

Trends in Reported Foodborne Illness in the United States: 1996-2013

Mark Powell

U.S. Department of Agriculture, Office of Risk
Assessment and Cost-Benefit Analysis
Washington, DC

International Association for Food Protection

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INTRODUCTION

- Current statistical methods for analyzing FoodNet data make pair-wise comparisons between most recent surveillance year and one or more baseline periods.
- Advantage: avoids specifying model form for trend
- Disadvantage: can't distinguish trends from year to year variability
- Objective: Analyze trends in reported U.S. foodborne illness with/without specifying model form for trend

DATA

- FoodNet (Foodborne Diseases Active Surveillance Network) data: 1996-2013
 - Reported illness counts by site (State_EntYr) and year
 - Population size by site and year (increased over time)
 - FoodNet composition stable since 2004
- *Campylobacter*
- *Listeria*
- *Salmonella*
- *Shigella*
- STEC O157
- *Vibrio*
- *Yersinia*

METHODS

- Poisson Log-Linear Model with Site (1996-2013)
 - $\text{Log}(\text{count}_{ij}) (y_{ij}) = \log(\text{population}_{ij}) + b_0 + b_1(\text{Year}_i) + b_j(\text{Site}_j) + \varepsilon_{ij}$
 - $E[y_i] = \mu_i$ (point on predictive curve)
 - Poisson (count) model is heteroscedastic
 - Generalized Poisson dispersion: $\text{Var}[y_i] = \phi\mu_i$
 - Negative Binomial dispersion: $\text{Var}[y_i] = \mu_i + \delta\mu_i^2$
 - Differs from CDC method in that time is treated as a continuous covariate, considers generalized Poisson as well as negative binomial dispersion
- A conventional approach, but assumes log-linear trend

METHODS

- Penalized B-spline Regression
 - Semi-parametric method – no assumed trend model form
 - B-spline basis functions provide local control, local fit is insensitive to points far removed
 - Penalized form of B-spline regression is insensitive to number, placement of join-points (“knots”)

METHODS

- X: cubic B-spline basis with 2 internal knots
 - 6 basis functions (unconstrained)
- S: 2nd order difference matrix
 - penalize differences among neighboring coefficients (β)
- All Sites (1996-2013)
 - Composition of FoodNet sites stable since 2004
- Original 5 Sites (1996-2013)
 - Attempt to control for changes in FoodNet composition over time

Preliminary Results: Poisson Log Linear Model

- Significant Negative Trend Term
 - *Campylobacter*, *Listeria*, *Shigella*, STEC O157, and *Yersinia*
- Significant Positive Trend Term
 - *Vibrio*
- Significant Site-Level Effects
 - All pathogens

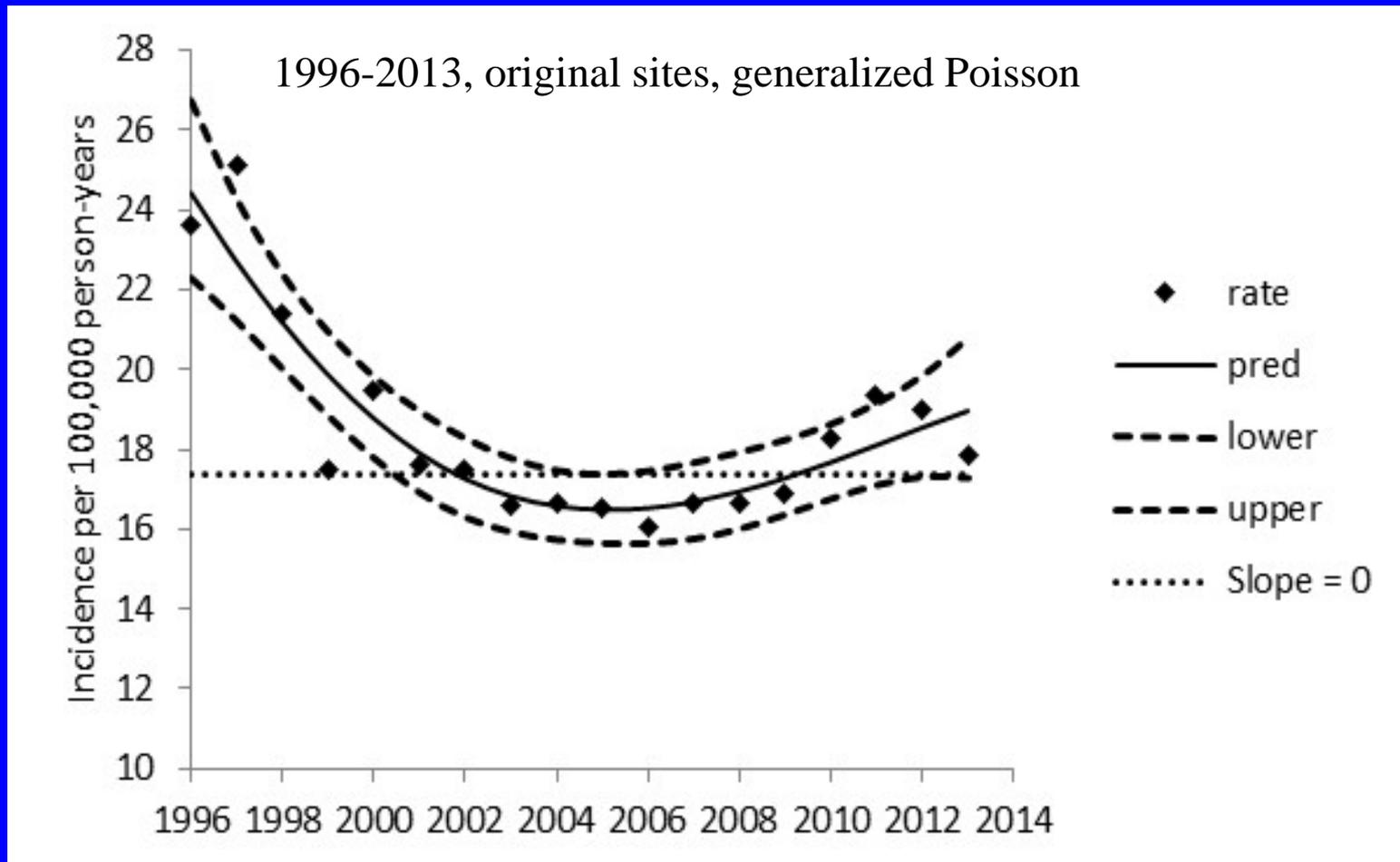
Preliminary Results: Poisson Log Linear Model

- *Salmonella*
 - Significant Positive Trend Term for Generalized Poisson
 - No Significant Trend Term for Negative Binomial
- Generalized Poisson better fit than Negative Binomial
 - All pathogens (incl. *Salmonella*)
- Log linear model not a good overall fit

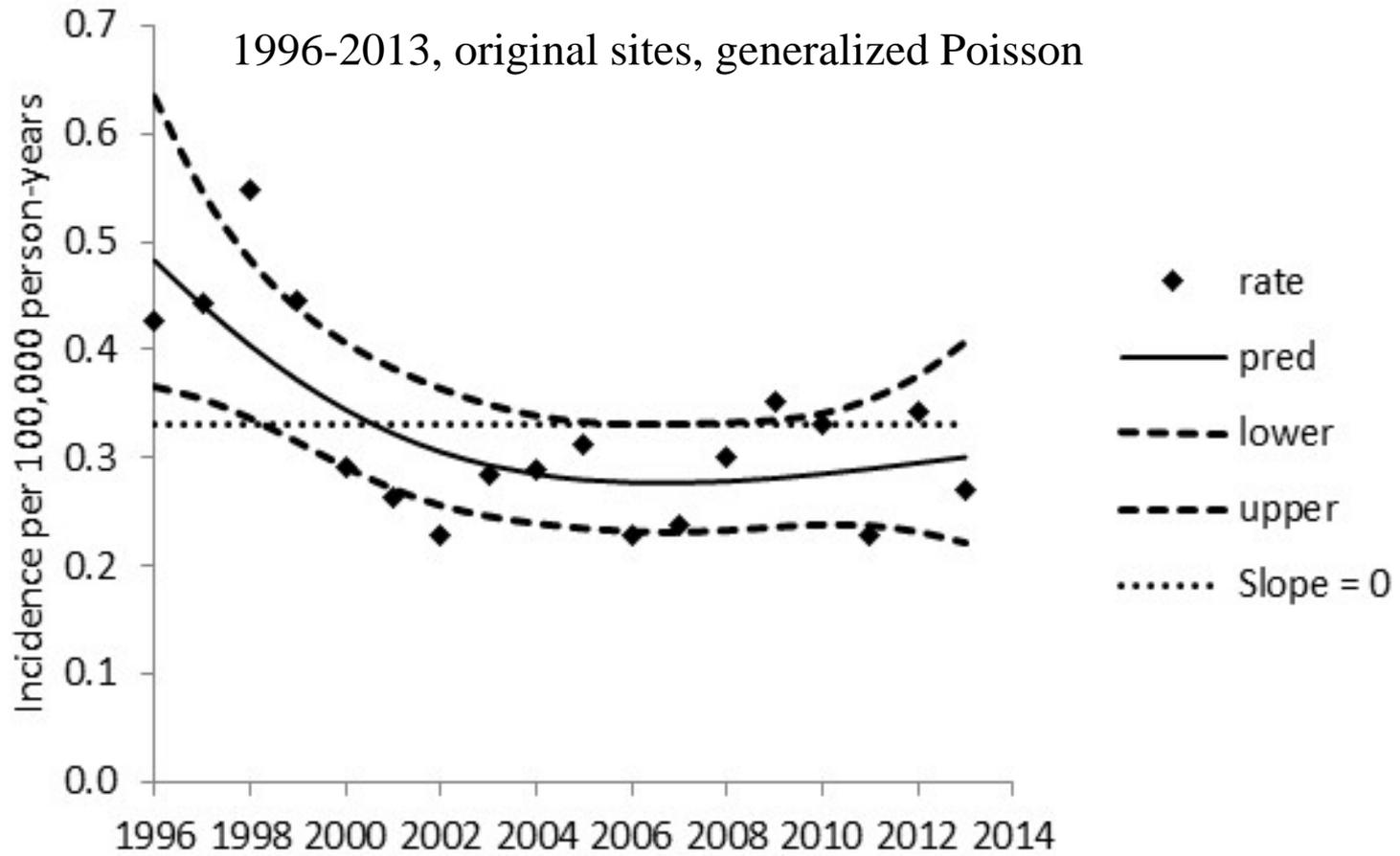
Preliminary Results: Penalized B-Spline Regression

- *Campylobacter, Listeria, STEC O157, Yersinia*
- Early declines followed by a period of no significant trend
- Results consistent for All Sites, Original Sites, Generalized Poisson, Negative Binomial

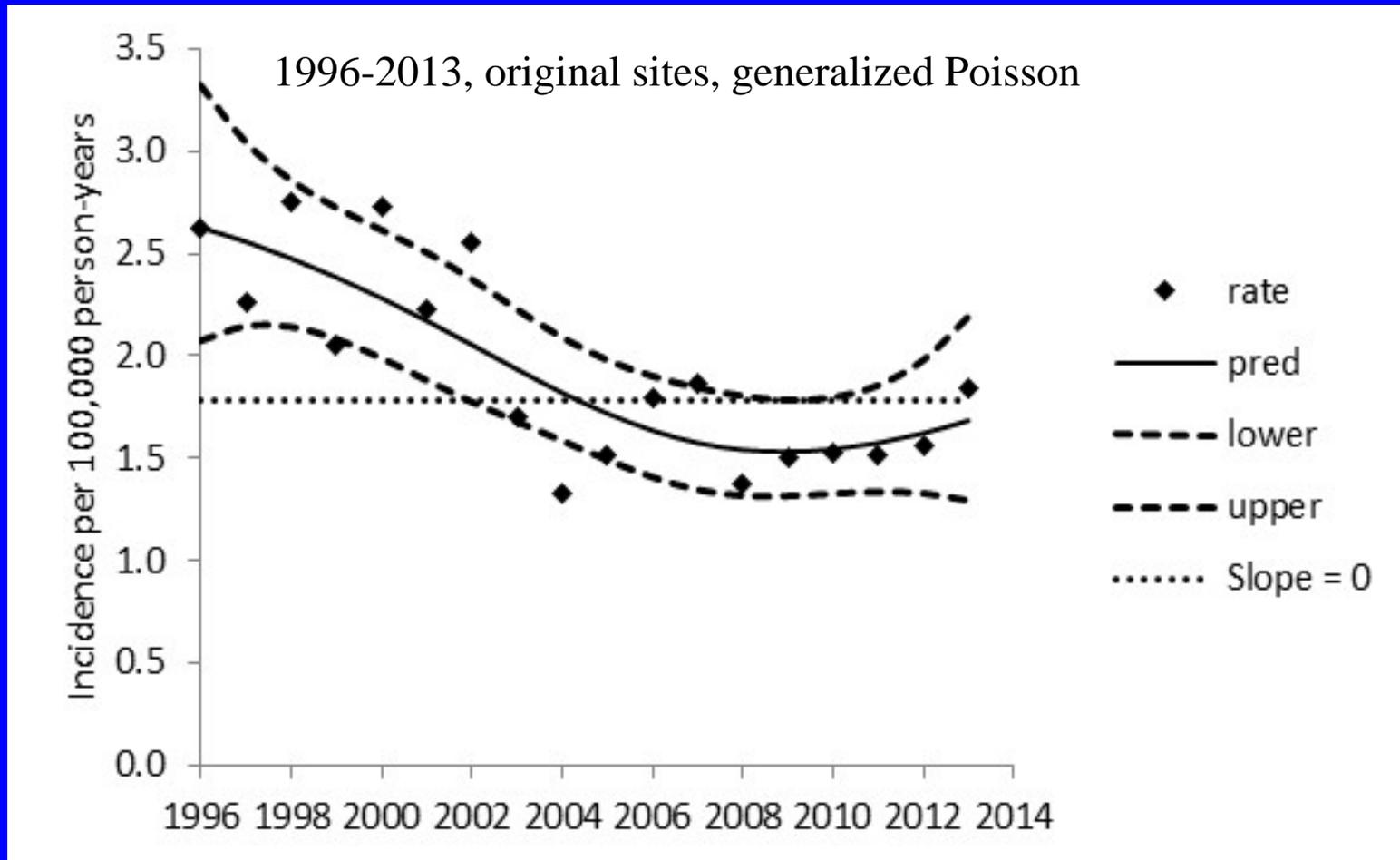
Campylobacter



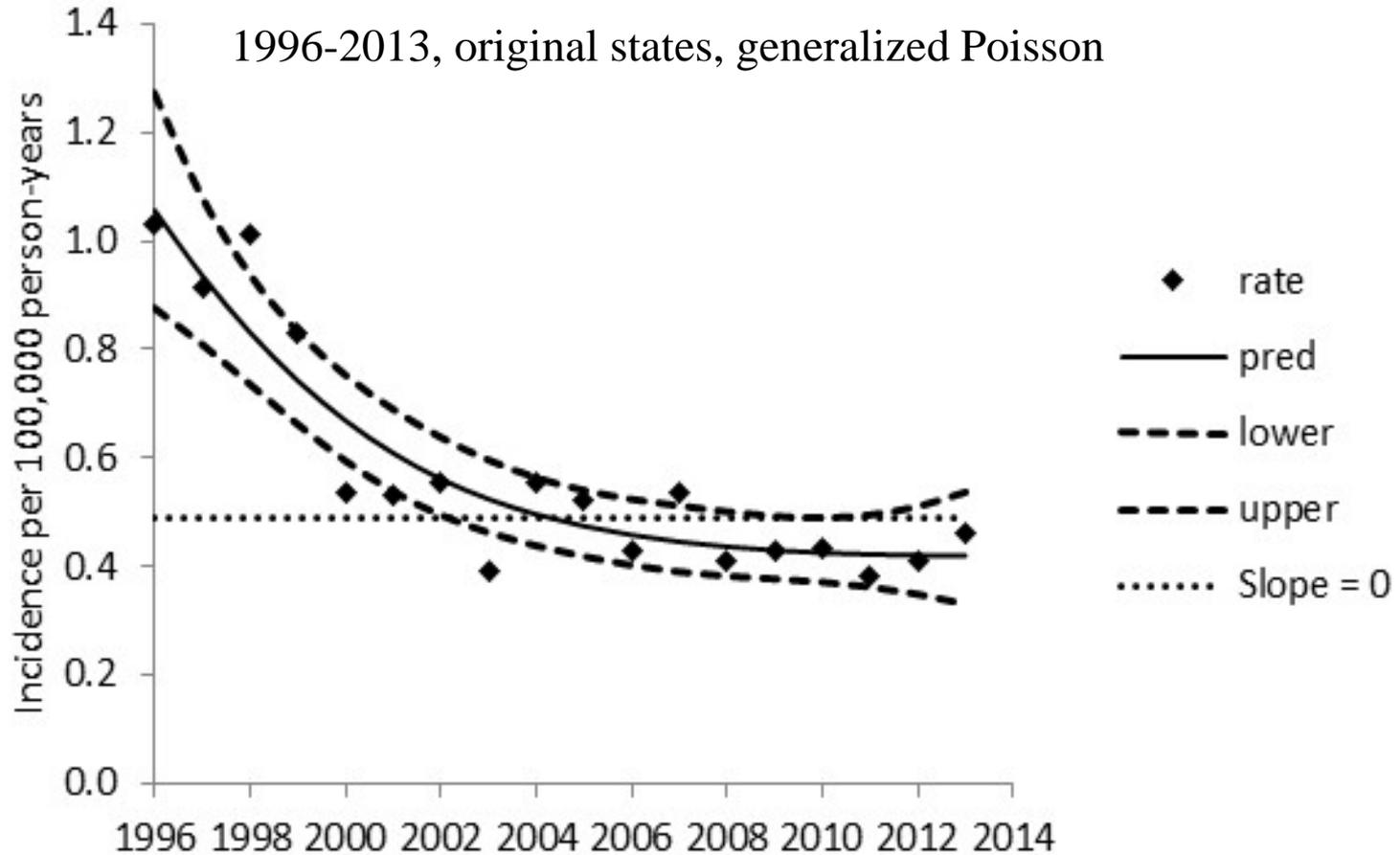
Listeria



STEC 0157



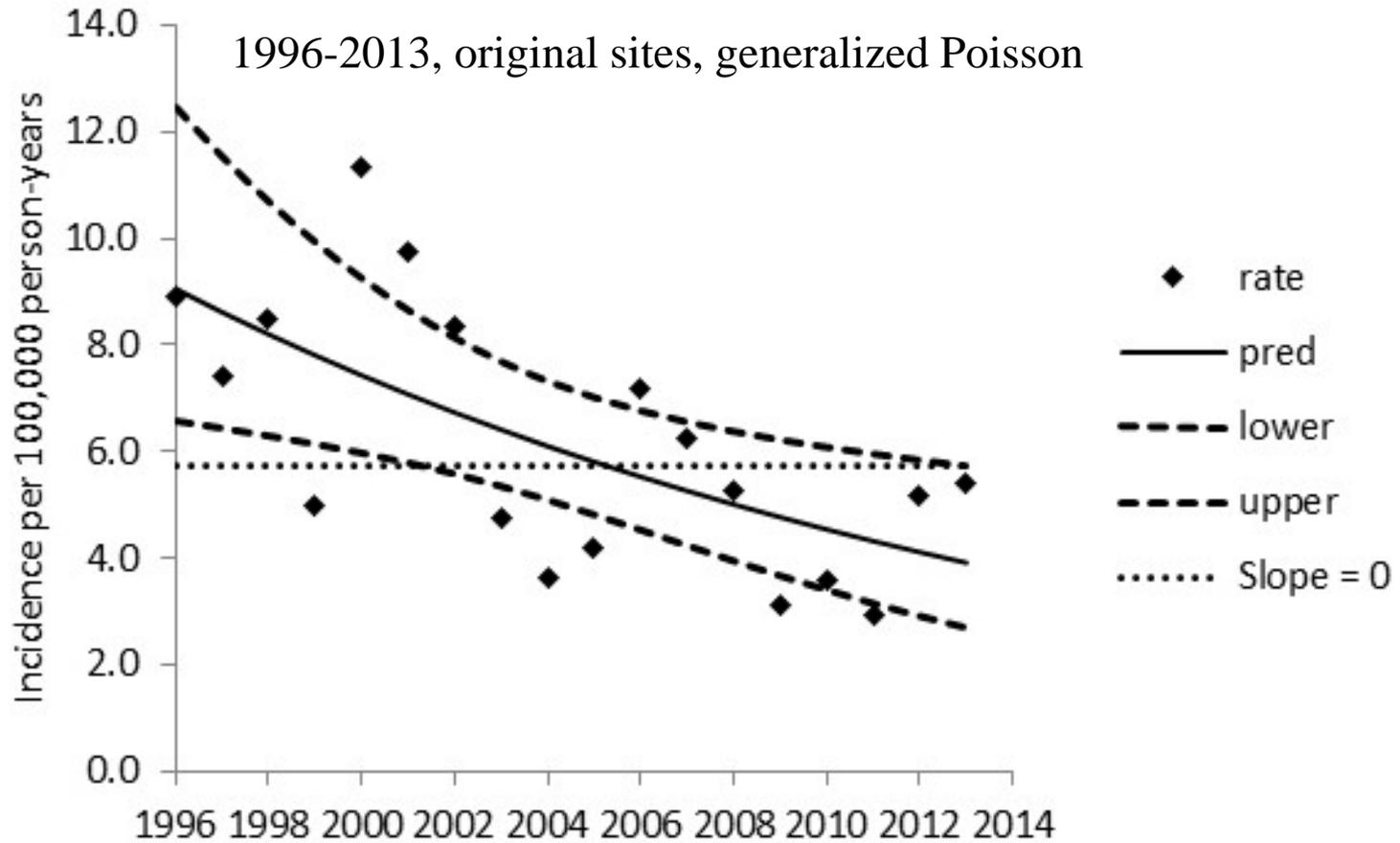
Yersinia



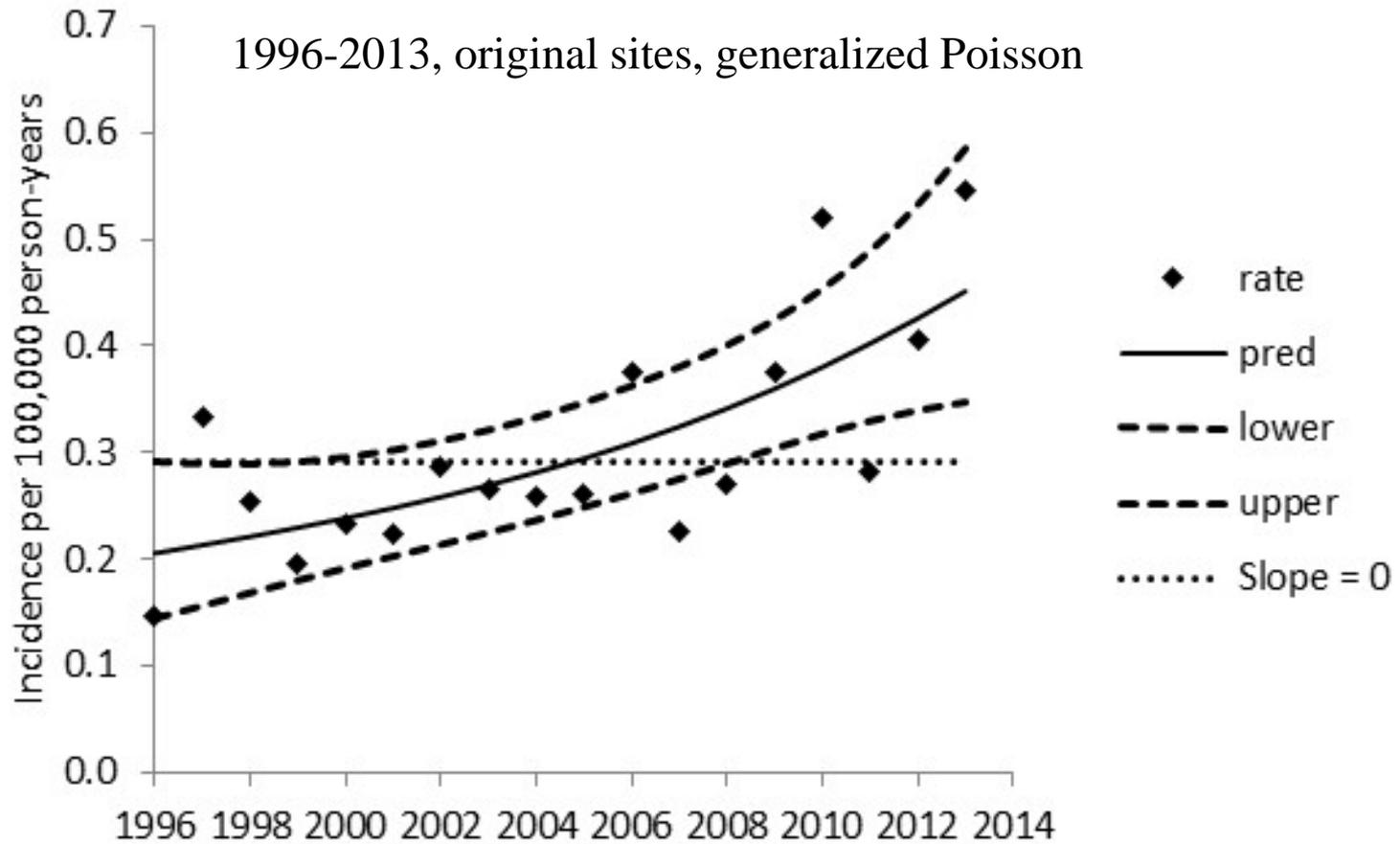
Preliminary Results: Penalized B-Spline Regression

- *Shigella* and *Vibrio*
- Continuous trends without an apparent plateau
- *Shigella* decreasing
- *Vibrio* increasing
- Results consistent for All Sites, Original Sites, Generalized Poisson, Negative Binomial

Shigella



Vibrio



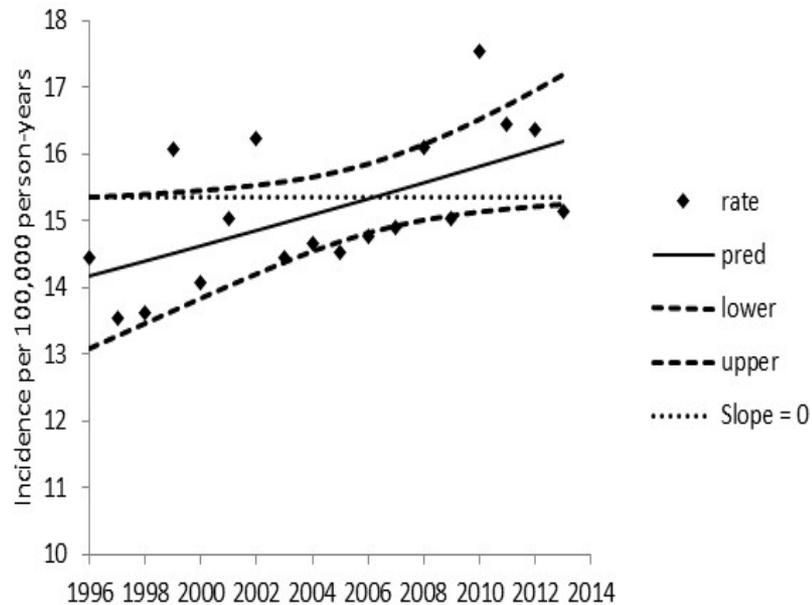
Preliminary Results

Penalized B-Spline Regression

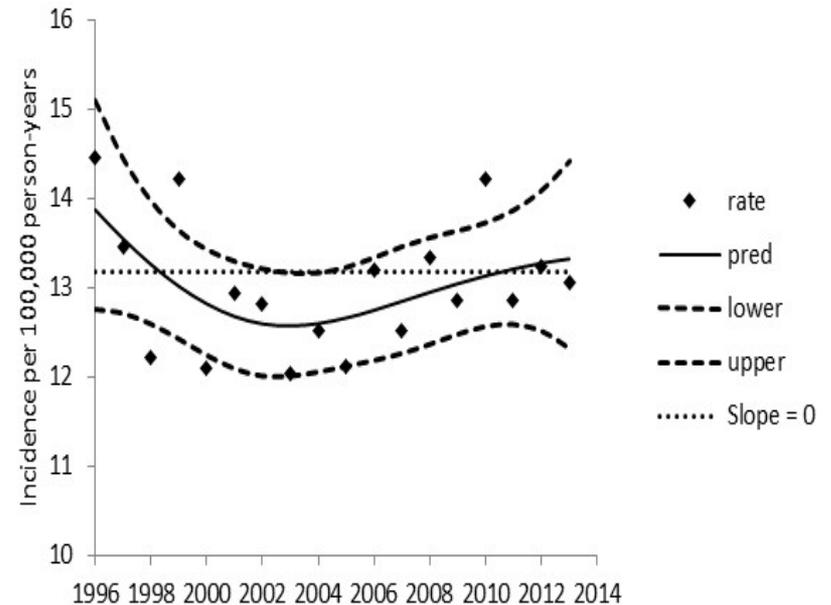
- *Salmonella*
- Inconclusive whether there is no trend or an increasing trend
 - Significant Trend in All Sites, 1996-2013
 - Inf. Smooth → Log-linear model ($p < 0.01$)
 - No Trend in Original 5 Sites, 1996-2013

Salmonella

All Sites, 1996-2013



Original Sites, 1996-2013



SUMMARY

- Early decline followed by year-to-year variability about lower level
 - *Campylobacter*, *Listeria*, STEC O157, *Yersinia*
- Continuous decline
 - *Shigella*
- Continuous increase
 - *Vibrio*
- Inconclusive whether increase or no trend
 - *Salmonella*

Limitations

- Results are preliminary
- Reported illness is a proxy, not true incidence
- Not all FoodNet reported illness is foodborne
- Assumes data missing at random
- Descriptive model, not infer causes
- Uncertainty about generalizing from FoodNet population to national level not quantified

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Disclaimers

- Results are preliminary and have not been subject to a formal peer review process.
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Thank you