SESUG 2022 - Paper 172
Statistical Analysis of School Shootings in the United States as Stochastic Terrorism

David J Corliss

Peace-Work, Plymouth, MI

ABSTRACT

This study presents a longitudinal analysis of school shooting attacks in the United States. Raw data from the US federal CHDS school shooting database was analyzed to exclude suicides, accidents, and threatening actions not resulting in injury. Exploratory data analysis indicates two historical time periods with distinct behaviors. Time series cluster analysis indicated a change in attack behavior about the year 1991: prior to that time, attacks and fatalities were relative few, normally distributed, and show little variation from year to year. Beginning about 1991, a second type of attack pattern is found superimposed on the historical pattern, with both continuing to the present. This second pattern is found to be consistent with stochastic terrorism, characterized by a highly variable annual attack rate, marked increases in deaths and lethality (deaths per incident), and a skewed distribution with a risk of a high number of fatalities driven by a small number of extreme events. This study illustrates diagnostic characteristics of stochastic terrorism, which are use to recommend an operational definition: (1) an act of terrorism, where the attack targets a community as a whole and the specific victims unknown to the attacker (2) the attacker is motivated by an Instigator through mass communications encouraging violence in the expectation that unspecified persons will attack the targeted group.

INTRODUCTION: SCHOOL SHOOTINGS IN THE UNITED STATES

While there has been increasing concern over gun violence over the years, especially in the area of school shootings, research in this area is very incomplete. Tragic events, including mass shootings at schools in Columbine in Aurora, CO, Sandy Hook, CT, and Stoneman Douglas HS in Florida, have not translated into a substantial body of rigorous scientific research. Historically, questions related to general threats to the physical well-being of the public at large have been investigated by publicly-funded research organizations such the Centers for Disease Control and Prevention in Atlanta (CDC, https://www.cdc.gov/). However, there is substantial resistance in some circles to prevent research into gun violence in the US. In 1996, an amendment in the US federal government omnibus spending bill established the requirement that “none of the funds made available for injury prevention and control at the Centers for Disease Control and Prevention (CDC) may be used to advocate or promote gun control" (see Public Law 104–208, 104th Congress). At that time, the amount of funding previously budgeted to the CDC for gun violence research was re-directed toward other projects.

The intent and exact legal requirements of this regulation, known as the Dickey Amendment after its author, US Representative from Arkansas Jay Woodson Dickey, Jr., have been debated. However, the practical effect of the Dickey Amendment has been to prevent any federally-funded research in the area of gun violence. While this has left a significant void in the area of gun violence research, NGO’s may be unaffected by government restrictions. This study was produced by the NGO Peace-Work, an all-volunteer cooperative of statisticians, data scientists and other researchers applying statistical modeling and methods to issue-driven advocacy, including poverty, education, human trafficking, and social justice.

STOCHASTIC TERRORISM

While historical examples exist, Stochastic Terrorism has in recent years become an important emerging topic in terrorism studies. In statistical science, stochastic means intrinsically random. Applied to terrorism, the term describes a process in which one crucial step involves a random process. M. Hamm and R. Spaaij (2017) described stochastic terrorism as “‘the use of mass media to provoke random acts of

ideologically motivated violence that are statistically predictable but individually unpredictable". Examples include the Boston Marathon bombing, where the attackers had no direct contact with instigators but rather were influenced and radicalized online (Seelye 2013).

Looking at a number of attacks, a specific pattern emerges which defines stochastic terrorism as distinct from other terrorist attacks which this paper will term Direct Terrorism. In stochastic terrorism, three distinct roles are seen. There is one of more attackers who target a community with whom the attacker has a grievance, real or imagined, rather than targeting specific individuals with whom there is a specific issue. This feature is, of course, characteristic of all terrorist attacks: stochastic terrorism is a subtype of terrorism overall. In stochastic terrorism, addition to the attacker(s) and victim(s), there is also an instigator with whom the attacker has no direct connection. In conventional terrorism, the instigator plans the attack, selects and prepares the attacker, and targets the attacker at the victims. In stochastic terrorism, the instigator has no direct contact with the attacker but instead motivates many to violence through some form of mass communication, with the intention that some will respond to this call for violence by carrying out an attack. While a general call for violence to a group among which no individuals are specified is diagnostic of stochastic terrorism, the call for violence can be any general medium and it not required to be on-line. As one example, pamphleteers inspired anarchists to political violence in the early 20th century and to religious violence in the 16th. An early example demonstrating this pattern might be found in the words of the English King Henry II reported to say to an assembled crowd of knights "Will no one rid me of this troublesome priest?" in the expectation that some would attack Thomas Becket without asking specific individuals to do so in a specific time, place, and manner. See Figure 1 for a description of roles in Direct versus Stochastic terrorism.

Figure 1: Distinct Roles and Relationships in Direct and Stochastic Terrorism

This understanding of roles and relationships enables the establishment of an operational definition or stochastic terrorism:

- Terrorism: Attack is on a community, with the specific victims not known to the attacker
- Stochastic: Instigator motivates many to violence in the expectation that some not directly known will act
- Process: Attacker motivated by Instigator through communications to a group
- Target: Attacker selects the target guided but not precisely specified by the Instigator

School shootings in the United States, especially mass shootings, are often found to follow these defining characteristics of stochastic terrorism. As there have been sadly very many of these in recent years, they provide a body of data that can be explored using statistical methods. Thus, while school shootings are essentially unknown outside the United States, the data support analysis of stochastic terrorism in general.

DATA DEVELOPMENT

Source data for this study comes from the K-12 School Shooting Database, a project of the United States Center for Homeland Security Defense and Security with the Federal Emergency Management Agency (FEMA), This compilation, undertaken at the Naval Graduate School in Monterey, California, captures information on K-12 school shootings in the United States from 1970 forward. Information is taken from newspaper and magazine articles, academic journal reports and case studies, law enforcement, internet searches, and other sources. The project seeks to collect a wide range of data on school shootings, including date, location, victim numbers, information about the school, whether suicide occurred or was attempted, type of incident (e.g., racially motivated, accidental etc.) and other fields. Each incident is assigned a reliability rating on a scale of 1 (lowest) to 5 (considered most reliable).

This publicly available database is continuously updated, containing 1,405 records as of September 1st, 2019. Each record in the database comprises a single incident. The database contains no other resources, performs no analysis, and makes no conclusions or recommendation: it is exclusively a compilation of data identified in searches. This study by Peace-Work seeks to analyze attacks, defined as deliberate acts where persons other than the shooter were wounded or killed, whether the shooter was harmed or not.

Data privacy was maintained at all times. While these data are taken from a publicly available source, no personally identifying information in the CHDs database was read into a SAS dataset for this analysis.

Data were aggregated by school year prior to analysis. School year was extracted from the date on each record, with a year defined as running from August 1st through July 31st. To identify deliberate attacks resulting in victims with physical injuries, five selection criteria were applied to the raw data records in the Schools Shooting Database:

- As the analysis was performed at the School Year level, partial school years were excluded from this analysis – specifically, records prior to 8/1/1970 and after 7/31/2019.
- Suicides where the shooter was the only victim were excluded. These records are identified in the first of four fields regarding suicide in the CHDS database.
- Accidental shootings were excluded: Category = ‘Accidental’ in the CHDS data
- Unreliable incident reports were excluded: Reliability = 1 in the CHDA data, described as “Independent Single Author/Moderator Blog, report/list lacking citations, or cited source cannot be located”.
- Threats where no person was physically harmed were excluded: killed + wounded = 0 => drop the record.

STATISTICAL ANALYSIS

Exploratory data analysis indicated two different historical periods. Early years in the time series show relatively fewer incidents, fatalities, and variability in these characteristics. This is called the Historical pattern. Beginning in the early 1990’s, a sharp increase is seen in school shooting incidents and fatalities. These new records in the Modern era possess distinct characteristics, including more deaths per incident, greater variability from year to year, and a highly skewed distribution with a long tail where the historical

years presented a normal distribution. The resulting pattern, since the early 1990's, is a combination both Historical and Modern-type attacks (Figure 2).

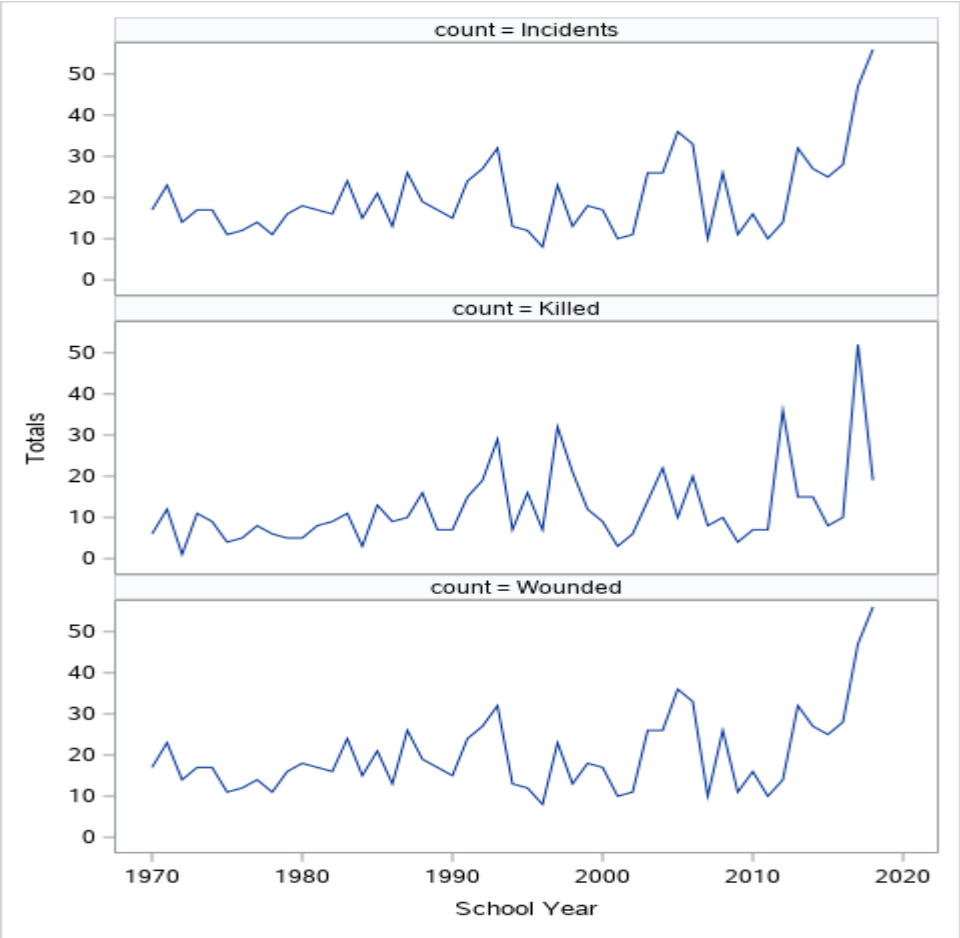

Figure 2: Historical Patterns in US School Shootings by School Year

In the past few years, there has been a marketing increase in school shooting incidents (Figure 3). Due to the small amount of data since that time and educational disruptions caused by the COVID-19 pandemic, these years have an uncertain impact and are not included in this longitudinal study. They remain of the greatest concern and will be closely watched going forward.

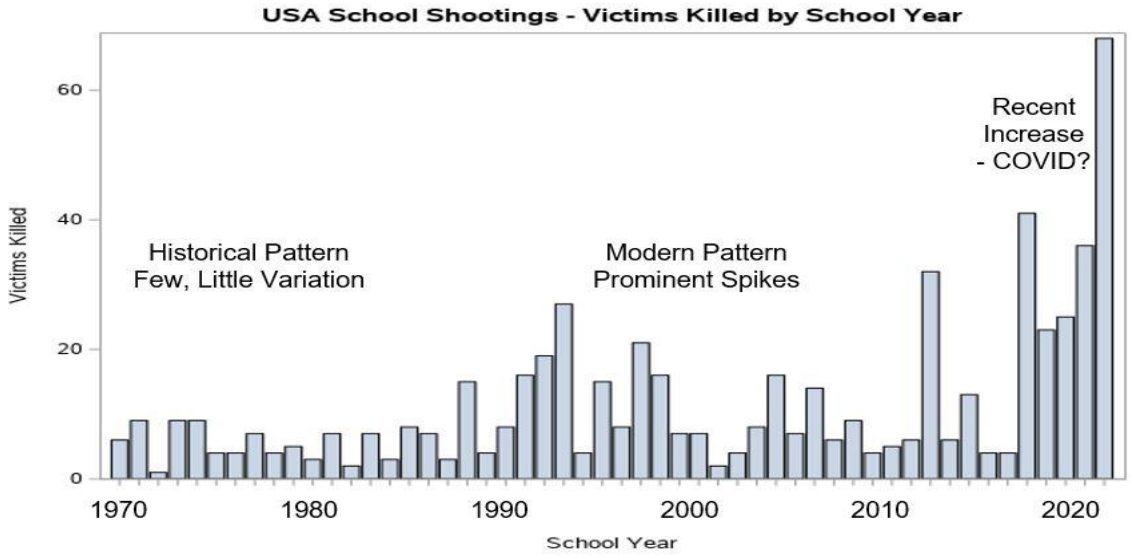

Figure 3: US School Shootings by School Year Through Present

Time series cluster analysis with the SAS procedure FASTCLUS was used to identify distinct periods in the history. Following best practices for this method, both totals at each point in time and rate of change variables were considered in the analysis. Incidents per school year, number killed, and absolute magnitude of the changes for each gave the clearest separation of the clusters.

The analytic design calls for initially creating more clusters than needed and then pruning the result. Three time series clusters were identified: (1) 1970-71 to 1990-91, (2) 1991-92 to 2016-17, and (3) 2017-18 to 2018-19. With just two years as the very end placed in a separate cluster – effectively, an outlier – the third cluster was combined with the second.

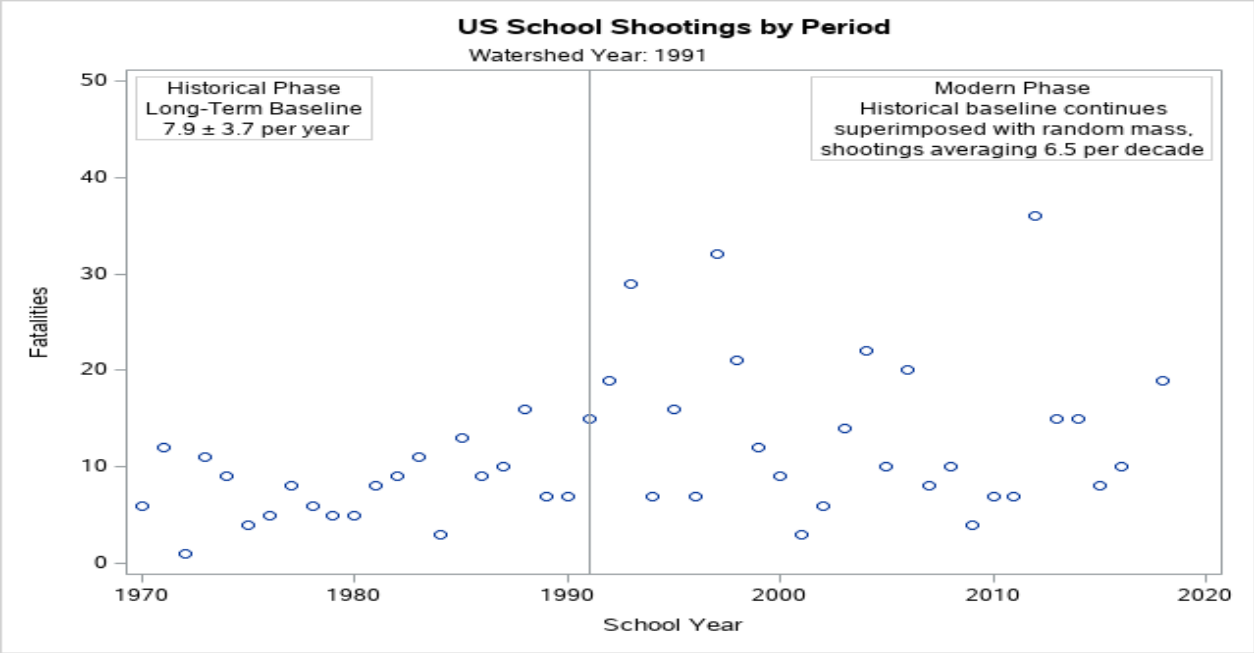

Figure 4: US School Shootings by Time Series Cluster

Comparison of the summary statistics prior to the 1991-1992 school year to the following period – a superposition of Historical and Modern time series allows calculation of these statistics for the Modern series only. Properties of the two types are summarized in Table 1.

Historic Properties: Through the 1990-1991 School Year

			Mean	Std Dev
Incidents	21	17.00	16.81	4.04
Killed	21	8.00	7.86	3.58
Wounded	21	18.00	26.48	20.89
Killed per Incident	21	0.47	0.47	0.17
Wounded per Incident	21	1.06	1.58	0.96

Modern Plus Historic Properties: 1991-1992 Through 2018-2019 School Year

Variable	N	Median	Mean	Std Dev
Incidents	28	23.50	22.54	11.72
Killed	28	13.00	15.46	10.98
Wounded	28	30.50	30.21	23.30
Killed per Incident	28	0.55	0.69	0.50
Wounded per Incident	28	1.30	1.34	0.57

Calculation of Modern Pattern Only: 1991-1992 through 2018-2019 School Year

Variable	N	Median	Mean	Std Dev
Incidents	28	6.5	5.73	12.53
Killed	28	5	7.6	11.96
Wounded	28	12.5	3.73	12.06
Killed per Incident	28	0.77	1.33	0.54
Wounded per Incident	28	1.92	0.65	-0.15

Table 1: Summary statistics on US school shootings from successive time series clusters. The historical pattern is consistent with ordinary crime and continues to the present. The modern pattern, emerging in the early 1990s, is consistent with the defining characteristics of stochastic terrorism.

SCHHOL SHOOTINGS AND STOCHASTIC TERRORISM

The time series cluster analysis used in this study initially found three clusters; the third cluster consisting of the last two complete school years in the data, immediatetly prior to the COVID-q9 pandemic, was combined with the second, similar interval beginning in 1991-1992. Alternatively, if the stochastic terrorism hypothesis is correct, it should be pointed out that increase seen in the last two years prior to the pandemic are consistent with a documented (Corliss, 2018) rise in hate speech sources in Twitter during this same period (Figure 5).

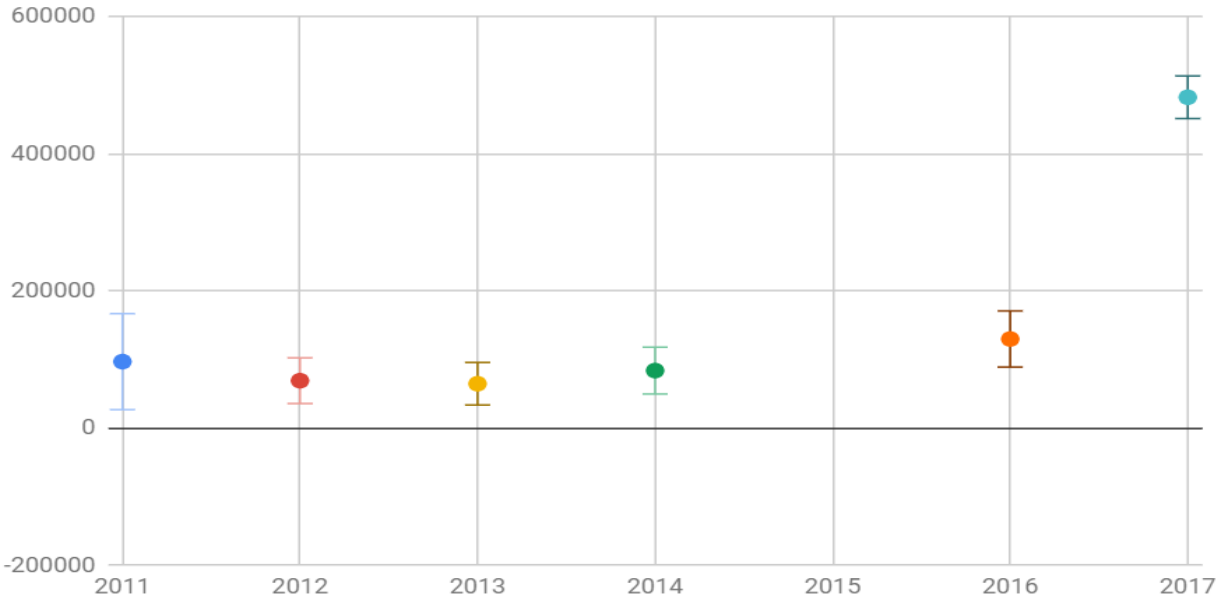

Figure 5: Time Series of Hate Speech Source in Twitter, 2012-2017 (Corliss, CIRM, 2018)

This interpretation is also consistent with the the high numbers seen as the pandemic has waned.

One noteworthy property of these data is something *not* observed: there is no apparent effect of the US federal assault weapons ban. Neither a decrease when instituted in September 1994 nor an increase following its expiration 10 years later is observed. Several factors may have affected this outcome, including but not limited to

- The ban was on *manufacture*, not ownership or use
- Wide availability in the United States of weapons included under the ban
- Limited scope of the ban – many highly lethal and / or high rate of fire weapons were not included. For example, the perpetrators of the 1999 Columbine High School mass shooting used several different weapons, none of which were included in the assault weapons ban.

CONCLUSIONS

Time series cluster analysis of school shooting incidents in the CHDS school shooting database identifies two historical periods. This analysis only included deliberate attacks, excluding accidents, suicides without other victims, and unreliably reported events. In the first time period, from the beginning of the data in 1970 through about the 1990-1991, there was an average of 16.8 ± 4.0 incidents and 7.9 ± 3.6 deaths per school year. Data per year in this period are normally distributed.

Beginning in the early 1990's, a second type of attack was observed in addition to a continuation of the historical pattern. These modern attacks, continuing to the present, have an average of 5.7 incidents and 7.6 deaths per school year. Variability increased substantially in a highly skewed distribution, with the standard deviations exceeding the means at 12.5 for incidents and 12.0 for deaths. The Modern pattern of attacks is far more lethal (average 1.33 killed per incident) than the Historic (0.47 killed per incident). The mean number killed per incident increased more than 280% from the Historic period, even as the number wounded fell by half. Analysis of the time series does not support the finding of any effect from the US ban on the assault weapons manufactured from September 1994 through September 2004. However, the timing of the rise of the modern-type attacks is consistent with the growth of internet, where a number of

perpetrators were very active. As often described by perpetrators and consistent with the observed time series, breeding ground for the modern type of attacks is found first in internet chat groups and later through social media. This hypothesis for the sea change in school shooting observed in recent decades involves perpetrators being motivated and encouraged personally by virtual connections – a phenomenon that could be termed *micro-hate* - and further incited by the *macro-hate* of stochastic terrorism. Investigation of this hypothesis is recommended.

FURTHER RESEARCH

Further research on the properties and defining characteristics of stochastic terrorism is needed. It is intended that establishment of a standard for stochastic terrorism in peer-reviewed literature will support the future development of a legal standard. Legislation implementing this standard will be needed to hold to account the instigators of these terrorist attacks as well as the direct attackers.

In July 2022, the United States Department of Homeland Security project supporting the capture, verification, and creation of the publicly-available database supporting this project became unfunded. The project is now being continued by volunteer investigators led by David Riedman (personal communication). Both the database and its official status as a product of a US government agency are essential to continue this work, It is hoped funding for this project will be restored.

ACKNOWLEDGEMENTS

Thanks are due to the SAS Institute for making available SAS OnDemand for Academics at no cost to for noncommercial use, including this project. Deep gratitude is due to David Riedman for continuing the database project through to the present in the absence of government funding.

REFERENCES

Aman, M, Reid Maloy, J., (2021) “Stochastic Terrorism: A Linguistic and Psychological Analysis”, Perspectives on Terrorism, 15, 5

Corliss, D. J. (2012), “Dynamically Evolving Systems: Cluster Analysis Using Time”, Proc. SAS Global Forum 2012

Corliss, D. J. (2018), “Bayesian Capture Recapture in Social Justice Research”, CIRM

M. Hamm and R. Spaaij, (2017), “The Age of Lone Wolf Terrorism”, Columbia University Press

Riedman, David (2022). K-12 School Shooting Database.

School Center for Homeland Defense and Security, Retrieved 7/22/2022 from https://www.chds.us/ssdb/

Seelye, K. Q. (April 23, 2013). "*Bombing Suspect Cites Islamic Extremist Beliefs as Motive*". The New York Times. et al.

Tryon, R. C., 1939, Cluster analysis. Ann Arbor: Edwards Brothers

CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the author at:

David J Corliss
Peace-Work
davidjcorliss@peace-work.org