Appendix 2

This appendix details methods used throughout the manuscript.

Numbers of Police Brutality Incidents

I collected all incidents from the Police Brutality 2020 database (PB2020 2020) using their RESTful API (https://api.846policebrutality.com/api/incidents) via R v3.6.3 (R Core Team 2020) with the httr v1.4.1 (Wickham 2019) and jsonlite v1.6.1 (Ooms 2014) packages. I collected all incidents during the May 25 to September 25 2020 interval, and specifically filtered Portland Oregon incidents. I also filtered the total and Portland incidents by chemical weapons tags using entries marked "gas", "marking-round", "pepper-ball", "pepper-spray", "spray", "tear-gas", or "tear-gas-canister", and then simply divided to determine ratios. Source code is available in the provided files as pb2020.R.

Estimating Case Fatalities

Idrissi et al. (2017) provide a catalog of 70+ years of zinc chloride toxicity studies in humans, many of which occur in clusters (only 11 of 28 were solo patients). To avoid sample size variation bias, I simply calculated the fatality rate for each cluster (rather than each case) and averaged those values to achieve an among-cluster rate.

Collecting and Identifying Munitions

Protesters, concerned civilians, medics, legal observers, trash cleaners, scientists, and neighbors have been collecting munitions, including those documented in the dossier in Appendix 1, since the beginning days of the protest (Appendix 1). I was able to leverage this specifically to address the uncertainty around Hexachloroethane (HC) usage by connecting with the network of individuals already collecting and documenting (often via twitter, Appendix 1) munitions and notifying them of the particular can types of interest. Because HC cans are so distinctive when deploying and afterwards (main text Fig. 2, Appendix 1), it was possible to retroactively evaluate documentation and collections of munitions to enumerate the HC cans. In addition, I have put out specific calls publicly for submissions of photos via the Chemical Weapons Research Consortium website (https://chemicalweaponsresearch.com) via secure email and secure form, which has yielded dozens of submissions, but no additional HC cans (Simonis *personal observation*). The avenues remain open to submissions and I will update the data set used here with any further HC cans.

I also watched through hours of footage and read through aggregated news and tweets (Appendix 1) to investigate potential other deployments. I relied primarily on Eric Greatwood's streamed videos (Greatwood 2020), aggregated news sources from The Recompiler Magazine's RE: Portland project (The Recompiler 2020), and public twitter threads. If a can seen on video spewed sparks, off gassed white/grey/black "smoke", and glowed and burned hot and long (~2 minutes), it was considered an HC can, due to the distinctive nature of its incendiary aspects. Further, if any recovered can was so corroded to be illegible and was of the distinctive size of the HC cans (Appendix 1), it was considered as such.

“Fed Out” Time

I used the documents included and cited in Appendix 1 (Greatwood 2020, The Recompiler 2020) to determine the amount of time each night during July 2020 that the federal agents were outside of their buildings. Primarily, I used timestamps from videos, and augmented them with time-stamped tweets as needed.

Data created from this evaluation (including sources for each night) is in the fed_presence.xlsx file in the provided documents.

Crowd Size

I used the estimates provided by the news and social media aggregating site The Recompiler, which has a project (RE: Portland) that has collected documents of the Portland BLM protests since the end of June 2020, prior to the arrival of the DHS agents (The Recompiler 2020). On nights where a range was given, the midpoint was used.

Data from this collection is included in the summary_data.csv file.

Chemical Analyses

Eleven environmental samples were collected from a variety of sources around the areas of HC deployment (Fig. A1.1). Sample narratives are in the figure legend. Samples were stored frozen in quart-sized mason jars until being submitted to Specialty Analytical in Clackamas, Oregon for evaluation using standard EPA methods for volatile organic compounds (SW8260D and E8260D); semi-volatile organic compounds (E8270E); and Zinc, Chromium, and Lead (SW 6020B).

Full reports from Specialty Analytical are provided in file analytical_chemistry.pdf.

Bayesian Estimator

As a starting point estimator, I constructed a hierarchical Bayesian model that combined the two observation streams (visual confirmation of deployment and recovery of canister) to infer about the underlying unknown number of canisters deployed by DHS (d_i). I explored potentially including a breakpoint for the intercept (Western and Kleykamp 2004) as well as a slope term for the rate of deployment as a function of crowd size. However, crowd size is significantly correlated with fed time ($r = 0.4$, $p = 0.006$), so we did not include it to avoid collinearity associated model convergence issues. The breakpoint model also did not behave well, which is understandable given the small size of the data set and the confounding impact of fed time. Thus, we kept the estimator simple to start.

The model's hourly rate rate of deployment (λ_i) is a log-linear (to handle Poisson response) function the raw intercept (λ^r) and stochastic error term (ε_i), and then is weighted by the time DHS agents were on the street/out of their buildings each night (FT_i). The number of canisters deployed each day is then a Poisson distribution with rate $\lambda_i * FT_i$ truncated at the minimum by the known cans deployed (C_i) and at the maximum by 20 to avoid fitting issues.

Equation 1 (Process Model)

$\varepsilon_i \sim \text{Normal}(0, \sigma^2)$
$\lambda_i = \exp(\lambda^r + \varepsilon_i)$
$d_i \sim \text{Poisson}(\lambda_i * FT_i)\ T(C_i, 20)$
$D = \sum d_i$

The true number of canisters deployed each day is unknown, but we can estimate it from the two sets of observations: visual confirmation of can deployments (o_i) and recovery of cans (r_i). Visual confirmation is a Binomial distribution governed by a detection rate (v). Similarly, recovery is a Binomial distribution controlled by a detection rate (ρ). The binomial distributions are truncated at the minimum values by the known number of observed (OC_i) and recovered (RC_i) cans (i.e., no false positives) each day. The observed distribution is truncated on the maximum side at $maxOC_i$, the number of cans deployed minus the number known to have not been observed but were recovered ($nORC_i$). The number of observed and not observed cans are then distributed among the three groupings for which we have data: observed and recovered (or_i), observed but not recovered (onr_i), and not observed but recovered (nor_i), as well as the fourth by difference (not observed or recovered $nonr_i$)

Equation 2 (Observation Model)

$o_i \sim \text{Binomial}(v, d_i)\ T(OC_i, maxOC_i)$
$r_i \sim \text{Binomial}(\rho, d_i)\ T(RC_i, 20)$
$maxOC_i = d_i - nORC_i$
$no_i = d_i - o_i$
$or_i \sim \text{Binomial}(\rho, o_i)$
$onr_i \sim \text{Binomial}(1- \rho, o_i)$
$nor_i \sim \text{Binomial}(\rho, no_i)$
$nonr_i = d_i - (or_i + onr_i + nor_i)$

Generally "uninformative" priors were used on the raw scale.

Equation 3 (Priors)

$\lambda^r \sim \text{Normal}(0, 1)$
$v^r \sim \text{Normal}(0, 1)$
$\rho^r \sim \text{Normal}(0, 1)$
$v = \text{ilogit}(v^r)$

$\rho = \text{ilogit}(\rho^r)$
$\sigma \sim \text{Uniform}(0, 100)$

I fit the model using JAGS (Just Another Gibbs Sampler, v4.2.0) (Plummer 2003, Plummer 2016) via the runjags v2.0.4-6 (Denwood 2016) R package (R Core Team 2020). I used four MCMC chains with varying starting values for parameters and ran each for 10,000 adaptation, 50,000 burn-in, and 1,000,000 final samples thinned to 10,000 per chain to toal 40,000 samples across chains. I evaluated chain convergence using the autocorrelation, sample size adjusted for autocorrelation, and Gelman-Rubin statistic (Gelman and Rubin 1992) for each parameter. I also conducted posterior predictive checks (Gelman et al. 2004) to quantify the capacity of our model to predict observations that resemble the observed data set. Statistical summaries are shown in Table 1.

Overall, the Gibbs sampler was able to efficiently and effectively search the joint posterior distribution (Eq. 1). Convergence was high among the parallel chains, as evidenced by the potential scale reduction factors (psrf, a.k.a. Gelman-Rubin statistic; Gelman and Rubin 1992) being all ~1.0 (Table 1). All parameters exhibited a low MCMC autocorrelation and had a resultantly large effective sample size (Table 1).

Source code is available in the provided files as jags.R.

Translation of $ZnCl_2$ Production to Potential Fatalities

I translated the total number of canisters deployed to human fatality potential focusing on production of $ZnCl_2$ gas. Using a simple set of unit conversions, a standard Military Style HC can contains 19 oz of HC mix Type C (Eaton et al. 1994), there are 28.4 g in an oz, assuming no loss of mass, 1 g of Type C mix generates 1 g products; $ZnCl_2$ constitutes 0.764 w/w of all products (Shaw et al. 2016), which translates to 412.25 g $ZnCl_2$ per military-style HC canister.

It is particularly difficult to gauge specifically the lethal dose or concentration of $ZnCl_2$, given the multiple modes of uptake (inhalation, orally via gulping/gasping, dermally). Thus, for a simple approximation, we use the LD50 value of 725 mg/kg, the midpoint of reported values for animal models (Blau and Sneider 2012). To be conservative, we use a 100 kg person, resulting in a lethal dose of 72.5 g. This then gives enough $ZnCl_2$ to cause 5.7 fatalities per can.

Source Code and Data

All data and code used in the manuscript are included in the submission as additional files.

Literature Cited

Blau, R. and N. Seidner. 2012. Hexachloroethane obscurant replacement. ATK Propulsion Systems. Strategic Environmental Research and Development Program. Report TR031214.

Denwood, M. J. 2016. runjags: An R Package Providing Interface Utilities, Model Templates, Parallel Computing Methods and Additional Distributions for MCMC Models in JAGS. Journal of Statistical Software, 71(9), 1-25. doi:10.18637/jss.v071.i09

Eaton, J. C., R. J. Lopinto, and W. G. Palmer. 1994. Health effects of hexachloroethane (HC) smoke. US Army Biomedical Research and Development Laboratory. Technical Report 9402.

Gelman, A. and D. B. Rubin. 1992. Inference from iterative simulation using multiple sequences. Statistical Science 7:457-511.

Gelman, A., J. B. Carlin, H. S. Stern, and D. B. Rubin. 2004. Bayesian Data Analysis. Chapman and Hall/CRC, London.

Greatwood, E. 2020. Veteran for Peace. https://www.facebook.com/EricGreatwood/videos

Idrissi, A. E., L. van Berkel, N. E. Bonekamp, D. J. Z. Dalemans, and M. A. G. van der Heyden. 2017. The toxicology of zinc chloride smoke producing bombs and screens. Clinical Toxicology 55:167-174.

Ooms, J. 2014. The jsonlite Package: A Practical and Consistent Mapping Between JSON Data and R Objects. arXiv:1403.2805 [stat.CO] https://arxiv.org/abs/1403.2805.

Plummer, M., N. Best, K. Cowles, and K. Vines. 2006. CODA: convergence diagnosis and output analysis for MCMC. R News 6: 7-11. oro.open.ac.uk/id/eprint/22547

Plummer, M. 2016. JAGS: Just Another Gibbs Sampler. v4.2.0. https://sourceforge.net/projects/mcmc-jags/files/JAGS/4.x/

R Core Team. 2020. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Shaw, A. P., J. S. Brusnahan, J. C. Poret, and L. A. Morris. 2016. Thermodynamic modeling of pyrotechnic smoke compositions. ACS Sustainable Chemistry and Engineering 4:2309−2315.

The Recompiler. 2020. RE: Portland. https://pdx.recompilermag.com/about/

Western, B. and M. Kleykamp. 2004. A Bayesian change point model for historical time series analysis. Political Analysis 12:354-374.

Wickham, H. 2019. httr: Tools for Working with URLs and HTTP. R package version 1.4.1. https://CRAN.R-project.org/package=httr

Tables

Table 1. Statistical fit results from the Bayesian estimator of HC canister use. See Equation 1.

	Lower 95	Median	Upper 95	Mean	SD	Mode	Mcerr	MC % of SD	SSeff	AC 1000	psrf
D	23	24	27	24.2	1.39	23	0.007	0.5	40000	0.001	1.00
λ^r	-3.397	-2.089	-0.843	-2.120	0.66		0.003	0.500	38335	-0.003	1.00
v^r	-2.182	-0.135	1.782	-0.129	1.01		0.005	0.500	40976	0.004	1.00
ρ^r	-0.091	0.563	1.227	0.567	0.34		0.002	0.500	40000	0.002	1.00
σ	0.000	1.243	7.425	2.228	3.28		0.027	0.800	14622	0.000	1.00

Figure Legends

Figure 3. Sample locations and pictures for the 11 environmental chemistry samples taken around the downtown area of present-day Portland, OR. (a) medic filter: filter medium from a NIOSH Organic Vapors DMA 6001 filter set worn by a medic only on 2020-07-27, 2020-07-28, 2020-07-29 in the area of SW 4th and Main. Medic only brought out mask when chemical weapons were used and always positioned themselves outside of the visible plume to treat individuals as they came out. (b) HC Can: dust/particle residue from inside Defense Technology Hexachloroethane (HC) Smoke can deployed and recovered post “completion” on 2020-07-28 night into 2020-07-29 (#14 in Appendix 1 Dossier). (c) A’s backpack: Cut out from a black Jansport backpack that was worn by a protester the night of 2020-07-23 and prepped for sampling thereafter. (d) 3rd and Salmon Plants: shrub within the fence at the Federal Courthouse and Tree at the corner of Lownsdale, samples taken 2020-07-27 night after a bleach smell was noticed and 2020-07-28 during the following daytime. (e) Lownsdale Surface Soil SW 3rd and Salmon: Scoop of topsoil from the NE corner of the park taken 2020-07-28 midday. (f) SW 3rd Street: samples of paper and other refuse on the street in front of the Federal courthouse on 3rd near Salmon from immediately after a bleach smell was noticed 2020-07-27 into 2020-07-28. (g) E’s Shirt: water taken from a soak of a shirt worn by a protester on 2020-07-26 into 2020-07-27, with noticeable bleach-like smell and visible loss of coloration. (h) Green Smoke: dust/particle residue from inside Defense Technology Green Smoke canister deployed and recovered post “completion” on 2020-07-28 into 2020-07-29. (i) S’s Leggings: water taken from a soak of leggings worn by protester recovering spent canisters 7-28 into 7-29. (j) Witches’ Tent: passive sample taken from existing cotton rounds, paper towels, etc that were present in the Witches’ medical tent in Lownsdale the night of when the tent reeked of bleach 2020-07-26. https://twitter.com/Cascadianphotog/status/1287714834893565952. (k) Spicy Bucket Scrape: residue scraped from inside of a Home Depot 5 gallon bucket used to cover smoke and gas canisters during 2020-07-27 and 2020-07-28 nights

Figures.

Figure 3.