Green Criminology and the Reconceptualization of School Violence: Comparing Green School Violence and Traditional Forms of School Violence for School Children

Kimberly L. Barrett (a)
Sociology, Anthropology and Criminology Department
Eastern Michigan University
KBarret7@emich.edu

Michael J. Lynch
Department of Criminology
University of South Florida
mjlynch@usf.edu

Paul B. Stretesky[b]
Social Sciences and Languages
Northumbria University
paul.stretesky@northumbria.ac.uk

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(a) Corresponding author. Sociology, Anthropology and Criminology Department, Eastern Michigan University, 712 Pray-Harrold, Ypsilanti, MI 48197, USA

Abstract School crime and violence continue to be important topics of criminological inquiry. Forms of violence that have received much attention from criminologists include school gun violence, assaults, and bullying. What appears missing from criminological studies are analyses of different forms of violent victimization imposed on school children related to environmental injustice, pollution, and exposure to toxins. In this article, we argue for the interpretation of these harms as violent victimizations. To facilitate this, we draw upon definitions of violent victimization developed in green criminology, conceptualizing exposure to environmental toxins as violent assault, and introduce the term green school violence (GSV). Next, we draw upon the medical, environmental, and public health literature to offer a series of examples of GSV in the United States, discuss numerous environmental hazards present in American schools, and describe their scope and severity. A conservative estimate of the frequency of GSV suggests that far more school children are victimized by GSV than forms of interpersonal acts of violence.

*Keywords***:** Green Crime; Green Criminology; Public Health; Schools; School Violence

Introduction

Criminologists have long been interested in the topic of school violence. This interest was further stimulated by a series of widely publicized acts of violence in schools over the past two decades (Klein, 2012). Criminologists have, however, tended to interpret school violence narrowly by focusing on individual acts of physical force (Klein, 2012). These individual acts of violence represent the kinds of acts that criminologists have long studied, and that call attention to the individual context of violence. Omitted from this conceptualization of violence are other forms of mass victimization school children routinely suffer. Those forms of violence are, for example, a consequence of the structural locations of schools near toxic waste sites and polluting industrial facilities (Stretesky & Lynch, 2002), include defects in school architecture that expose students to physical structures that create violent environmental exposures to indoor toxins, and the chemical solutions used within schools and on school grounds that elevate the level of harmful environmental chemicals to which school aged children are exposed. Economically disadvantaged schools, and schools with large percentages of racial and ethnic minority students appear especially vulnerable to these harms (Green et al., 2005; Pastor, Sadd, & Morello-Frosch, 2002).

The problem of toxic exposure in schools is no small concern, as we shall demonstrate in this article. As Neal (2008) notes, racial and class based segregation plays an important role in structuring the kinds of school environments in which children spend significant portions of their time. The issue of exposure to environmental toxins in school is a focus of medical research (Powell & Stewart, 2001) because of the adverse health and learning consequences of exposure to environmental toxins in schools (Legot et al.,

2011). A variety of toxins are found in schools (Herrick et al., 2004; Herrick, 2010). The appearance of these environmental toxins in schools has also long been recognized as important because research indicates that some toxins impact child behavior and learning (Marlowe et al., 1985).

Given the importance of and widespread exposure to environmental toxins in schools, we examine children's exposure to environmental toxins in schools as a form of environmental victimization that is currently omitted from the criminological literature. We argue that due to the scope, severity, and unequal distribution of environmental toxins in and around schools, these exposures should be examined as a form of school violence. In doing so, our approach to treating school children's exposure to environmental toxins in schools as a form of school violence is informed by research related to green criminology (Lynch & Stretesky, 2002; White, 2007). This green criminological perspective on school violence challenges the conceptualization of school violence as comprised of the forms of one-on-one crimes criminologists have traditionally studied when examining crime (for critique see, Reiman & Leighton, 2012). In contrast to this traditional conception of violence, we argue that school children are exposed to a wide variety of violence, including environmental injustices, that originate with exposure to environmental toxins within the internal environment of school settings and the broader environment external to schools. These exposures should be considered "green violence" produced by human manipulation of the environment.

In addition to defining children's exposure to environmental toxins in school settings as a form of school violence and children as green victims of these crimes, we address the potential scope of green school violence and its relationship to forms of one-

on-one school violence criminologists traditionally address. We do so by comparing estimates of one-on-one forms of school violence (e.g., assault, etc.) to victimization estimates for green school violence or environmental exposure rates for children in U.S. schools.

Defining School Violence

A single, uniform definition of school violence has not been formally agreed upon by criminologists. However, criminologists specializing in violence and delinquency have offered various definitions of school violence. In a study exploring gender and school violence, Danner and Carmody (2001) state, "'school violence' refers to violence that occurs in or around K-12 schools," (p. 92) [1]. In their edited volume, "*Violence in American Schools: A New Perspective*," Elliott, Hamburg, and Williams (1998) provide the following definition of school violence that was agreed upon by contributors: "Violence refers to the threat or use of physical force with the intention of causing physical injury, damage, or intimidation of another person," (p. 13). Elliott et al. (1998) state an expressed focus on interpersonal acts of violence. The authors go on to provide examples of violence, which include hitting, shoving, or pushing another person with intent to harm or intimidate. Elliott et al.'s definition of school violence has been described as a guiding framework for criminological research on school violence, and also for school violence data collection initiatives (Danner & Carmody, 2001).

According to Addington (2009), the definition of school violence has changed over time. Specifically, Addington (2009) states that the earliest definition of school violence focused heavily on assaults and/or robberies, but by contrast, more

contemporary definitions of school violence encompass a spectrum of behaviors, ranging in severity from verbal threats to lethal assaults. Critiques by Henry (2000; 2009) have called attention to a need for criminologists to further explore the role of power dynamics in school violence, including the need to move beyond strictly interpersonal acts of school violence.

School Violence Research

Interest in school based violence increased dramatically in response to well-known school violence incidents such as the school shootings at Pearl High School (Pearl, Mississippi, October, 1997), Thurston High School (Springfield, Oregon, May, 1998), Columbine High School (Littleton, Colorado, April, 1999), and Heritage High School (Conyers, Georgia, May, 1999). Criminologists have conducted empirical examinations of school crime, including applications of mainstream criminological theories in an effort to elucidate violent school victimization (Stewart, 2003; Welsh, Greene, & Jenkins, 1999; Wilcox et al., 2005). Dependent variables in these and other school violence studies include aggressive behaviors and physical attacks between students (Brezina, Piquero, & Mazzerolle, 2001; Ousey, Wilcox, & Brummel, 2008; Payne, Gottfredson, & Gottfredson, 2003; Schreck, Miller, & Gibson, 2003; Wilcox, Tillyer, & Fisher, 2009; Wynne & Joo, 2011), student weapon carrying (Brown & Benedict, 2004; Wilcox & Clayton, 2001), sexual assault and harassment victimization (Tillyer, Gialopsos, & Wilcox, 2013), and threat of injury by someone at school (Augustine et al., 2002). A similar pattern emerges among studies pertaining to bullying-- a particular form of school violence that gained increased attention from researchers and practitioners following recent high profile bullying related suicides and other tragedies.

Dependent variables in these studies include forms of physical, emotional, and relational aggression (Cullen et al., 2008; Moon, Hwang, & McCluskey, 2011; Patchin & Hinduja, 2011).

The periodic reoccurrence of school violence events has led to costly and expansive national policy campaigns designed to reduce school violence (Klein, 2012). The *No Child Left Behind's Safe and Drug-Free Schools and Communities Act* [2] permitted federal spending of up to $3.8 billion total on drug and violence prevention initiatives from 2002 through 2007. In 2009-2010 across all 98,817 U.S. public schools, 91.7% control or monitor building access during school hours, 5.2% implement random metal detector checks, and 12.1% conduct random sweeps for contraband, in efforts to promote student safety and security (Robers, Zhang, & Truman, 2012). The percentage of schools using security cameras has tripled from 19.4% in 1999 to 61.1% in 2009 (Robers, et al., 2012). Many schools also began implementing zero-tolerance policies, imposing harsh school discipline (e.g., justice system referral, suspension, expulsion) in response to student misconduct. A number of criminologists have called into question the effectiveness of these initiatives, and have critiqued the consequences of zero tolerance policies and school security initiatives (see, for example: Addington, 2009; Bracy, 2011; Hirschfield, 2008; Kupchik, 2010).

What several critics of zero-tolerance and growing school security initiatives have noted is that while there is much interest in school violence, paradoxically, violent interpersonal victimization in schools is relatively rare (Dinkes, Kemp, & Baum, 2009; Robers, Kemp, & Truman, 2013), and significant decreases in both physical and emotional school bullying have been reported (Finkelhor et al., 2010; Rigby & Smith,

2011). In 2008, less than 15% of students reported being the victim of physical bullying (Finkelhor et al., 2010), and in 2009, 1% of students age 12-18 self-reported violent victimization in school (Robers et al., 2012).

To be sure, understanding these issues represents an important area of criminological study. However, in replicating the traditional criminological focus on on-on-one harms, school violence research has overlooked and ignored the widespread forms of violence which affects school aged children that results from their exposure to environmental toxins, hazards and pollutants founds within the immediate context of school settings and in the broader local environments in which schools are embedded.

The exposure of school aged children during the school day to environmental hazards possess the potential to harm broad cross sections of school children, and produce a large number of small yet important incidents of violent environmental toxin exposures, or what we call here green school violence (GSV). GSV incidents impact students biologically by exposing them to environmental toxins, and each of these acts can therefore be considered as the equivalent of an assault. We selected the term "green school violence" specifically to emphasize that the concern with the victimization of children from environmental hazards within schools is a green issue derived from green criminology. That emphasis implies the need to address how the green victimization of children in schools is produced by political economic, class, and race relationships found within society. In contrast, the alternative, "environmental school violence" ignores how the structure of society influences the victimization of children in school setting in relation to how green hazards are distributed within society along race and class lines. Moreover, the term "green," in contrast to the

term "environmental" shows a commitment to social justice issues that are of importance to green, radical and critical criminology, but not necessarily to the field of criminology more generally. While some may prefer the term "environmental school violence," the term "green school violence" makes a social justice commitment to addressing the ways in which the political economic structure of society unnecessarily exposed school-age children to green forms of violence.

Background: Green Criminology

Green criminology, introduced more than two decades ago (Lynch, 1990), is a growing and vibrant area of specialization within criminology that examines environmental harms and their scope, distribution, control and consequences for humans, non-humans species and the ecosystem and its components. Originally defined as the study of how political economic relations and conditions promote green crimes and harms by affecting the definition and forms of law and social control and the production and distribution of toxic wastes, pollution and hazards (Lynch, 1990), green criminology has been expanded in a variety of directions over the past two decades (Lynch & Stretesky, 2014; South & Brisman, 2014; White & Heckenberg, 2014). The current literature on green criminology includes theoretical, qualitative and quantitative studies of the causes, consequences and control of green harms and crimes. These studies range, for example, from examinations of food crimes and the genetic modification of foods and agricultural chemicals and productions (Walters, 2004, 2006, 2007, 2011), to the study of harms against non-human animals (Beirne, 1995, 1997, 1999, 2002; Nurse, 2013; Sollund, 2011), illegal trade and transnational environmental crimes (Bisschop, 2012; South & Wyatt, 2007; Wyatt, 2013), issues related to environmental justice (Lynch,

Stretesky & Burns, 2004; Stretesky & Lynch, 2011, 2002), environmental crime, law and social control (Burns, Lynch & Stretesky, 2008), specific issues such as global warming (Agnew, 2012; Lynch, Burns & Stretesky, 2010; White, 2012), and numerous case studies of specific examples of green crimes. Green criminology seeks to expand the scope of criminology by drawing attention to green acts of violence that have traditionally been omitted from the criminological literature. Green criminology builds on observations in the scientific literature outside of criminology for both its inspiration and empirical basis for identifying harm, and as such, green criminologists explore environmental harms that are explicitly defined as illegal by criminal laws, as well as harms that are technically lawful, but certainly damaging (White & Heckenburg, 2014). The disciplines that green criminology draws on in this regard include epidemiology, the medical literature, geography, sociology, and political and environmental sciences (Lynch & Stretesky, 2011).

It is important to note that green criminology has been described as a perspective rather than a theory, and there is not a unified "theory" of green criminology (White, 2008). However, green criminologists have discussed various causes of environmental crimes, and the meanings of environmental crimes (for elaboration see Brisman, 2014). According to White and Heckenberg (2014):

> "For many green criminologists the biggest threat to environmental rights, ecological justice and non-human animal well-being are system-level structures and pressures that commodify all aspects of social existence, that are based upon the exploitation of humans, non-human animals and natural resources, and that privilege the powerful over the interests of the vast majority," (p. 17).

This notion is important, as it allows for more informed solutions when responding to environmental harms, and sheds light on the source of environmental degradation. Specifically, if power imbalances and systemic inequality foster environmental victimization of vulnerable populations (including, but certainly not limited to, school children), serious solutions to environmental harm should target these structural-level, systemic problems. This observation is also consistent with what Iadicola & Shupe's (2013) term structural violence. Iadicola & Shupe (2013) define structural violence as, "violence that occurs in the context of establishing, maintaining, extending, or reducing hierarchical relations between categories of people within a society," (p. 380). Many of the harms green criminologists are concerned with stem from dangerous production practices, insatiable (and unsustainable) expansion of capital accumulation, and reckless disregard for the most vulnerable members of the world population. These vulnerable populations can include (though certainly are not limited to) school children.

In the present study, we employ the framework developed within green criminology to examine one specific issue -- the scope of green school violence (GSV) in the US. The issue of the environmental victimization of school children has been addressed in other disciplines using various theoretical perspective, empirical data and terminology. To be sure, we are not the first to call attention to environmental health concerns for school children. While existing studies are not uniform in their approach to the examination of school violence, they share a concern with identifying the kinds of environmental hazards to which school children are exposed, the consequences of that exposure, and the discussion of solutions to this problem.

Environmental Hazards in Schools: Forms, Choice and Child Abuse Issues

School settings present a wide variety of environmental hazards to which school age children are exposed and subjected. As described more completely below, these environmental hazards include internal environmental threats presented by the presences of toxins such as asbestos, lead or arsenic on school grounds and in buildings, to external environmental threats linked to the proximity of schools to hazardous waste sites, polluting facilities, and the general level of pollution in an area where schools may be situated.

The proximity of schools to external environmental hazards is an important topic for several reasons. First, proximity to external hazards such as toxic waste sites or pollution emitting production facilities can impact the entire population of a school. Second, in the environmental justice literature, proximity to these external hazards has been shown to be related to class and race characteristics of area residents, meaning that exposure patterns for school children are likely to vary as a result of the racial and class composition of schools and the neighborhoods in which they are located (Stretesky & Lynch, 2002). Third, in the context of exposure to environmental toxins, these patterns of exposure for school age children challenge the orthodox assumption that proximity to environmental hazards is based on the free and rational choices individuals make. The sequencing of exposure -- that is whether environmental hazards are present when people move into and populate an area or whether those hazards are added to neighborhoods with particular characteristics -- has been an issue of concern in environmental justice research (Saha and Mohai, 2005). This sequencing issue is environmental justice research's equivalent of the "chicken and egg" question -- Are environmental hazards placed near minorities and the poor? Or are minorities and the poor more likely to move

into areas where toxic hazards are already prevalent? This is an important question related to how free will and social structure affects proximity to hazardous waste sites.

We refer to this environmental justice issue because it is, in our view, irrelevant to the exposure of school children to GSV for three primary reasons. First, by reason of age, school age children cannot make the kinds of life choices adults make. They do not, for example, possess the resources or even the legal right to move residences. Thus, if a child lives in a neighborhood in which the schools are proximate to toxic waste sites or other environmental hazards, that proximity is not the consequence of any choice a child ordinarily makes. Second, children do not choose the school they will attend, and that choice is ordinarily made for them by legal structures that define school boundaries or by other dimensions of social and economic structure relations (e.g., the nature of housing markets and prices; the way in which property is zoned). Third, making free choices requires access to information and knowledge, two conditions that are challenged when the population under consideration is children.

Despite our observations, some may be willing to suggest that a child's proximity to a toxic hazard or environmental pollution is still a matter of choice -- one that parents make when they choose a place of residence. Given the fact that in American society such choices are widely constrained by race and class, even these choices should not be viewed as free choices (by for example, red-lining; see: Massey & Denton, 1993). Indeed, we would argue that in a social system freed from structural constrains on choices, few people would choose to live near a toxic waste site, or would select to raise their children in an area where toxic threats abound. Even if we wish to say that children are forced into proximity by the choices their parents make, the choices parents can make

are not structurally unconstrained.

Given the legal, social, economic and knowledge constraints children face in making choices, we argue that when children are found in locations proximate to environmental hazards, this is not due to the exercise of free choice. Indeed, if they are choices, a school child's proximity to a toxic or environmental hazard should be interpreted as a consequence of the choices that adults make, either as parents or as legal actors, governmental actors or as heads of corporations. In other words, when children are proximate to an environmental hazard, we would argue that if that proximity reflects a choice, it reflects an adult choice. Because adult choices concerning economic production and consumption and the distribution of those practices and the toxins they produce drive this process, it is production decisions rather than any other choice that places school children in proximity to an environmental hazard.

Environmental Hazards in Schools

Environmental hazards in schools take many forms. Children in todays' schools are threatened by environmental hazards both inside and outside of school buildings, as well as both solid and ambient pollutants present in the school environment. It is important to recognize that the effects of exposure to toxins are age and dose related. Young children, because they are in the process of development, are more adversely impacted by exposure to toxins than adults (Bearer, 1995). Likewise, the exposure to toxins that might not impact an adult can have significant and negative consequences on a child because children, on average, tend to weigh much less than adults and therefore receive a larger dose of the toxin relative to their body weight (Bates, 1995). Numerous

studies have examined the enhanced susceptibility of young children to environmental toxins. Studies indicate, for instance, that school aged children are more susceptible to exposure to toxins contained in ambient air pollution (Morello-Frosch, 2002). As a result we review the how environmental threats pose risk to children in their school environment.

School drinking water. The quality of drinking water in schools is a topic relevant to criminologists interested in school violence. Toxins found in polluted waterways include, though are not limited to, lead, copper, mercury, arsenic, and uranium. The deleterious effects associated with these toxins, include: aggression, impulsivity, delinquency, reduction in IQ points, and emotional behavioral disorders (Stretesky, 2003, Needleman, 1995). Moreover, lead exposure has been correlated with property and violent crime at the individual and aggregate level of analysis (Needleman et al., 2002; Stretesky and Lynch, 2001; Wright et al., 2008). At high level exposures, acute physical symptoms can also occur, and these pollutants have been demonstrated to be lethal. With respect to many heavy metals (e.g., lead, mercury), scientists have not been able to establish a threshold deemed safe for human exposure (Needleman et al., 1990).

School drinking water can become contaminated by industrial pollution sources, Superfund or environmental hazard sites, or when lead pipes carry drinking water into schools (Chatham-Stephens et al., 2011-2012). In 2004, a meeting facilitated by the EPA focusing on lead in drinking water at school and child care facilities, schools were identified by discussants as “particularly vulnerable to lead because of the nature of schools buildings and water use patterns,” (U.S. EPA, 2004, p.2). In 1998, the California

Department of Health Services reported that it had detected lead in the drinking water of 53.3% of California's public elementary schools (U.S. EPA, 2003). Prior to remediation efforts in 2003 and 2006, an EPA report identified 8 schools in Michigan using drinking water supplies contaminated with upwards of 18 parts per million (ppm) of arsenic (the legal limit is 10 ppm) (U.S. EPA, 2012a). Collectively, these schools served a population of 5,370 people. In 2006, arsenic was detected in 21 samples drawn from water taps and drinking fountains in Seattle's public schools, prompting the school to shut off the water, and provide bottled water to students and staff until the problem could be resolved (U.S. EPA, 2012b).

External hazards on school grounds. Additionally, school children are victimized by toxins present in the exterior of school buildings. Schools in close proximity to expressways and heavy traffic are vulnerable to increased levels of outdoor air pollution and soil contamination in the playground where pollution may settle. Air pollutants that pose the most serious risk to human health are ground-level ozone and particulate matter (Chatham-Stephens, et al. 2011-2012). Once inhaled, particulate matter can cause irritation and inflammation in the lungs, which has also been associated with cardiovascular problems. Likewise, ground level ozone has been linked to lung disease and asthma in humans (Kampa & Castanas, 2008). An inverse association has been found between respiratory risk of air pollutants near a school and student test scores (Pastor, Sadd, & Morello-Frosch, 2004a).

Pesticides that schools use in treating and maintaining school grounds have also been found to pose health risks to children (Alarcon et al., 2005; Gilden et al., 2012). Pesticides can be inhaled, ingested, or absorbed by touching a treated surface both during

or after treatment (Chatham-Stephens et al., 2011-2012), and can also be tracked inside the building by students and faculty (Nishioka et al., 2001). Pesticide exposure has been linked to acute flu-like symptoms as well as long-term more serious health issues like cancer. Alarcon et al. (2005) identified 2593 school-related pesticide poisonings (from 1998-2002). Between 1993 and 1996, the Government Accountability Office identified around 2,300 reported school pesticide poisonings. A 2008 report issued by the Oregon Toxics Alliance identified over 56 school related pesticide exposure complaints, with at least 11% of cases resulting in complaints of illness from students and staff, and in some instances, requiring medical attention for symptoms (Arkin, 2008). In at least 7% of these complaints, students had to be evacuated from classrooms or playing fields due to pesticide vapors. It was determined by state investigators that in at least 23% of these cases, pesticide users had violated the law or sufficient evidence existed to require a letter of advisement.

Internal hazards in school buildings. Criminologists should also be concerned with hazards posed to children inside school buildings. Indoor air pollution, radon, lead, mercury, mold, and asbestos have all been identified as posing threats to children in schools (Chatham –Stephens et al., 2011-2012). Older school buildings may present students and staff with more of a risk than newer buildings, particularly with regard to lead, indoor air pollution, and asbestos. A 1999 report by the National Center for Education Statistics found 28% of all U.S. public school buildings were built prior to 1950 (Rowand, 1999). Structures built prior to 1950 are at an increased likelihood to be furnished with lead and mercury based paint, which can flake, generate dust, and subsequently be ingested or inhaled by children. Lead has been associated with a myriad

of deleterious effects on humans, and on children especially (Needleman, 2002; Needleman & Gatsonis, 1990; Olympio et al., 2010). Improper disposal of lab equipment, batteries, and fluorescent light-bulbs has been identified as a potential source of mercury exposure for school children (Chatham-Stephens et al., 2011-2012).

School children may also be exposed to radon inside of their school buildings. Radon may be present both inside and outside of school buildings, enters the atmosphere when uranium decays, and is a tasteless, colorless, radioactive gas. Radon has been identified by the World Health Organization (2009) as a "worldwide health risk in homes." According to the EPA, radon is second only to smoking in leading causes of lung cancer, and the EPA estimates that radon exposure is responsible for about 21,000 deaths annually (EPA, 2015) [4]. McDermott-Levy, Kaktins, & Sattler (2013) have argued that while radon is naturally occurring, the practice of hydraulic fracturing ("fracking") may place site workers and locals at an increased potential to be exposed to radiation. Casey et al. (2015) document an association between unconventional natural gas development (identified by the authors as horizontal wells, hydraulic fracturing) and indoor radon concentrations. In a 1993 report (the most recent EPA study on radon in schools), the EPA reveals that in a nationwide survey nearly one in five schools had at least one school room with a short-term radon level above EPA limits (U.S. EPA, 1993). The EPA went on to estimate that more than 70,000 school rooms have high short-term radon levels. If approximately twenty students occupy the 70,000 radon-affected classrooms for just one day, this constitutes 1.4 million children being exposed to radon.

Race, Class and Unequal Exposure to School Hazards

Research indicates that children are not equally exposed to school related environmental hazards. One of the earliest studies to raise the issue of inequality in exposure to school-based hazards was conducted by Robert Bullard (1983) in his study of Huston (Texas) landfills. Specifically, Bullard (1983:275) set out to determine whether "black children [are] more likely to attend schools near municipal landfills than their nonblack counterparts (e.g., whites and Hispanics)." Bullard conducted interviews with Houston's Air Quality Board and obtained secondary data from the Texas Department of Health, the U.S. Census Bureau and the Houston Public Schools. Bullard (1983:284) discovered that all of Houston's black schools were situated near a Houston landfill and 66 percent of the black schools were located near solid waste sites. Moreover, nearly 77 percent of the predominately black schools were situated near at least one municipal landfill and 85 percent were located near private landfills. In short, at the time of Bullard's study, black students in Houston were more likely to attend school near waste disposal sites.

As a result of Bullard's study, the unequal distribution of exposure to environmental toxins in school settings has become a major concern among health researchers. Pastor, Sadd and Morello-Frosch (2002, 2004a,2004b; Pastor, Morello-Frosch and Sadd, 2006) found that in Los Angeles, minority school aged children were more likely to attend public schools near environmental hazards, and as a result, experienced higher health risk. Additional studies by researchers, such as Chakraborty and Zandbergen (2007) analysis of air pollution exposure risks for school age children in Orange County, Florida, confirm these results (see also, Landigran, Rauh and Galvez, 2010; for rural populations see, Evans and Marcynyszyn (2004).

In a recent study, Legot, London and Shandra (2010) found widespread evidence of an association between community race and class characteristics and proximity to the top 100 producers of developmental neurotoxin pollution in the US. Exposure to neurotoxins is a serious concern, as neurotoxic agents have the ability to compromise healthy functioning of the human brain. Because schools function to educate and promote the healthy development of children, exposure to neurotoxicity can seriously undermine the goals of educational institutions. Mohai et al. (2011) found that public schools in Michigan located in areas with the highest levels of air pollution (fourth and fifth quintiles) had increased percentages of students failing to meet state assessment program standards in English and math. This association demonstrated to be statistically significant, even after controlling for confounders including expenditure by pupil, number of students, student-to-teacher ratio, and percentage of students receiving free lunch (Mohai et al., 2011) [3]. Mohai et al. (2011) also observe that 44.4% of Michigan's white school children, as opposed to 62.2% of Michigan's Hispanic school children and 81.5% of Michigan's African American school children, attended schools located parts of the state with the highest level (10^{th} decile) of air pollution. Like many other studies, this research indicates that race, ethnicity and income impact the likelihood that school aged children will be exposed to environmental toxins, and hence to the forms of environmental violence such exposure produces.

Other researchers that study schools have also discovered inequalities in exposure to pollutants by race, ethnicity and income. This includes the observation that minority children are also likely to go to school near busy roads, where they are exposed to traffic-related pollutants (such as lead prior to its ban in gasoline in 1996). For instance, Green et

al., (2004) studied traffic patterns near schools in California and documented that nearly 150,000 primary school students lived within 150 meters of very busy roads that served more than 50,000 cars per day. The researchers also discovered that “as the traffic exposure of schools increased, the percentage of both non-Hispanic black and Hispanic students attending the schools increased substantially” (Green et al., 2004:62). Green et al., (2004) found similar patterns for poverty, as schools that had more children who were eligible for reduced lunch were also likely to be situated near busy roads. This implies that students who attend predominately minority and poor schools are likely to be exposed to higher levels of pollution in the air when at school. This finding is important because critical reviews of the research on indoor and outdoor pollutants tend to suggest that exposure to pollution in schools has negative health consequences and can significantly lower the academic performance of children attending polluted schools (Mendell and Heath, 2005). Thus, the medical research strongly indicates that the disproportionate exposure to chemicals in school has the strong potential to alter the life course, and do so in unequal ways that may be related to crime risk factors among minorities and the poor. As a result, Mendell and Heath (2005:40) believe that the immediate remediation of many U.S. schools is necessary because “effective public actions do not always require or wait for documented causality.” (See also McConnell et al., 2010).

Traditional School Violence and Green School Violence

The literature on environmental exposure in schools suggests that green school violence is significant. As is illustrated below, the rates of GSV are extraordinarily large and, in aggregate, are much more damaging to children’s health and wellbeing than more

traditional physical forms of school violence that children. As noted earlier, green criminologists have argued that exposure to environmental toxins and pollutants is a form of violence. As a result, each exposure to an environmental toxin should be counted as an act of violence on a student. As a result it is possible to compare the rate and probability of victimization from traditional acts of school violence that have occupied the attention of criminologists to those produced by GSV. It is important to point out that we do not argue that there is a hierarchy of victims or that those environmental victims are more or less worthy of attention than victims of physical harm. Instead, we simply seek to estimate events based on school health literature to argue for the inclusion of these victims in criminology literature because this form of form of harm has been excluded from the school violence literature.

Toward an Estimate of Green School Violence

In a school setting, traditional forms of violence include a variety of acts such as exposure to weapons, or the consequences of the use of weapons in school, physical assaults, or bullying. The portion of the National Crime Victimization Survey devoted to school violence indicates that despite the widespread attention school violence has received, it has, like other crimes, been in decline for nearly two decades. Results from the 2011 National Crime Victim Survey's School Crime Supplement indicate that in 2011, there were approximately 597,500 violent victimizations (Robers et al., 2013). It is important to come up with a measure of green school violence to make some comparisons between physical and environmental violence.

The National Crime Victim Survey School Crime Supplement [NCVS-SCS]

Indicators of School Crime and Safety, 2012 (Robers et al. 2013) presents rates of interpersonal, physical school violence. Incident rates per 1,000 students were derived using this data. These figures measure "violent victimization" by reports of simple assault, as well as serious violent crimes, which were reported to have occurred inside a school building, on school property, as well as en route to or from school. "Students" is in reference to students at or between ages 12 to 18 only, and the NCVS-SCS reports a population of over 25 million students between the ages of 12 to 18 in the U.S. in 2011. College students are not eligible to complete the NCVS-SCS. These data suggest that there are about 24 physically violent victimizations for every 1,000 students.

Estimates of air pollution exposure among the US population observe that nearly 40% of the US population is exposed to air quality that violates the law on any given day. In order to illustrate our point concerning air pollution exposure among school children, we focus on schools located in cities. Given that the air pollution exposure rate for the US population is 40%, and urban schools are much more likely to be located in an Air Quality Control Region (ACQR) in non-attainment status, we can conservatively estimate that urban school children are exposure to air quality that violates the law one half of the days they are in school (or 90 days on average in the US).

Unlike acts of violence, which are estimated annually, air exposure estimates are often daily estimates. To make the air pollution exposure similar to the in school rate of violence (which is an annual count of incidents) we need to adjust our air pollution estimate to reflect exposure incidents. Let us assume that during the 90 days of exposure to air that violates legal standards (and we should note here, this does not mean that students are not exposed to unhealthy air pollution levels at other times), students

attending urban schools are exposed for 4 hours each day. Further, based on average breathing patterns, a child is takes 4,320 breaths of polluted air during that 4 hour period. Thus, in one day, one child is victimized 4,320 times, and in the one half of the school year that they are exposed to air quality that violates the law, that one child experiences 388,800 acts of GSV. Using an approximation of city students, polluted air yields about 2.9 billion GSV victimizations annually.

As noted, traditional acts of school violence are estimated to affect 24 children in 1,000. However, for the same 1,000 children, there are 114,615 acts of GSV related to air pollution exposure in violation of the law. In other words, for every one act of traditional school violence there are more than 2.7 million GSV incidents related to air pollution exposure alone.

Admittedly, to make our point we have potentially overestimated the extent of GSV by selecting schools in non-attainment areas. At the same time, however, we have applied conservative assumptions concerning the proportion of school days a non-attainment area could be faced with air violating air pollution standards. But, even overestimates here of several hundred thousand GSV incidents would still produce a huge difference between GSV and traditional school violence. Moreover, to make a more accurate comparison, these data reflect victimizations of students age 12 to 18. While interpersonal violence is rare amongst young children (11 and under), this age group remains vulnerable to the adverse effects of toxins, including air pollution. Thus, this consideration suggests our figures may actually underestimate GSV victimizations associated with air pollution. Finally, these estimates do not account for the added adverse effects associated with proximity of a toxic waste site. In urban areas it is likely

that at least 5% of children attend schools close enough to hazardous and toxic waste sites to cause millions more exposures among a population of 1,000 school aged children. So, too, would exposure to toxins and pollutants in drinking water supplies. Unlike counts of interpersonal school violence, these estimates do not account for exposure to pollutants on the way to or from school, or exposures that result from use of school premises (e.g., playing fields, playgrounds), outside of school hours.

Discussion

School violence defined as physically harming or threatening to physically harm other students, teachers and or staff has attracted considerable attention from a variety of researchers. Criminologists have contributed to the production of knowledge in this area. This paper has argued that criminologists should consider adopting more expansive definitions of school violence that take into consideration exposure to pollution, toxins, and other forms of environmental degradation. A more expansive definition of school violence is justified by discussing previous works that have critiqued extant definitions of school violence, and have also called attention to the structural inequalities that produce violence. This study is further justified given the wide scope and severity of GSV, as illustrated by findings from public health and epidemiology studies, as well as an estimate of one form of GSV—air pollution. GSV represents an important interdisciplinary concept that criminologists can employ to work towards developing a victimology of school children and school violence.

While this manuscript draws attention to an important area in need of criminological study, it is not without limitation. For example, while we draw attention

to a number of studies that have identified environmental harms in schools, we do not provide a comparison of harms children suffer at school versus harms children suffer in other locations. Thus, it could be argued that children may attend schools that have fewer environmental hazards than are present in and around their homes. To be sure, the same could be said of where children are victims of interpersonal acts of violence. With respect to environmental harms, McConnell et al. (2010) explore this matter in an analysis of childhood asthma and traffic-related air pollution, and find associations between asthma and traffic-related pollution from sources located near schools that exist independent of exposures from sources near childrens' homes (p. 1024). Chakraborty and Zandbergen (2007) find that more children are exposed to air pollution at their homes than at their schools. Criminologists could contribute to this literature by examining, in future works, where children are most vulnerable to environmental crimes. This could include studies that compare GSV to environmental crimes that occur in other locations.

It is true that our initial measure of GSV leaves significant room for improvement. One limitation of this initial measure is that it is unable to capture variation in schools and inequality by race, ethnicity and class. Another limitation is that this particular measure of GSV examines exposure to polluted air, while additional potential hazards are omitted. Measuring the full degree to which schools are toxic environments, and the variability of toxicity across schools, represents an important direction for future studies of GSV. That said, it is not our intention here to create a definitive index of GSV. Rather, we present relevant examples that can be used to create a measure of GSV that can be compared to traditional acts of school violence (for fuller discussion of the methodological concerns present in estimating children's exposure to air pollutants in

school, see Mejía et al., 2011).

The study of GSV is further justified given that this area of study has important implications for public policy. For example, observations with respect to the policy responses to traditional forms of violence (e.g., school shootings) versus green school violence (e.g., school pesticide exposures) suggest disparate legal responses to two forms of extremely violent behaviors. That is, a school's incorporation of interpersonal violence prevention initiatives, such as zero-tolerance policies tied to the Gun Free Schools Act, is incentivized by federal funds. Comparable federal initiatives for prevention of or reaction to school violence associated with environmental health threats do not yet seem to be formalized. For instance, while zero tolerance policies have been initiated to punish children who are argued to threaten, or who have imposed, interpersonal violence in schools, zero tolerance policies do not appear to be applied to producers of environmental hazards (consider, e.g., recidivism rates among corporate criminals). Zoning laws that prohibit guns and drugs within school zones have been implemented, but in many areas, comparable zoning laws do not ban citing of hazardous waste facilities near schools.

Another policy implication stemming from this issue concerns the disparate impacts of GSV across age, race, class, and ethnic groups. Given children's unique vulnerability to environmental threats, combined with their distance to social, political, and economic resources, children appear especially susceptible to environmental threats in school in ways that their adult counterparts are not (Bearer, 1995). It also appears that intersectionality between age and other minority statuses—e.g., youth who identify as belonging to a racial or ethnic minority—may be associated with non-normal

distributions of GSV (Stretesky & Lynch, 1999). That said, this suggests that (1) children are dependent on adults to make policy decisions about natural resources in ways that do not threaten their health, and (2) children belonging to ethnic and racial minority groups appear especially in need of these policy provisions. Emergent studies in green criminology that assess various public health problems from a treadmill of production perspective suggest that the most effective policy initiatives will recognize the association between natural resources and political economy and will target the relationship between capital accumulation and ecological disorganization (Lynch & Stretesky, 2013; Stretesky, Long, & Lynch, 2013), rather than, for example, the actions of individual school administrators..

Conclusion

In sum, mainstream criminology has examined many interpersonal forms of school violence. In this article, we draw upon arguments made to expand the definition of school violence beyond interpersonal acts (Henry, 2000; 2009), and apply the concept of structural violence (Iadicola & Schupe, 2013), to explore school violence from a green criminological perspective. We introduce the concept of GSV, and cite numerous examples from public health and epidemiology literatures to convey the need for criminologists to take up this important area of study. By bridging together epidemiological and public health studies with school violence research conducted by criminologists, we highlight an important new direction in green criminology as well as schools and crime research. It is our hope that criminologists continue to explore this area, and refine measures of GSV, in an effort to better understand the impact of environmental crimes on children.

Endnotes

1. K-12 schools refer to schools that serve children in Kindergarten ("K")- and/or any grade level up and through 12th grade ("12"). Children in Kindergarten are approximately 5 years of age; Children in 12th grade are approximately 17 years of age.
2. The No Child Left Behind Act was enacted by the U.S. Congress in 2002. No Child Left Behind was a reenactment of the Elementary Secondary Education Act.
3. The National School Lunch Program is a federal assistance program that provides free or reduced price school meals for eligible children. Eligibility is need-based, and determined by family income. The percentage of students eligible to participate in the National School Lunch Program is frequently used by researchers as a proxy for socioeconomic status, with higher percentages or eligible children indicating higher levels of economic disadvantage.
4. While earlier studies on the association between radon exposure and cancer drew on samples of miners, epidemiological evidence has since emerged linking residential radon exposure to lung cancer. In this regard, the EPA cites two studies: Krewski et al., 2005 and Darby et al. 2005 that find empirical evidence associating residential radon exposure and lung cancer. In 2006, the *Journal of Toxicology and Environmental Health* featured a special issue devoted to residential radon epidemiology (Zielinski & Field, 2006).

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