides have led to frustration for residents and city officials and serious safety concerns as the riders of these groups often drive aggressively in heavy traffic while ignoring signage, signals and safety regulations. In large rides, it is common for participants to ride on the wrong side of the road opposing traffic at speeds in excess of the established speed limit, run red lights, and ride on sidewalks. These urban dirt bike events (UDBE) provide riders an ad-hoc venue for the performance of various stunts and tricks. This behavior poses a significant safety hazard for nearby pedestrians, other traffic and the ATV and dirt bike riders themselves. These rides also pose a significant nuisance to surrounding neighborhoods – the noise and aggressive style of many of these rides contribute to a feeling of insecurity among residents and deteriorates the quality of life of those who live in areas where these rides regularly occur.

As this report will show, UDBE are a relatively new phenomenon for most cities. With the exception of Baltimore, it was found that these large-scale events, (defined in this report as events with 10 or more unlicensed off-road vehicles participating), first occurred in most cities beginning in the mid-2000s. Since 2010, the geographic propagation of these events has grown exponentially. In 2014, UDBE were found in 19 metropolitan areas around the United States. The rapid growth in these events, coupled with the serious safety concerns that they pose has led local officials and residents grasping for an appropriate solution to the issue.

However, police and local officials have been challenged to find a meaningful and effective response to this issue for a number of reasons. First, many cities across the United States have established discouragement, or “no-chase” policies for police in making the determination to engage in a high-speed pursuit. These policies were implemented to discourage high-speed pursuits, which have historically have been found to lead to injuries and fatalities of the participants of the pursuit and bystanders alike (Charles et al. 1992). In many cities, pursuit bans have meant that riders of these events feel relatively immune to prosecution. Adding to the difficulty is the nature of organizing these events through word-of-mouth and social media, similar to “flash mobs”; which limits the scope for preparation and timely response from local officials. Lastly, the events are constituted of dozens and sometimes hundreds, of unregistered and unlicensed off-road vehicles, eliminating typical methods for tracking and detaining vehicles being operated unsafely.

This report is divided into two sections, the first section provides a background on the growth and current expanse of these Urban Dirt Bike events. This report will highlight the problem through brief case studies in Atlanta, Baltimore, and New Haven, CT. The second section focuses on identifying potential technology based approaches which are available to policymakers, urban planners and policing agencies to address the problem.

2. Framing the Problem

Urban dirt biking has expanded rapidly across the U.S. in the past decade. No data currently exists that characterizes the full extent of these activities and as such, represents the first task undertaken in support of this research. Because of the lack of formal data sources, the study team relied on popular media reports and social media as mechanisms for identifying events and estimating their size. Further, because urban dirt bike events coincide with no-chase policies, efforts were made to capture the extent of no-chase policies to highlight the correlation and provide insight into potential regions that may be ripe for future urban dirt bike events.

2.1 News and Social Media Review

The study team conducted an extensive review of all popular news and social media to establish a baseline within the literature and properly frame the problem. In order to focus the research, the study team decided to focus only on events that met the following two criteria:

1. They were to involve 10 or more off-road vehicles (typically an ATV or dirt bike);
2. The events were to occur either wholly or partially on public roadways which remained open to vehicular traffic.

These criteria were established for two reasons. First, a minimum number of riders helped ensure that these events were part of an established culture in a city, and that a city wasn't characterized as having this culture when only a single person or a few participants were involved. Second, the restriction on the location of these events pinpointed the events which were "flagged" to those of which city officials are most concerned; UDBE on public roadways and presenting significant safety concerns.

The media review was conducted in two phases. In Phase I, a search was conducted for each metropolitan area in the United States with a population of over 250,000 for the terms "[city name] dirt bike", "[city name] bike life", on Google, YouTube, and UConn Summon 2.0 (UConn Library website). "Bike Life" is an established phrase within the UDBE culture, often used to distinguish groups geographically, i.e., "Hartford Bike Life" as a handle for those interested in UDBE in the Hartford region. Cities which were found to have events following the established criteria were flagged and mined in Phase II. In Phase II, a timeline for each city was constructed to determine UDBE growth and propagation.

2.1.1 History

Urban Dirt Biking likely originated in Baltimore in the mid- 1990's. Baltimore provides the origin of the "bike life" culture and terminology. Baltimore is still today widely recognized as the "bike life capital" of the United States, and is often the site of some of the country's biggest UDBE. Over the past decade, UDBE have spread across the Northeast and mid-Atlantic regions, and today span the east coast from Norfolk, VA to Boston, MA. (UDBE spread to more cities each year from its Baltimore Origin - Figure 1). Based on popular and social media records, the spread of UDBE appears to be accelerating (Figure 1) and widening its geographic domain (Figure 2). In total, it was found that Urban Dirt Bike events have occurred in about 22 U.S. cities as of February 2015.

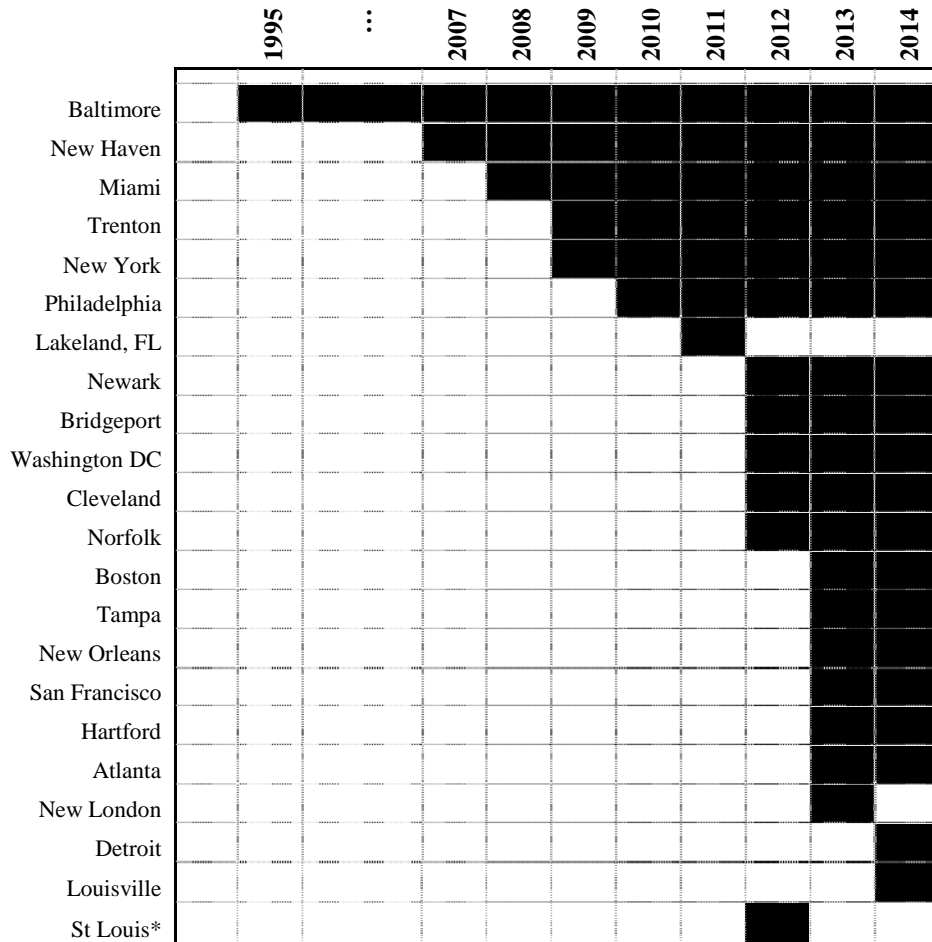


Figure 1: A timeline of UDBE in the United States

2.1.2 Geography

UDBE are often found in the Northeast and mid-Atlantic metropolitan areas. (Figures 3 & 4) Apart from the semi-continuous region from Norfolk to Boston, UDBE were found in 10 additional US cities, with most of this growth taking place since 2012 (Figures 2 & 3). In Connecticut, relevant events were found in all metropolitan areas that are wholly located within the states borders. In particular, these events were found in Hartford, New Haven, East Haven, New London, and Bridgeport. Table 1 presents the 22 cities with UDBE and the size of their maximum reported UDBE.

Table 1: Max number of riders found within the media review in this study.

Metro	Date of Max Event	Maximum # of Riders
St Louis	9/1/2012	2000
Miami	1/15/2015	300
Atlanta	9/17/2014	300
Louisville	11/20/2014	300
Philadelphia	10/26/2014	200
Baltimore	6/29/2014	125
Washington DC	9/14/2014	125
Norfolk	7/22/2014	125
New York	3/9/2014	100
Boston	8/8/2013	100
San Francisco	12/25/2014	60
New Haven	9/28/2014	50
Bridgeport	7/1/2013	50
Trenton	9/6/2010	35
Cleveland	9/15/2014	35
Hartford	7/23/2013	35
New Orleans	5/7/2013	30
Detroit	10/19/2014	30
Tampa	5/1/2013	25
Newark	12/13/2014	20
New London	10/29/2013	15
Lakeland, FL	9/3/2011	10



Figure 3: UDBE across U.S. and Metropolitan areas with 250,000 or greater population

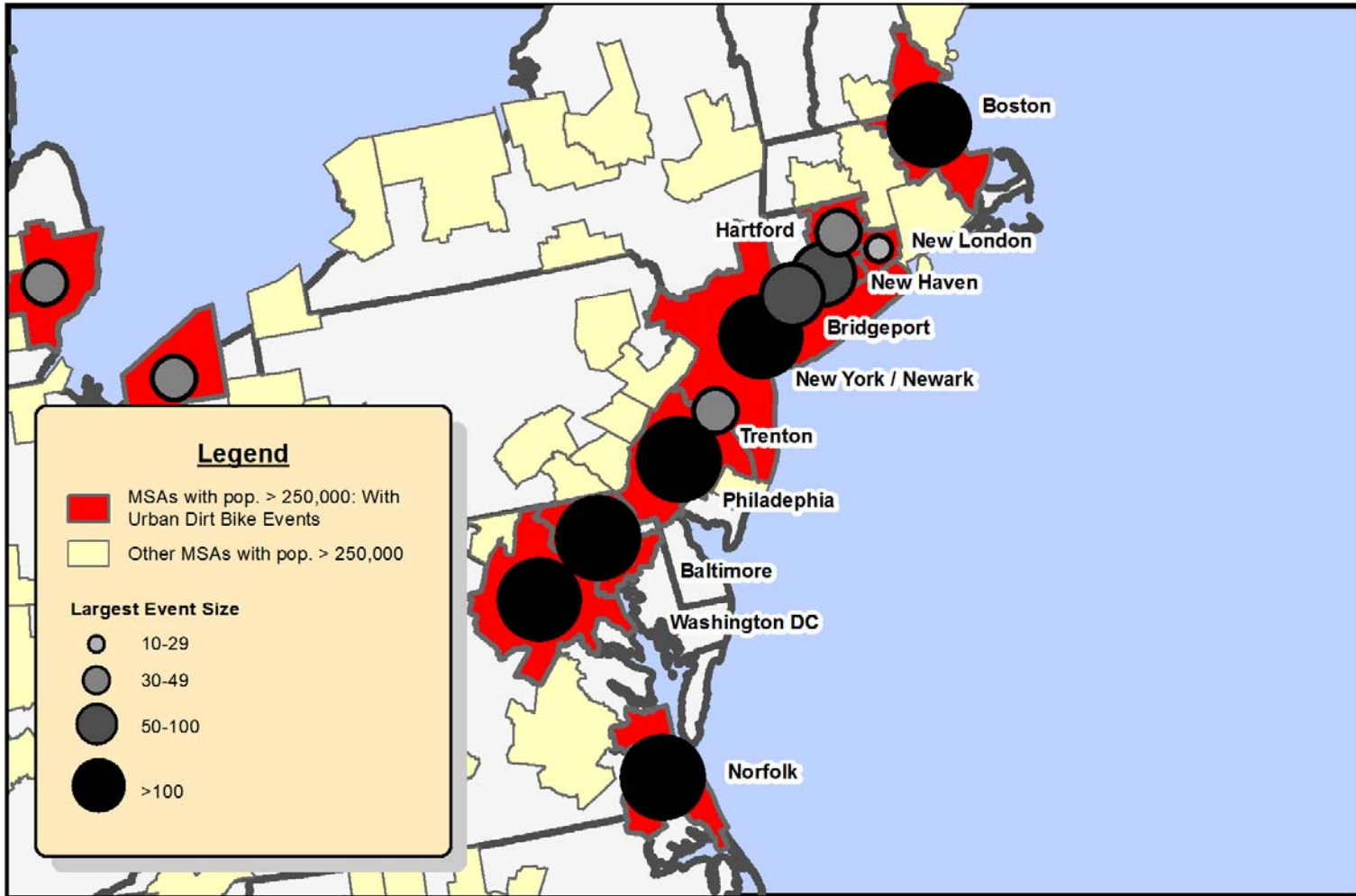


Figure 4: Geography of UDBE in Northeast U.S.

2.1.3 No-chase policies

UDBE are a product of the intersection of unlicensed vehicles (ATVs and Dirt Bikes) and pursuit discouragement (“no-chase”) policies within the police force. Many cities across the United States have established no-chase policies for police, which influence the determination to engage in a high-speed pursuit. These policies were implemented to discourage high-speed pursuits, which have historically have been found to lead to injuries and fatalities of the participants of the pursuit and bystanders alike (Charles et al. 1992). This danger increases when dealing with motorcycles, dirt bikes, and all-terrain vehicles where the operator is more exposed to external threats. The elusiveness of these smaller and more agile vehicles allow for more dangerous maneuvers to be made in pursuit situations. This added escapability requires pursuit policies to be carefully formulated to protect all parties involved. The recent statistics for Connecticut (which has a no-chase policy) suggest that this may in fact be effective, as in 2006-2007 there were only 16 pursuit-related injuries and no fatalities reported in those towns providing statistics (Rose and Cummings 2009) compared to much higher rates in Pennsylvania and California (which also have no-chase policies).

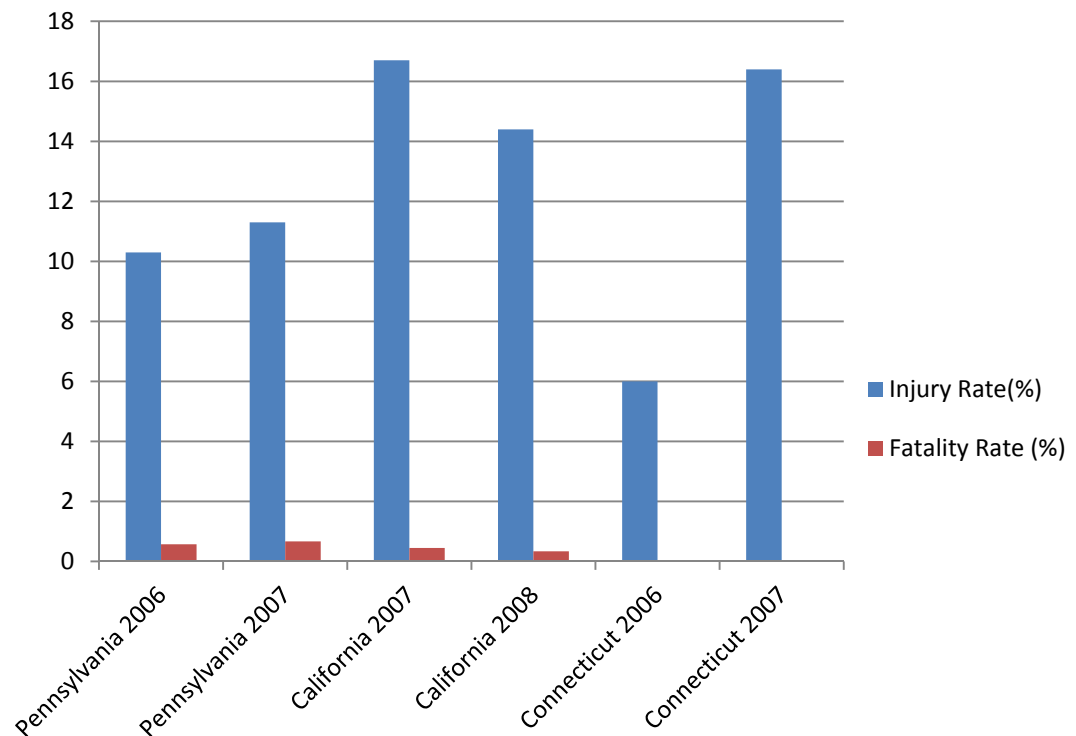


Figure 5: High-speed pursuit accident and fatality rates (adapted from Rose and Cummings 2009)

Discouragement policies and alternative pursuit policies seeking to minimize injury and fatalities are not uncommon. Hicks (2006) evaluates over 500 policies across the country to identify common elements in effective pursuit policies, which suggests that the potential for the

urban ATV problem to spread is high, as the intersection of large urban areas (Figure 3) with no-chase policies is likely to yield new locations for the spread of UDBE.

In decades past, pursuit policies were often vague. There has been a shift of pursuit policies becoming more restrictive, outlining specific procedures for officers to follow. In most cases, engaging in a pursuit requires the officer to evaluate the situation and compare the immediate danger of the situation against the danger that would come as a result of a pursuit. Often, the officer in question needs to attain permission from a supervisor to engage. Across various studies investigating police pursuits compiled by Illinois State University's Department of Criminal Justice Services in 1992, it was found that around 18 – 44% of high-speed pursuits ended in an accident, 5 – 24% end in injuries, and 1 – 3% lead to a fatality (Charles et. al 1992) These values represent all vehicles. It can be speculated that when looking at dirt bikes and ATVs, the injury and death rates may increase significantly due to the lack of protection provided by these vehicles. Charles et. al (1992) also break down fatalities reported by the National Highway Traffic Safety Administration. NHTSA reported 300 pursuit-related deaths in 1989 although evidence suggests the number may be much higher. They claim 74.3% of these deaths were occupants in the chase vehicle, 23.3% were third party victims in vehicles, 1.6% were occupants in police vehicles, and 0.6% were not operating a vehicle.

At the time of the Charles et al. report, a model policy for vehicular pursuit was developed by the IACP National Law Enforcement Policy Center (1989). This policy required pursuing officers to analyze the situation and decide whether or not there was an immediate danger to the public that outweighs the danger created by a pursuit. Secondly, pursuing officers were required to maintain effective communication with communications center personnel, constantly relaying information about the pursuit. This policy also demanded field supervisors to continually re-evaluate the situation and determine if the pursuit should be terminated. It also demands the primary officer in pursuit back off and become a secondary unit in the presence of air surveillance (Charles et. al 1992). Since then, a polished model policy was developed in 1996 which has refined definitions and minor procedural changes, such as after-action reporting, but adopts the same basic principles. These model policies are created as a template for departments to use when establishing their own pursuit policies. In 1997, a National Policy Survey was completed on 436 volunteering agencies that reports that 48% admitted to adopting to new, more restrictive pursuit policies in the last two years (Alpert 1997).

A side effect of no-chase policies is that they limit the ability of police to track and detain unsafe driving behavior during an event. This, coupled with the fact that the urban dirt bike vehicles are unlicensed limits post-event tracking of participants. These facts embolden UDBE participants, leading to an expansion of events and increasingly risky behavior.

2.1.4 Cultural Importance/Ties

Based on an analysis of reported and video testimonies of UDBE participants, many of those engaging in these events have had past trouble with the law, though this is not uniformly true. There is an element of rebellion within these groups akin to bike gangs that flourished in the 1970's and skateboarding enthusiasts in the 1980's. Riders commonly break basic traffic laws and taunt officers to engage in pursuits, mocking their limited abilities defined by the law. However, when asked about the benefits of participating in such events, the responses are much broader and nuanced.

Riders in troubled personal circumstances have only good things to say about these events – They claim the rides remove them from potentially harmful situations and suspect they would turn to drugs and participate in other illegal activities had these rides not existed. These riders also like to point out the convergence of rival groups. They acknowledge that gang members take part in what they call “bike life” but also claim that gang affiliations are abandoned when rides begin. A public hearing was held by the Board of Aldermen’s City Services and Environmental Policy Committee in New Haven in 2012 where concerned citizens as well as two 17-year old dirt bike riders, Justin and Mike, engaged in a discussion about the issue at hand. Numerous residents participated and explained their perspective, describing dangerous incidents between these riders and children, the rides disruptive and outlawish nature, as well as demands for action (Bass 2012).

The UDBE participants responded to these comments: “I see how y’all looking at it like we’re a nuisance to the community,” said one, continuing “I don’t take it like that. ... It’s just something I do. I love riding. I’ve been riding forever, since I was a little kid. I don’t do it out of spite to bother people and upset the community.” When asked if they would consider taking these rides to a designated area provided outside of the city, one participant claimed he would consider it but could not speak for the rest of the dirt bikers. The article made note of the fact that dirt bike tracks exist in Milford, a little over 10 miles from New Haven, and that law enforcement have already encouraged riders to take their hobby there. The participants acknowledged the illegality of his actions but stand firmly in their insistence that their experience is on balance positive (Bass 2012).

2.1.5 Temporal Variation

UDBE typically happen on weekends – Sundays and holidays in particular – but have occurred on every day of the week. As indicated in Figures 1 and 2, Baltimore is the origin for urban dirt biking. It acts as the geographic and cultural hub for the bike life movement. The rides have spread north and south at an accelerating pace, stretching past Philadelphia and New York City into Connecticut and also sweeping south to Miami. Since 2012, UDBE have moved westward, reaching as far as Oakland, CA. Important to note is that UDBE are not always, or even usually comprised of local riders. Members of these organized rides have been known to travel from cities up and down the east coast to participate in other cities’ rides. Cold weather does not disrupt UDBE as rides continue to happen throughout the winter.

2.2 Examples/Case Studies

2.2.1 Atlanta

Atlanta is a city relatively new to UDBE, with reports and articles dating back only to early 2013. However, Atlanta has already experienced frequent, large-scale rides, with hundreds of participants traveling from surrounding cities. The frequency of organized rides can be as high as several times per month, with documented evidence across many YouTube channels.

Atlanta adopted an extensive Standard Operating Procedure for vehicular pursuits in 2004 that defines the roles and responsibilities of each officer involved. As defined, two conditions must be met for an officer to engage in pursuit. The primary and secondary units must

have functioning blue lights, be marked as an official vehicle, and have working sirens whistles, and bells. Secondly, the pursuit is justified when the suspect possesses a deadly weapon, when the officer believes the suspect poses an immediate threat of physical violence, or “when there is probable cause to believe the suspect has committed a crime involving the infliction or threatened infliction of serious physical harm.” Supervisors must then confirm and continually reconfirm the justification for pursuit (Atlanta Police Department SOP 3050).



Figure 6: Atlanta UDBE Sunday, 8/17/2014, Source: Milligan et al. (2014)

A large event on 8/17/14 is depicted in Figure 6. Several hundred people on dirt bikes and all-terrain vehicles participate in an UDBE throughout the streets of Atlanta near Pittman Park. Riders disobeyed traffic laws and many reports were given by bystanders reporting dangerous behavior including an accident between ATVs and dirt bikes. The incident caused riders to divert towards the sidewalks, extending the danger to pedestrians walking nearby. In a recorded video found on YouTube of this event, an Atlanta Police Department car was spotted in proximity of the event but not engaging the riders, presumably providing escort and supervision.

In October 2013, Article III of Chapter 150 of the City of Atlanta Code of Ordinances made it “unlawful for anyone to operate an ATV or off road vehicle, as defined in this Chapter, on any city sidewalk, city park, city trail, city shared multi-use path, city bicycle path, city recreation facility, and all other city property.” The new Code of Ordinance also deemed it unlawful for anyone to operate an ATV or off road vehicle in the public right-of-way residential zoning districts and forced ATV and off road vehicles to follow the city’s noise ordinance. A man claiming to have participated in the ride on August 17th, 2014 admitted to CBS of the riders’ knowledge of the illegality of their actions. In a phone call, the anonymous man claimed the ride was in protest of this new legislation, specifically the section defined above restricting ATV and off road vehicle use in an urban setting. He claimed social media sites such as Facebook are the primary means of communication for organizing events such as these. He also predicted future events with the assistance of out-of-state riders to increase their numbers. Lastly, the man claimed that “the group just wants the community to come to an understanding over the use of these off-road machines” (Milligan et al. 2014)

2.2.2 Baltimore

Baltimore is the geographic and cultural hub for UDBE. It has been the location of several large scale events hosting riders that travel from cities along the east coast and acts as the home for the 12 o'clock boys, the best-known urban dirt bike group – which maintains its own website (<http://www.12oclockboys.com/>) and has been the subject of a documentary film. In this context, 12 o'clock refers to a perfectly vertical dirt bike wheelie, as the degree of verticality evidences the riders stunt proficiency. This documentary follows Pug, a young teen with an obsession over the 12 o'clock boys and the thrill that comes with these rides as he aspires to join the group when he's older.

Baltimore's pursuit policy, General Order 11-90, established in 1990 and titled the "Departmental Emergency Vehicle Operation", outlaws chases except in cases where immediate action is deemed necessary and "failure to pursue may result in grave injury or death" or there is "inefficient time to resort to other alternatives" (Bell et al. 2006). Baltimore's pursuit policy discourages officers in engaging in pursuits unless a major crime has been committed. Instead, officers are urged to get a tag number for the vehicle or let a police helicopter to monitor the situation from above. When a pursuit is necessary, it is followed by a supervisor and can be called off any time the supervisor deems the danger to be too high. Baltimore police officers typically support the efficacy of these policies in reducing pursuit-related incidents (The Oklahoman 2005).



Figure 7: End result of Baltimore UDBE 11/23/14, (George 2014)

An incident in November 2014 reported in *The Baltimore Sun* (George 2014) highlights to danger of UDBE and police pursuits. Upon sight of a group of dirt bike riders gathering in a nearby alley, a police unit initiated a pursuit. One rider fled on foot while the others escaped on their dirt bikes. The runner was picked up on an adjacent street by a friend riding a moped. After initiating the pursuit, officers in the area lost sight of the riders multiple times. Three officers nearby spotted the scooter, this time with only one rider and began another pursuit.

Baltimore's pursuit policy discourages any pursuit unless a supervising shift commander deems that the subjects in question are of immediate threat to the public. At this point in the pursuit, the supervising sergeant told the initial patrol car along with a second unit that had joined the chase to discontinue the pursuit for safety reasons. Fifteen seconds following this order, the police officers in pursuit called for paramedics.

As a result of the pursuit, the patrol car containing three officers crashed into a telephone pole after the moped made a sharp turn into an alley (Figure 7). The three officers as well as the scooter rider were seriously injured in the crash.

The use of dirt bikes in the city of Baltimore is illegal. However, the scooter operator was never seen using a dirt bike and the scooter was a licensed city vehicle. The only violation in this case was fleeing the police, but the police decided to not charge the rider. The police are investigating why the order to stop the pursuit was disobeyed as well as why there were three officers in one patrol car (George 2014).

2.2.3 New Haven, CT

Nine people were arrested the week of Friday June 7, 2013 to add to the six formerly arrested in the 10 week sting operation called "Operation Bike Life" in New Haven, CT. This operation signifies a change in the approach of police in apprehending illegal dirt bikers. Here, instead of chasing dirt bikers, police drove around in unmarked cars filming the UDBE participants, capturing information used post-event to track and target the participants. In a stark demonstration of some participants' desired for rebellion, officers reported that on one of the group's first day of videotaping, bikers surrounded their van, spitting, kicking, and throwing rocks at the van. The video evidence from these rides was compared with social media to create a database full of names, addresses, photos, and other information relating to individual riders.



Figure 8: Impounded New Haven UDBE vehicles, (MacMillan 2013)

Since 2013, Connecticut state law has increased penalty fines to \$1,000, \$1,500, and \$2,000 for first, second, and third offenses. In the weeks after Operation Bike Life, 15 arrests were made on 18 warrants with expectations of more arrests upon further investigation into the evidence (MacMillan 2013).

3. Technology Based Solutions

The second purpose of this study is to identify potential technology based solutions for mitigating the problems posed by UDBE. The technologies presented in this section were collected from historical review of UDBE, internet searches and interviews with technology domain experts at the University of Connecticut in Spring 2015. The potential solutions were not evaluated based on their cost, feasibility to implement, or on a legal or ethical basis but only on their potential to provide a technical solution to the problem. Further review by law enforcement officials is needed to evaluate these factors and identify and implement optimal approaches.

To organize the wide variety of approaches, the potential solutions were divided into their deployment phase (before, during or after a UDBE) and strategy classification (tracking, reporting, data mining, urban design, policy and miscellaneous).

Before an Event:

The primary focus of the strategies employed by police forces today is to try to prevent a UDBE before it happens. There are numerous technical, ethical and practical issues that surface during and after UDBE that make prevention a highly desirable goal. Examples of prevention strategies include engaging the community in reporting UDBE activities and monitoring social media sites used by UDBE organizers. Monitoring social media sites can provide information on the locations and times of UDBE. Although the most relevant feeds and pages are not always publically accessible, social media is often used to organize riders – making it a valuable prevention tool.

During an Event:

Responding during an event presents the greatest number of safety challenges from the UDBE participants' actions and toward their apprehension. No-chase policies also often limit the strategies that are available for police to employ during an event. Police have most often taken the approach of containment. Most technologies presented in this report reflect this tendency. Not surprisingly, in light of no-pursuit policies along with the public's safety, police have been known to be present at events but not engage. With this approach, rides can be monitored and kept in check while avoiding conflicts and encouraging riders to perform even more reckless evasive maneuvers. Helicopters can be used to monitor the movement of the riders. Once the helicopter has locked onto a rider's position, patrol cars have been known to back off and leave the pursuit up to the helicopter. Once the rider has reached his destination, the location is communicated to the officers on the ground and the necessary actions for detention are taken.

After an Event

Post event strategies are used to gather information on the UDBE participants and track them after the fact. This strategy was successfully deployed by the New Haven police in 2013. Participants can often be identified from posts made online by the participants themselves or through undercover operations similar to those used in New Haven.

3.1 Solutions Based on Existing Technologies

Table 2 provides a list of potential solutions based on existing technologies that are commercially available along with their implementation phase and strategy. These commercial products were not necessarily developed to address the problem of UDBE but have the potential to be adapted specifically for this purpose. Additional discussion with the manufacturers and law enforcement officials would be needed as a next step in pursuing these solutions. A brief description of each potential solution is provided along with resources for additional information.

Table 2: Potential Solutions Based on Existing Technologies	Strategy	Phase
Datatag MASTER Scheme	Tracking	Before Event
SeeClickFix	Reporting	Before Event
Geofeedia and BlueJay	Identification	Before Event
StarChase GPS	Tracking	During Event
HPEMS Immobilizer	Immobilization	During Event
Foam Vehicle Arrest System	Immobilization	During Event
X-Net and Pit-Bul Vehicle Arrest System	Immobilization	During Event
Nighthawk Tire Deflation Device	Immobilization	During Event
Datatag MASTER Scheme	Tracking	After Event
SeeClickFix	Reporting	After Event
Geofeedia and BlueJay	Identification	After Event

Datatag MASTER Scheme

Policemen from Baltimore claim that 29% of all dirt bikes that are seized were stolen (Shen 2013). The Datatag MASTER Scheme (or Motorcycle and Scooter Tagged Equipment Register) is an anti-theft system for motorcycles that's gaining popularity in the UK and has been backed by police and top motorcycle companies. Motorcycle companies recognize that sales of their products will increase if the risk of theft is addressed and therefore have been united in implementing the data tagging scheme.

There are four elements to this security system. The first is called Stealth Etching which is an identification system that can be applied to a dirt bike's part that can only be seen under ultra-violet light. The second element is called the Glasstag Transponder. This piece is a small identification beacon which can also be applied to numerous places on the bike that would need specialized equipment for access. The third element is Datadots. These pieces are microdots readable with a strong magnifying tool that are tagged to a specific serial code and can be hidden anywhere on the bike, having a low probability of being detected. The last element is tamper-proof stickers that have a unique ID number tracing back to the owner (Tibu 2013).

Although these technologies have been principally developed to deter theft, it is reasonable to believe that these technologies could be adapted to prevent urban dirt biking by providing advanced identification and location capabilities. A united effort by dirt bike manufacturers would be required to implement this strategy. This may be possible since UDBE

generally reflect poorly on their products. In general, a solution provided by dirt bike and ATV manufacturers is attractive.

Additional information about Datatag MASTER Scheme is available at the following website:
<http://masterscheme.org>

SeeClickFix

SeeClickFix is an internet based tool that allows citizens to report non-emergency issues to local government officials through mobile phone apps. Although originally conceived to report issues related to infrastructure, such as potholes, it is quite easy to imagine adapting the technology to address UDBE through enhanced reporting and response. In addition to providing a mobile phone app for citizens, the SeeClickFix also provides tools for officials to manage the incoming reports, route and assign tasks, establish a searchable knowledge base on subjects, and send out geographically targeted messages to citizens. In the context of UDBE, SeeClickFix has the potential to significantly enhance UDBE reporting activities as part of a community engagement strategy. SeeClickFix is a Connecticut based company with headquarters in New Haven.

Additional information about SeeClickFix is available at the following website:
<http://gov.seeclickfix.com/>

Geofeedia and BlueJay:

Since social media plays an important part in organizing and publicizing urban dirt bike events, technology that has the capability to gather information posted to the public can be highly beneficial before, during and after a UDBE. There are multiple programs that have the ability to search across many social media platforms and filter the results based on search criteria.

One of those programs, Geofeedia, filters social media posts based on geographic location. It is, however, limited to only posts tagged with their geographic location. Users of this program can draw custom perimeters around any location and view social media posts in that area as well as use a record function to document any posts for an extended period of time to be reviewed later. These types of programs give structure and efficiency to filtering through endless amounts of social media posts.

BlueJay is a similar platform that filter posts made on twitter based on keyword searches, geographic location, and can go into user-specific activity. BlueJay has access to the twitter firehose. In normal twitter searches, users are limited to what they can find. The firehose grants access to any and all twitter posts related to the filter. The normal twitter interface, API (or Application Programming Interface) can provide a range of related posts within 1-40% of the range of posts the firehose provides.

Additional information about Geofeedia is available at the following website:
<https://geofeedia.com/>

Additional information about BlueJay is available at the following website:
<http://brightplanet.com/bluejay/>

StarChase GPS:

The StarChase GPS system is a compressed-air launcher, mounted behind the grille of a police cruiser that uses a laser to target the fleeing vehicle. It then deploys a GPS tag onto the targeted vehicle. The officers can then fall back and receive vehicle coordinates to track the vehicle in real time. This tool was designed to counter the limitations created by restrictive no-pursuit policies. Starchase claims to have an average time of 1 minute and 45 seconds until the suspect slows down within 10 mph of the speed limit and an 80% apprehension rate. The launching device and GPS unit for the existing StarChase GPS system would need to be significantly redesigned to apply to the UDBE problem.

Additional information about StarChase GPS is available at the following website:
www.starchase.com

High Power Electromagnetic System (HPEMS) Immobilizer

A product called the High-Power Electromagnetic System (HPEMS) Immobilizer has been developed to stop vehicles by disabling their electronic control system to disrupt the engine using a high-powered electromagnetic pulse. The electromagnetic pulse is deployed through a high-gain antenna which operates under a given frequency and aperture, ensuring that the electromagnetic system is applied to the target vehicle only. This system is portable and lightweight, can be mounted on a variety of platforms and can be located at a large distance from the target vehicle.

Additional information about the HPEMS Immobilizer is available at the following website:
<http://www.ibssigma.com/en/products/eureka-aerospace-high-power-electromagnetic-system-hpems-immobilizer>

Foam Vehicle Arresting System (FVAS)

A Foam Vehicle Arresting System (FVAS) is a concept that is currently under development by the Army for rapidly deploying polymeric foam within a vehicle to arrest its motion. FVAS are currently capable of generating several cubic meters of high-strength foam that can plug all engine intakes and disrupt the steering process, eventually absorbing all energy from the vehicle and bringing it to a stop (Gosau 2008).

X-Net and PitBUL Vehicle Arrest Systems

The X-Net is a vehicle arrest system being used by the US and UK defense departments. It is a portable, deployable system that contains small spikes connected to a net that puncture the tire of any vehicle passing over it. As the vehicle continues, the net wraps tightly around the wheel, bringing the vehicle to a rapid stop (Blain 2007). The PitBUL (or Pit-Ballistic Undercarriage Lanyard) is a similar system concealed by a speed bump. These speed bumps can be made active remotely from a distance of 300 feet. This system also deploys a net that tangles

up the wheels of a vehicle, bringing it to a stop (Pacific Scientific Energetic Materials Company: Pit-BUL).

Additional information about the X-Net Vehicle Arrest System is available at the following website: <http://www.qinetiq.com/services-products/survivability/infrastructure-and-base-protection/Pages/x-net.aspx>

Nighthawk Tire Deflation System

The Nighthawk Tire Deflation System is an alternative to the traditional hand-thrown spike strip systems that are used to puncture and deflate vehicle tires. Nighthawk is a remotely deployed and retracting spike strip technology that removes the human element from the operation. The system can be deployed, executed, and retracted in around five seconds, has the element of surprise, and has Spike Strip Technology that leaves no residual debris on the roadway (Pacific Scientific Energetic Materials Company).

Additional information about the Nighthawk Tire Deflation System is available at the following website: <http://psemc.com/industries-we-serve/law-enforcement/nighthawk-r/>

3.2 Solutions Based on New Technologies

In addition to identifying existing technologies that could be adapted to address the UDBE problem, fourteen UConn faculty members from various disciplines were asked to provide ideas on new and emerging technologies that could provide potential advancements and solutions. These ideas should be reviewed by law enforcement officials in terms of practicality and favorability of their implementation. For those deemed favorable, the development and design of a prototype device and engagement of a commercial partner would be the required next steps. Depending on the proposed technology, these steps could be relatively quick and straightforward or require a significant amount of time and investment. A summary of these concepts along with their implementation phase and strategy is given in Table 3.

Table 3: Potential Solutions Based on New Technologies	Strategy	Phase
Data Mining and Data Analytics	Identification	Before Event
Deterrent Spray, Paint or Foam	Deterrent and Identification	During Event
Unmanned Aerial Vehicles (UAVs)	Tracking	During Event
Acoustic Sensing	Tracking	During Event
Chemical Sensing	Identification	After Event
Facial Recognition	Identification	After Event
Data Mining and Data Analytics	Identification	After Event

Deterrent Spray, Paint or Foam

Sprays, paints or foams dispersed on vehicles and riders during an urban dirt bike event could serve as a significant deterrent to participation in these activities. These would include foul-smelling sprays/liquids and difficult to remove paints and foams. Appropriate means of dispersing these deterrents would also need to be selected. Possibilities include devices similar to paint ball guns and high power precision water guns. This strategy could also serve as a highly effective means to identify UDBE participants after participating in one of these events.

Unmanned Aerial Vehicles (UAVs)

Unmanned Aerial Vehicles (UAVs) have strong potential to provide useful functionality during a UDBE. UAVs equipped with high precision optical devices could be deployed to record high quality video that would be used for identifying participants in the UDBE. Alternately, UAVs could be used to deploy sprays, paints or foams used as a deterrent. Currently, there are numerous regulations restricting the use of UAVs in cities that would need to be addressed to employ this approach.

Acoustic Sensing

The noise produced by ATV and dirt bikes is quite different than that produced by cars and trucks. This fact could be used as a basis of a tracking system that worked within a larger unmanned smart identification or deterrent system. Acoustic sensors could be deployed as a static network over key areas of the city or could be incorporated into the tracking systems of UAVs. Tracking algorithms for these systems are well developed. Once an ATV or dirt bike is detected then additional actions could be taken. This could include activating optical devices to record video for identification, deploying a deterrent such as a paint ball or activating a vehicle arresting device. The importance of the acoustic sensing is that the system could be widely distributed, unmanned and automated.

Chemical Sensing

Just as individuals are screened for traces of explosive chemicals at airports, individuals participating in UDBE could be marked with benign highly traceable chemicals then identified with chemical sensing equipment. Details of such a system would need to be developed which would include the types of chemical markers to be used and how the markers are dispersed on individuals during a UDBE. Details of the sensing system would be more complex. The sensing system could be designed as a static distributed network of sensors or be implemented manually by individuals carrying chemical sensors. Sensitivity of the sensors and their range of application would control the nature of the design.

Facial Recognition

Facial recognition systems are an emerging technology area that has strong applications for identification of individuals participating in illegal activities. In the case of UDBE, facial recognition could be used to create a digital record of individuals who have participated in these

events. This record could then be used as evidence against those individuals when they are apprehended at a later date. As previously discussed, the data for facial recognition could be collected from UAVs or optical sensors distributed in a static sensor network triggered by acoustic sensors.

Data Mining and Data Analytics

Data mining and data analytics refers to the processing of large amounts of data to extract useful information and patterns that can be utilized to better understand behavior within complex systems. In the context of UDBE, an important source of data is social media. There are new methods being developed that will allow for identification of geographical location for posts that are not geotagged. This is important because only about 1% of social media is geotagged. Data mining also allows for the identification of connectivity between users. Through data analytics, it is possible to study patterns of past events and use this information to predict upcoming events.

4. Conclusions

The occurrence of Urban Dirt Bike Events (UDBE) in the United States has increased significantly with major events occurring in 22 U.S. cities within the last decade. UDBE are large-scale and organized events typically involving over ten and up to several hundred riders engaged in unsafe, threatening and illegal operation of ATVs and dirt bikes on cities streets and neighborhoods. Law enforcement officials face significant challenges in addressing this problem which include established “no-chase” policies which dictate conditions for police to engage in high speed chases; the high maneuverability of ATVs and dirt bikes; and the inherent danger associated with high speed chases.

There are a variety of distinct approaches that could be pursued to address the problem of UDBE. These include development of new policies and regulations for these vehicles as well as other sociological approaches. The focus of this report has been to evaluate potential solutions based on existing and new technologies. The technologies were evaluated solely on their potential to address the UDBE challenge. Other issues, such as cost, practicality, legal and ethical issues, were not considered at this point.

The study identified 8 existing technologies that could potentially be adapted to address the UDBE problem. In these cases, commercial products already exist and the ability to use these products immediately or readily adapt them is promising. Additionally, 6 new technologies were proposed by UConn faculty. Although conceptually promising, these technologies are generally less developed and would require further development to be implemented.

The wide variety of technologies identified in this study address different aspects of the problem including approaches to be used before, during or after an UDBE. The strategies associated with the various technology-based approaches include prevention of UDBE, enhanced reporting of UDBE activities, deterrents to participation, immobilization of vehicles, and enhanced tracking and identification of participants. As a next step in the potential implementation of these technologies, it is recommended that these concepts are vetted by city officials and law enforcement personnel to consider additional issues associated with the proposed solution approaches.

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