

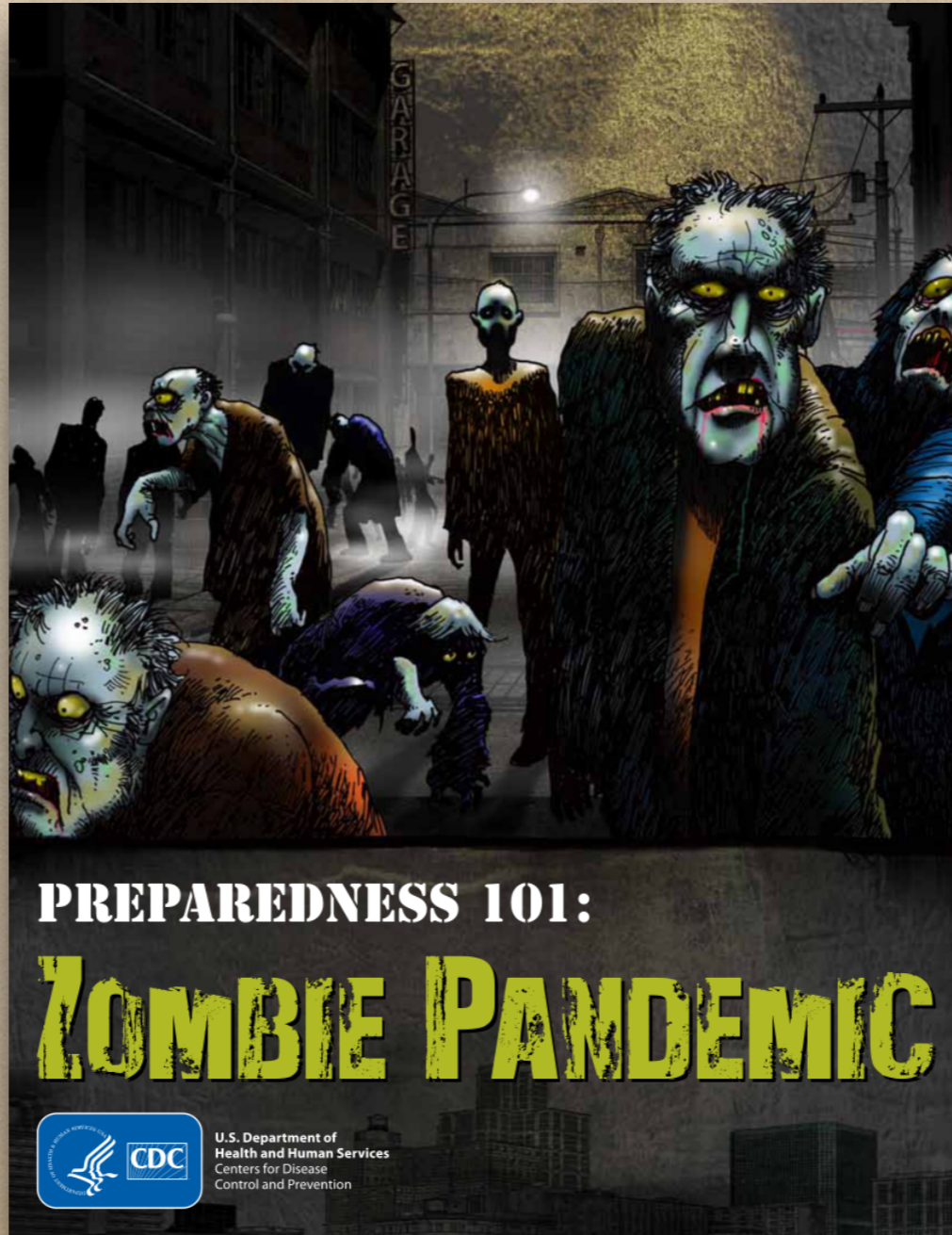
# ZOMBIE PREPAREDNESS

- improved zombie surveillance with



Michael Höhle  
Department of Mathematics  
Stockholm University

# ODO CAMPAIGN



Source: CDC Zombie Novella (click picture or see end for detailed source)



# OUTBREAKS

“Every undead outbreak, regardless of its class, has a beginning. Now that the enemy has been defined, the next step is early warning.”

The Zombie Survival Guide, p.25

# EARLY WARNING?

**ZOMBIEWARNING.COM**   
The Number One Zombie Attack Warning System Online

## Open Source Zombie Reporting Tracker

The information below is open source data reported to ZombieWarning.com. The information below has been entered into the tracker and is being made available for public viewing. We cannot guarantee the accuracy of the information contained in the Open Source Zombie Reporting Tracker.

Report Number	Country	Confirmed	Summary
Awaiting Data			

## Submit a report

If you have a report to submit for our review and *possible inclusion* on the Open Source Zombie Reporting Tracker, please send the information in an email to [report@zombiewarning.com](mailto:report@zombiewarning.com).



# SYNDROMIC SURVEILLANCE

## Google Trends for 'how to kill zombies'

doi:10.1038/nature07634

nature

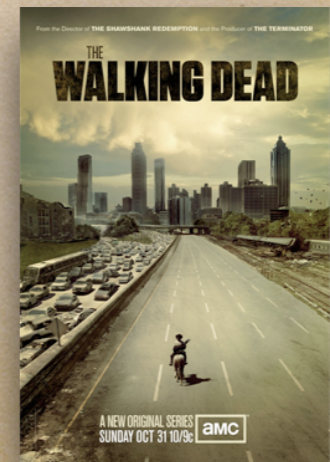
LETTERS

### Detecting influenza epidemics using search engine query data

Jeremy Ginsberg<sup>1</sup>, Matthew H. Mohebbi<sup>1</sup>, Rajan S. Patel<sup>1</sup>, Lynnette Brammer<sup>2</sup>, Mark S. Smolinski<sup>1</sup> & Larry Brilliant<sup>1</sup>



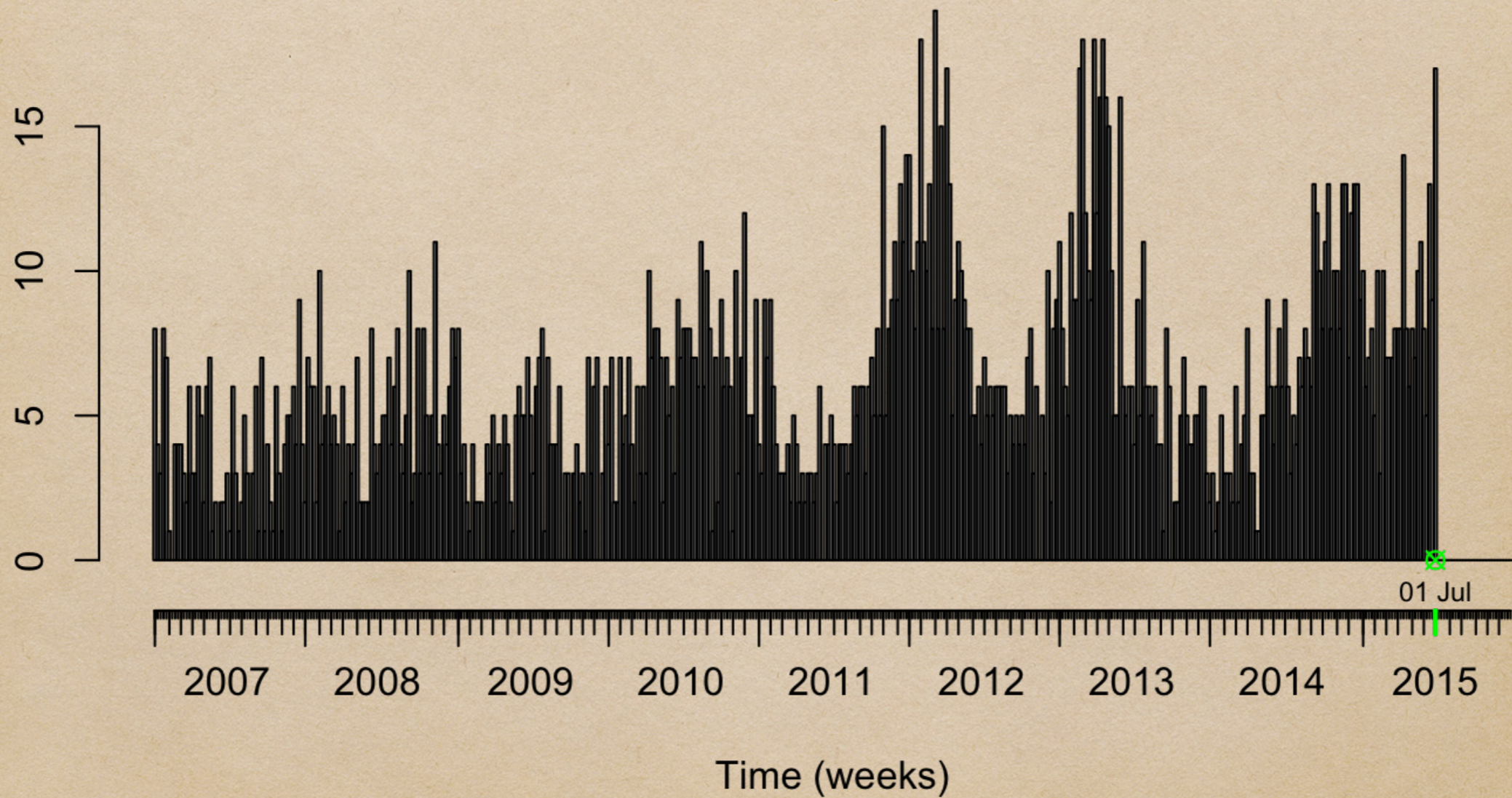
Start of the series  
'The walking dead'



# COUNT TIME SERIES APPROACH

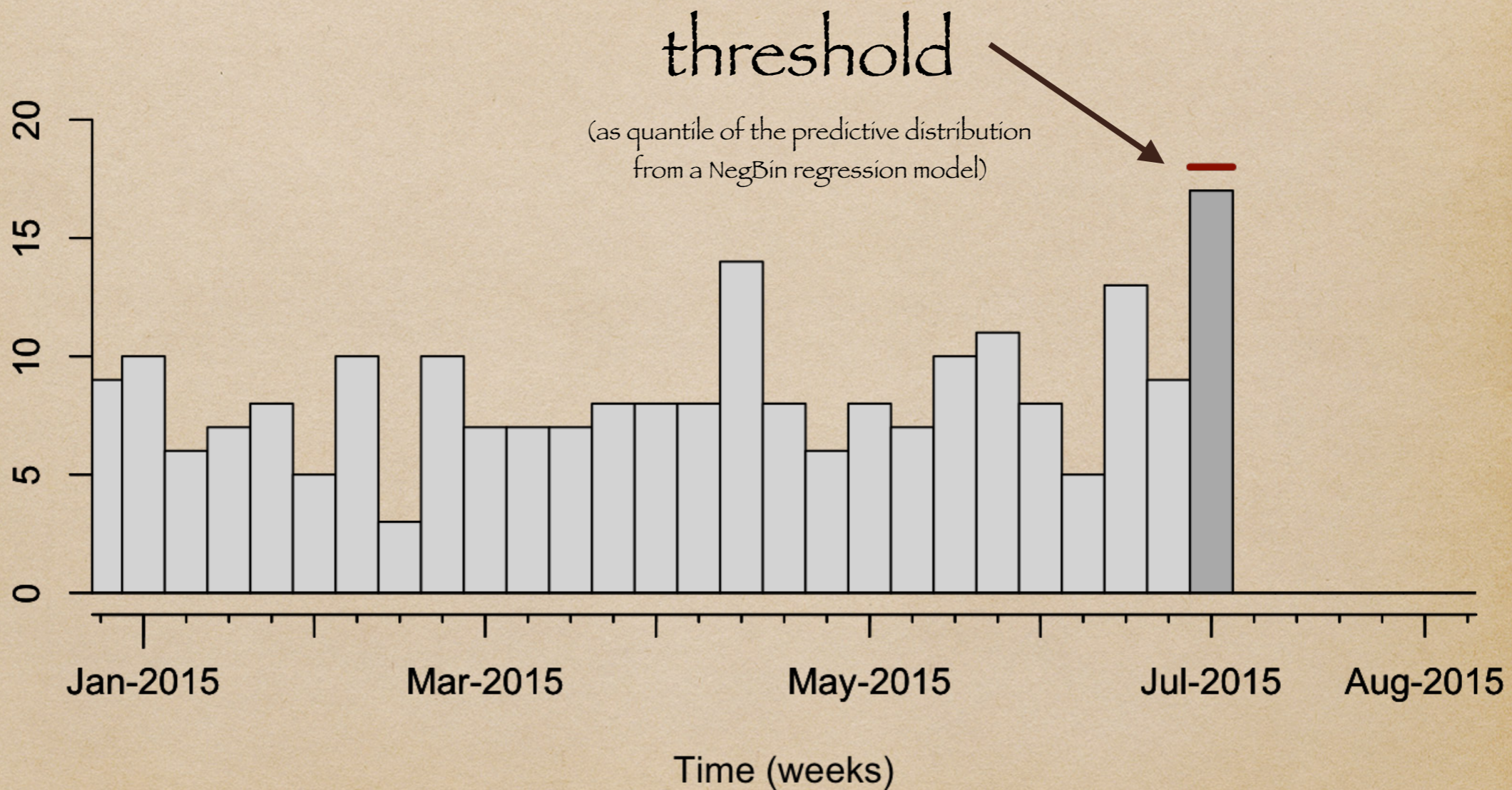
(for R/markdown backend of this part click picture or see last slide)

Homicides by headshots & decapitation



# ONE TIME POINT MONITORING

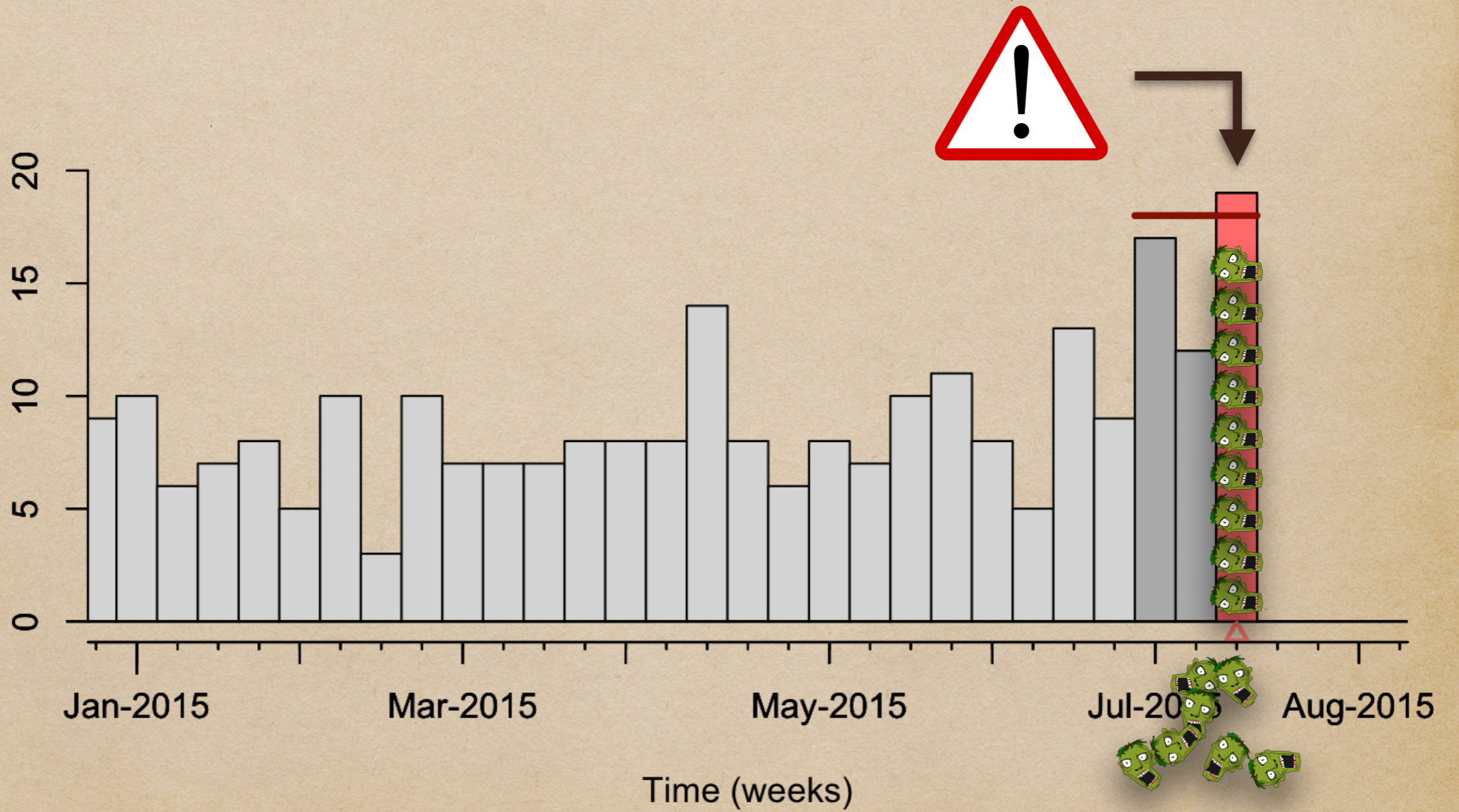
Homicides by headshots & decapitation





# REPEAT EACH WEEK

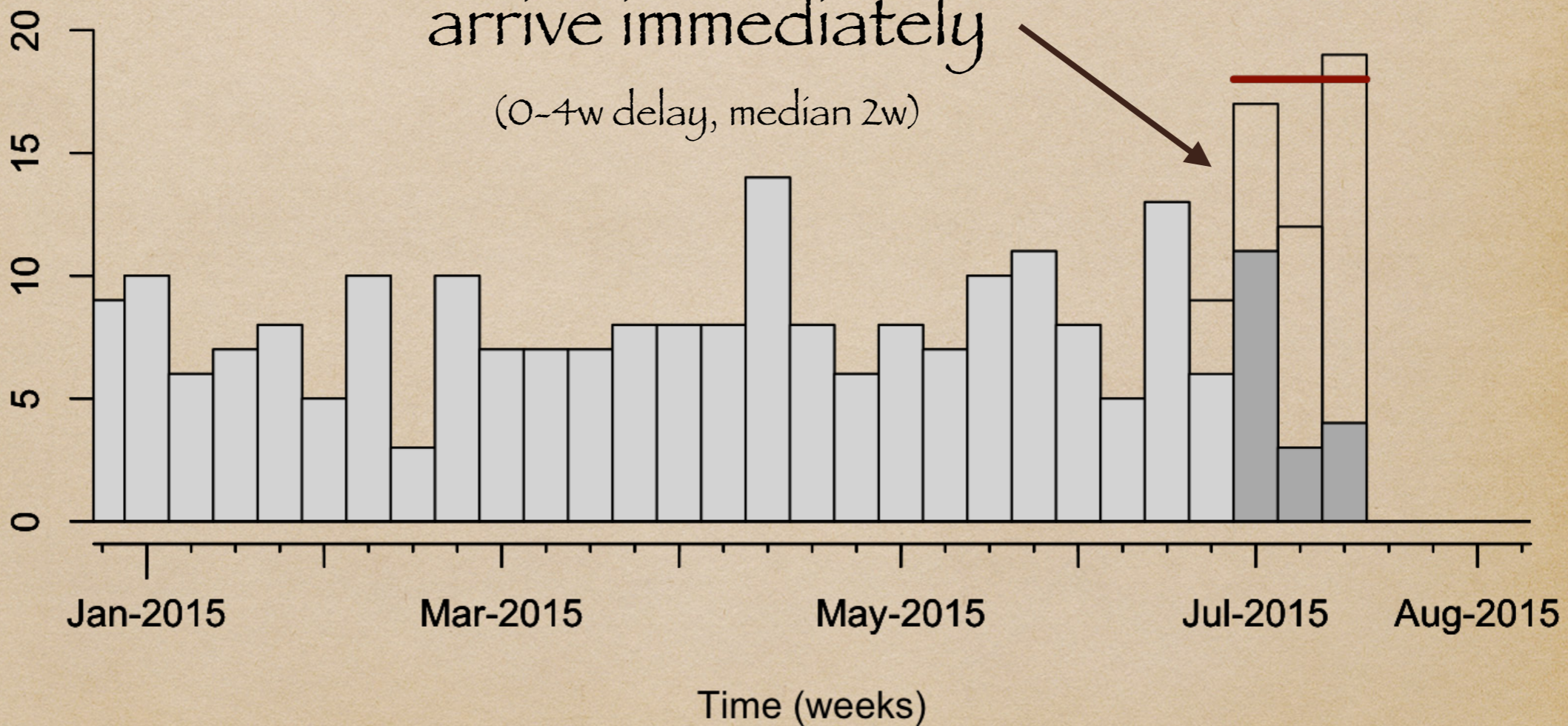
Homicides by headshots & decapitation



# REPORTING DELAYS

Reports don't  
arrive immediately  
(0-4w delay, median 2w)

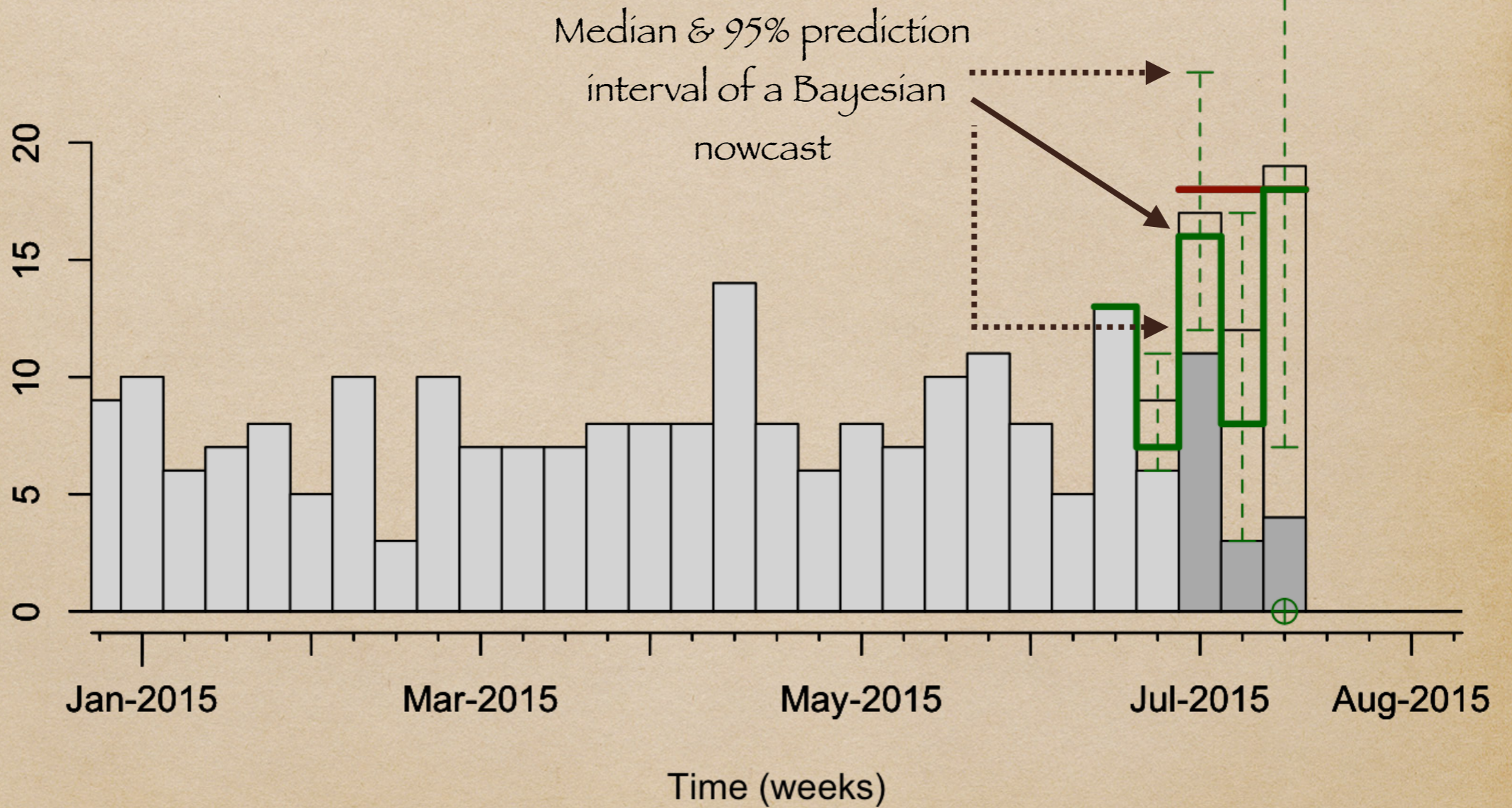
Homicides by headshots & decapitation



# NOWCASTING ZOMBIES

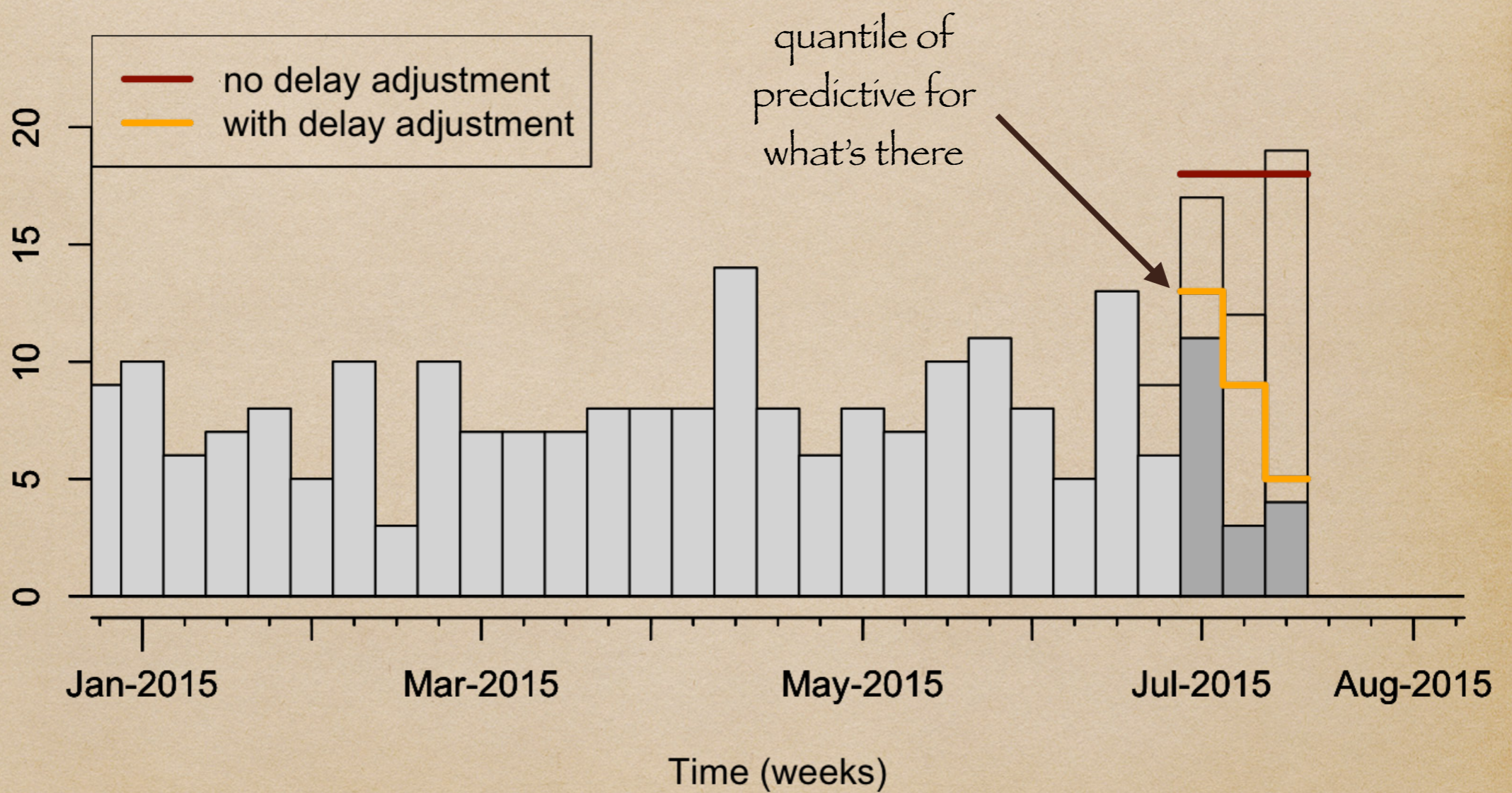


Homicides by headshots & decapitation



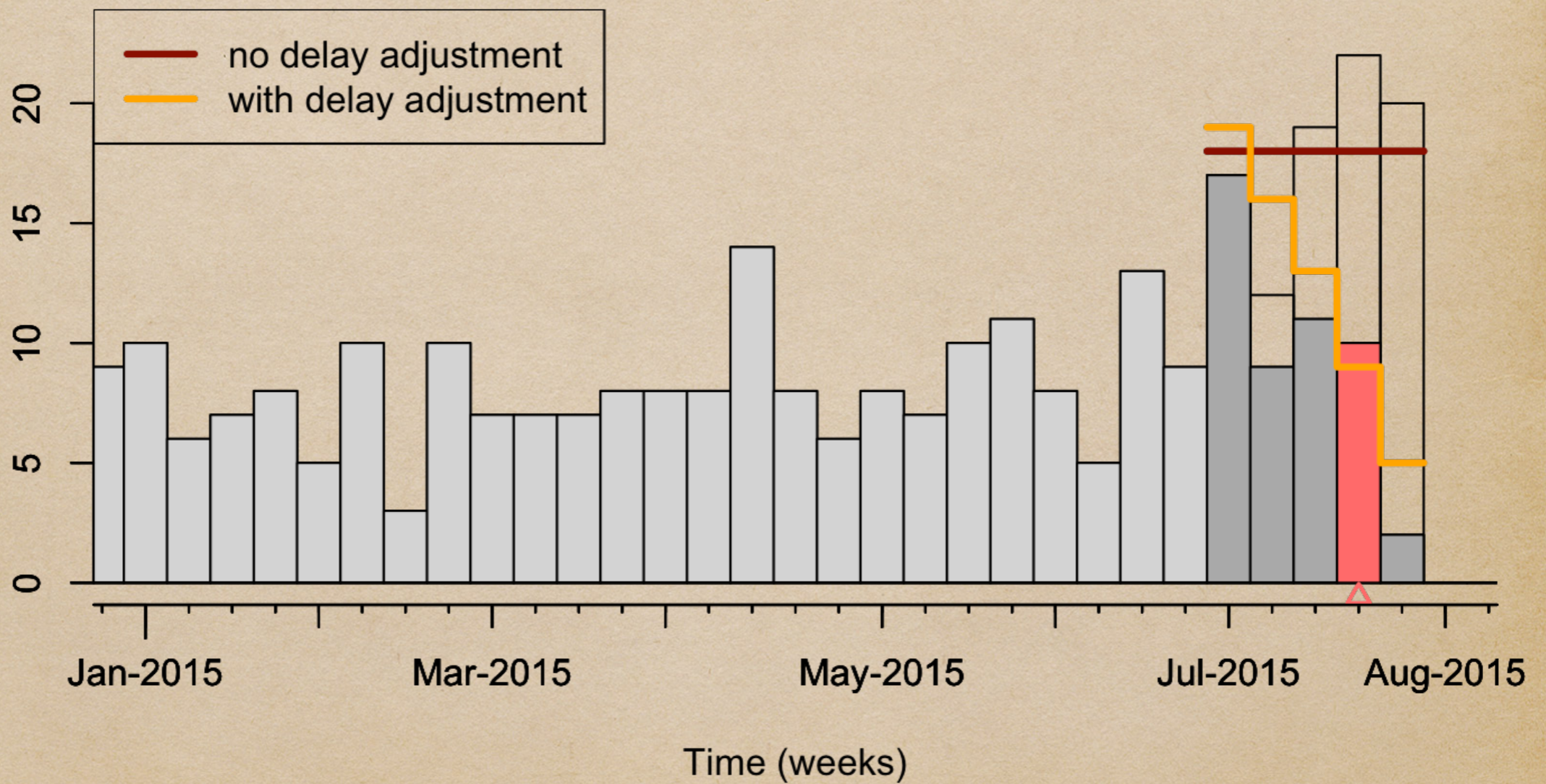
# ADJUSTED SURVEILLANCE

Homicides by headshots & decapitation



# ADJUSTED SURVEILLANCE

Homicides by headshots & decapitation



# IMPROVED ZOMBIE SURVIVAL



install.packages("surveillance")



# ZOMBIE FREE VERSION

Monitoring Count Time Series in R:  
Aberration Detection in Public Health  
Surveillance (2015), M. Salmon, D.  
Schumacher, M. Höhle, Conditionally  
accepted by 'Journal of Statistical Software'.

<http://arxiv.org/abs/1411.1292>

arXiv:1411.1292v1 [stat.CO] 5 Nov 2014

## Monitoring Count Time Series in R: Aberration Detection in Public Health Surveillance

Målle Salmon  
Robert Koch Institute

Dirk Schumacher  
Robert Koch Institute

Michael Höhle  
Stockholm University,  
Robert Koch Institute

### Abstract

Public health surveillance aims at lessening disease burden, *e.g.*, in case of infectious diseases by timely recognizing emerging outbreaks. Seen from a statistical perspective, this implies the use of appropriate methods for monitoring time series of aggregated case reports. This paper presents the tools for such automatic aberration detection offered by the R package `surveillance`. We introduce the functionality for the visualization, modelling and monitoring of surveillance time series. With respect to modelling we focus on univariate time series modelling based on generalized linear models (GLMs), multivariate GLMs, generalized additive models and generalized additive models for location, shape and scale. This ranges from illustrating implementational improvements and extensions of the well-known Farrington algorithm, *e.g.*, by spline-modelling or by treating it in a Bayesian context. Furthermore, we look at categorical time series and address overdispersion using beta-binomial or Dirichlet-Multinomial modelling. With respect to monitoring we consider detectors based on either a Shewhart-like single timepoint comparison between the observed count and the predictive distribution or by likelihood-ratio based cumulative sum methods. Finally, we illustrate how `surveillance` can support aberration detection in practice by integrating it into the monitoring workflow of a public health institution. Altogether, the present article shows how well `surveillance` can support automatic aberration detection in a public health surveillance context.

**Keywords:** R, `surveillance`, outbreak detection, statistical process control.

### Introduction

Nowadays, the fight against infectious diseases does not only require treating patients and setting up measures for prevention but also demands the timely recognition of emerging outbreaks in order to avoid their expansion. Along these lines, health institutions such as hospitals and public health authorities collect and store information about health events – typically represented as individual case reports containing clinical information, and subject to specific case definitions. Analysing these data is crucial. It enables situational awareness in general and in particular the timely detection of aberrant counts empowering the prevention of additional disease cases through early interventions. For any specific aggregation of characteristics of events, such as over-the-counter sales of pain medication, new cases of foot-and-mouth disease among cattle, or adults becoming sick with hepatitis C in Germany, data can be represented as time series of counts with days, weeks, months or years as time units of the aggregation. Abnormally high or low values at a given time point can reveal

don't read it!



# SOURCES & REFERENCES

(not shown as part of the lightning talk)

- ◆ slide 1: All slide titles are written in the free 'Exquisite corpse' font by Sinister Fonts. The zombie silhouette is by cliparteles available from <https://openclipart.org>.
- ◆ slide 2: The picture is p.1 of the graphic novel, "Preparedness 101: Zombie Pandemic" by the CDC campaign.
- ◆ slide 3: Zombie Survival guide cover picture from Wikipedia (follow the link by clicking on the picture).
- ◆ slide 5: The zombie head is done by quadrochave available at <https://openclipart.org>.
- ◆ slide 6: Click the links to get to the paper, the google trend or information about the series.
- ◆ slide 9: Warning sign is done by Steren available at <https://openclipart.org>.
- ◆ slide 14: This is the Preparedness 101 - Zombie Posters by the CDC campaign. The R logo is taken from <http://www.r-project.org/>. The 'monitoring' clipart is by GDJ and the working nerd is by valessiobrito both available at <https://openclipart.org>.
- ◆ slide 15: You may also want to read: Bayesian outbreak detection in the presence of reporting delays (2015), Salmon M, Schumacher D, Stark K, Höhle M. To appear in Biometrical Journal or 'Bayesian Nowcasting during the STEC O104:H4 Outbreak in Germany, 2011' (2014), Höhle M and an der Heiden M. Biometrics, 70(4):993-1002. The two papers contain the statistical background for the nowcasting & delay adjusted surveillance.

Note: R/markdown backend of the presentation is available from the R-Forge page.