Evidence of Effectiveness of Egg Quality Assurance Programs, Mandatory Refrigeration, and Traceback Investigations to Mitigate Egg-associated *Salmonella* Enteritidis Infections in the United States

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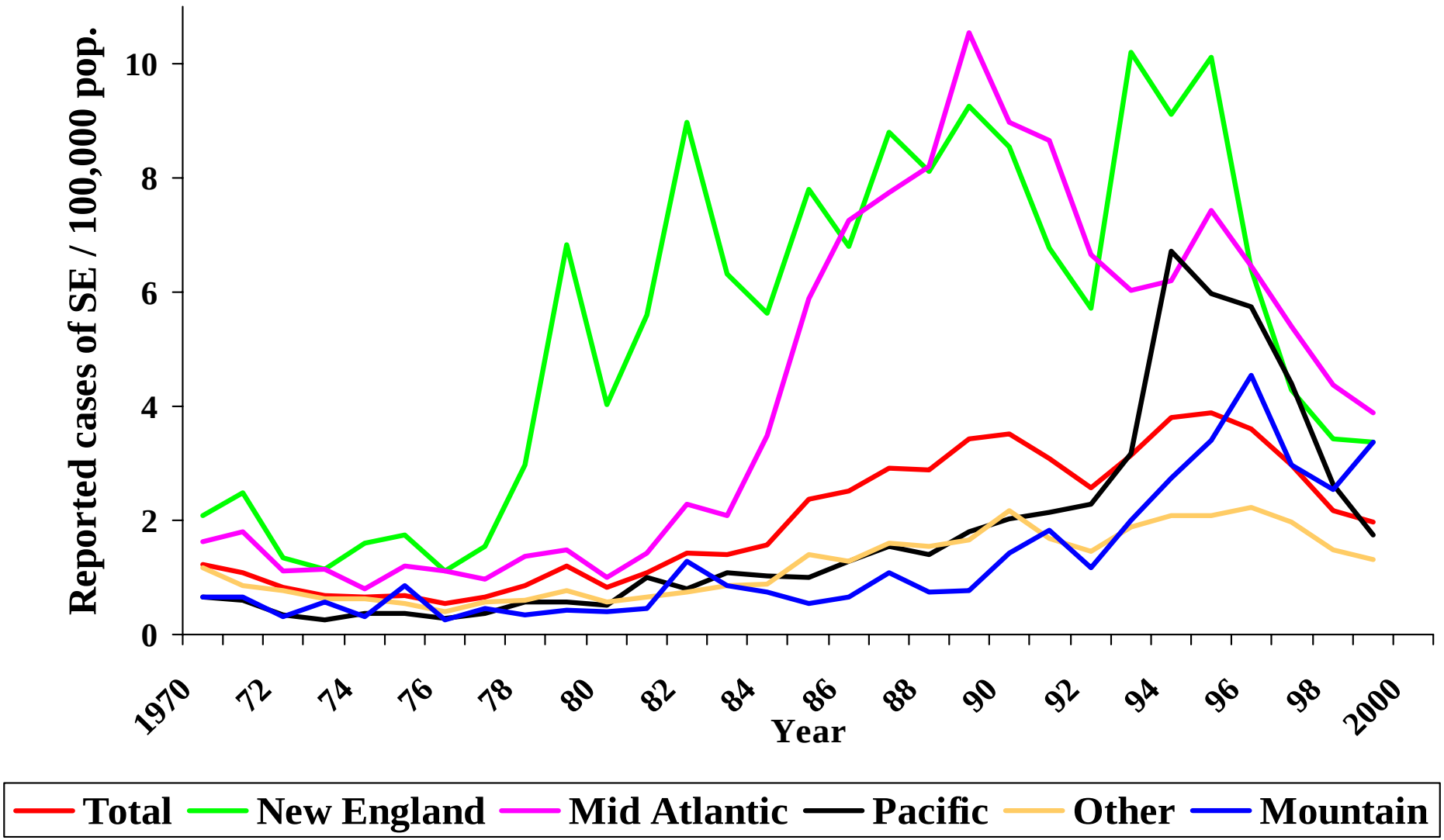
Emergence and Decline of *Salmonella* Enteritidis (SE), United States, BY Region.



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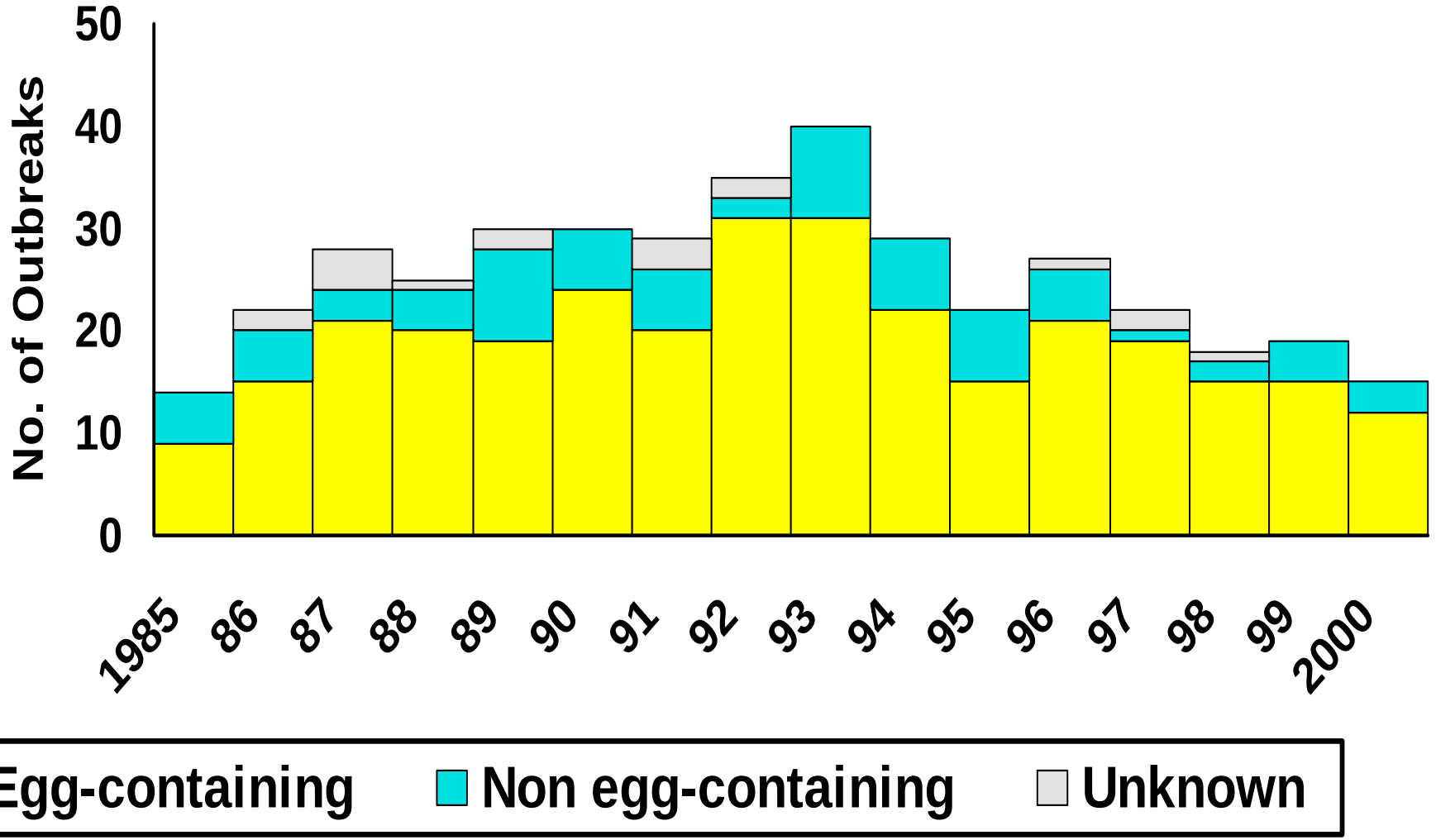
Outbreaks of SE With Confirmed Vehicle, by Egg Status, 1985-2000



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Egg-related Interventions to Mitigate SE (Three Examples).

- Mandatory shell egg refrigeration (by states)
- Traceback investigations from SE outbreaks to the source of eggs and the farm (by USDA/FDA)
- Egg quality assurance programs (EQAPs)
  - Voluntary and instituted within states
  - Typical components
    - Clean and disinfect poultry houses
    - Test the egg production environment for SE
    - Use pest control measures
    - Obtain SE free chicks
    - Wash, clean, and promptly refrigerate eggs

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Objectives.

- **Examined correlations between**
  - **introduction of programs to reduce SE contamination in eggs**
  - **changes in SE incidence in humans**

- **Specifically:**
  - **Mandatory refrigeration of shell eggs**
  - **SE traceback investigations from egg-associated outbreaks**
  - **Egg Quality Assurance Programs (EQAPs)**

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Methods: Data Collection.

- **Determined SE incidence by state, using:**
  - **SE isolations reported through the National *Salmonella* Surveillance System.**
  - **Census data, 1970-1999.**
- **Sent questionnaires to 50 states**
  - **Mandatory refrigeration of eggs? When?**
  - **EQAPs? When?**
- **Sought SE traceback investigations data from USDA&FDA.**
- **Obtained data on egg production, by state.**
  - *For each intervention, we compared the SE incidence before and after in groups of states.*

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Survey Results.

- 41 states responded
- 33 had an SE problem (defined as > 1 SE infection/100,000 pop/year)
- 20 of the 33 states had a mandatory refrigeration requirement of eggs.
- USDA traceback investigations led to 6 farms located in some of these 33 states
- FDA traceback reports do not identify the state
- 11 states had an EQAP

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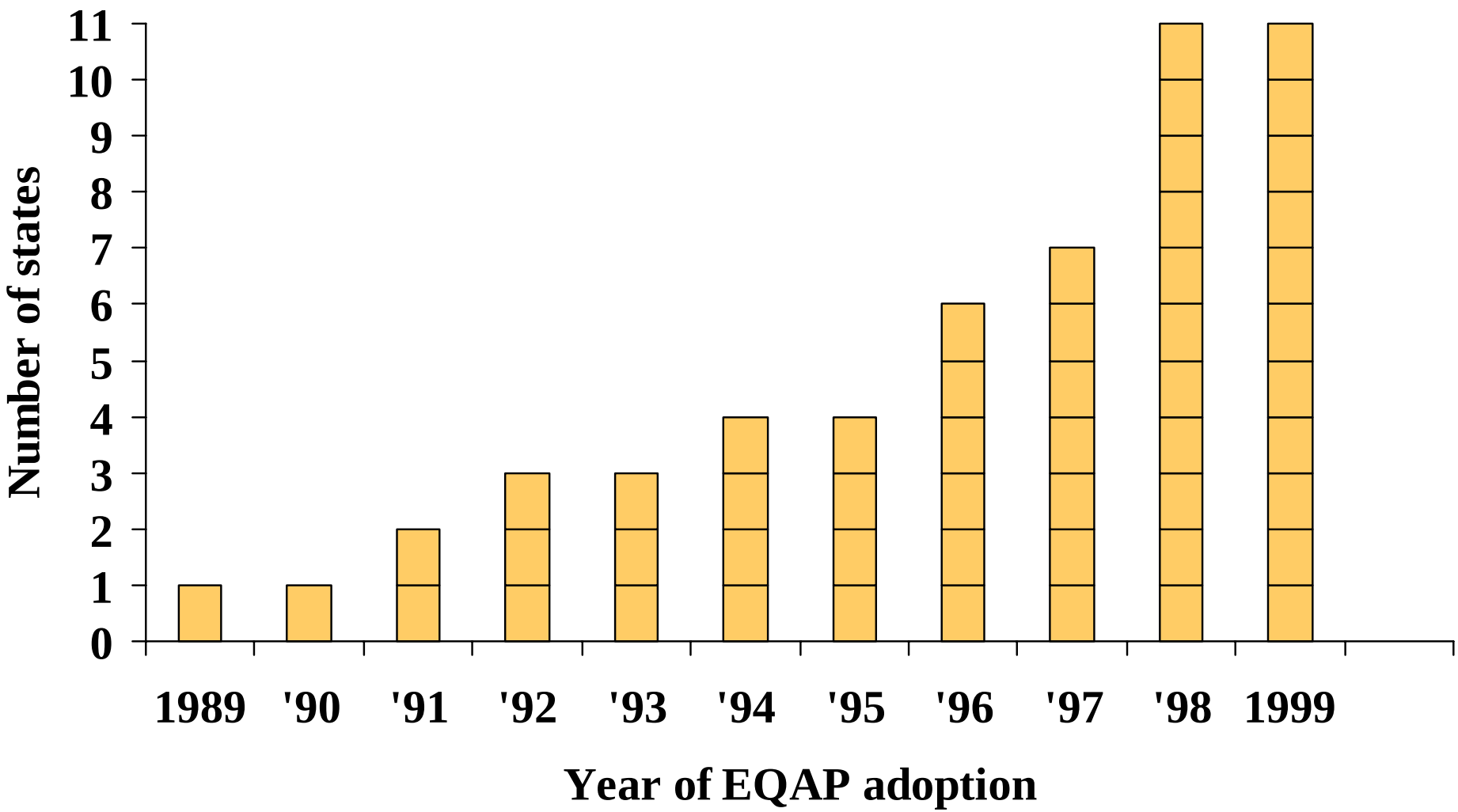
States With EQAPs, By Year (N=11).



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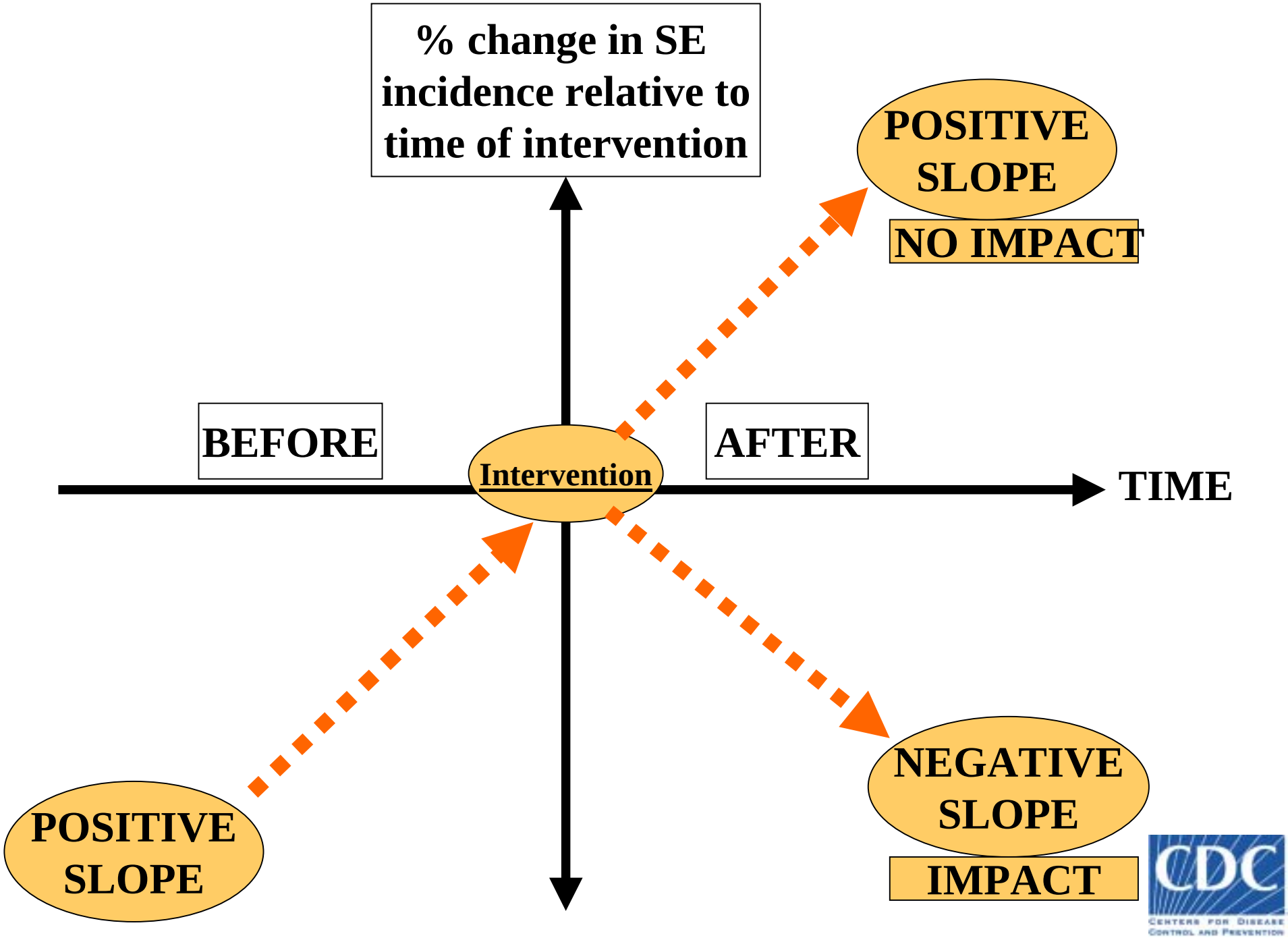
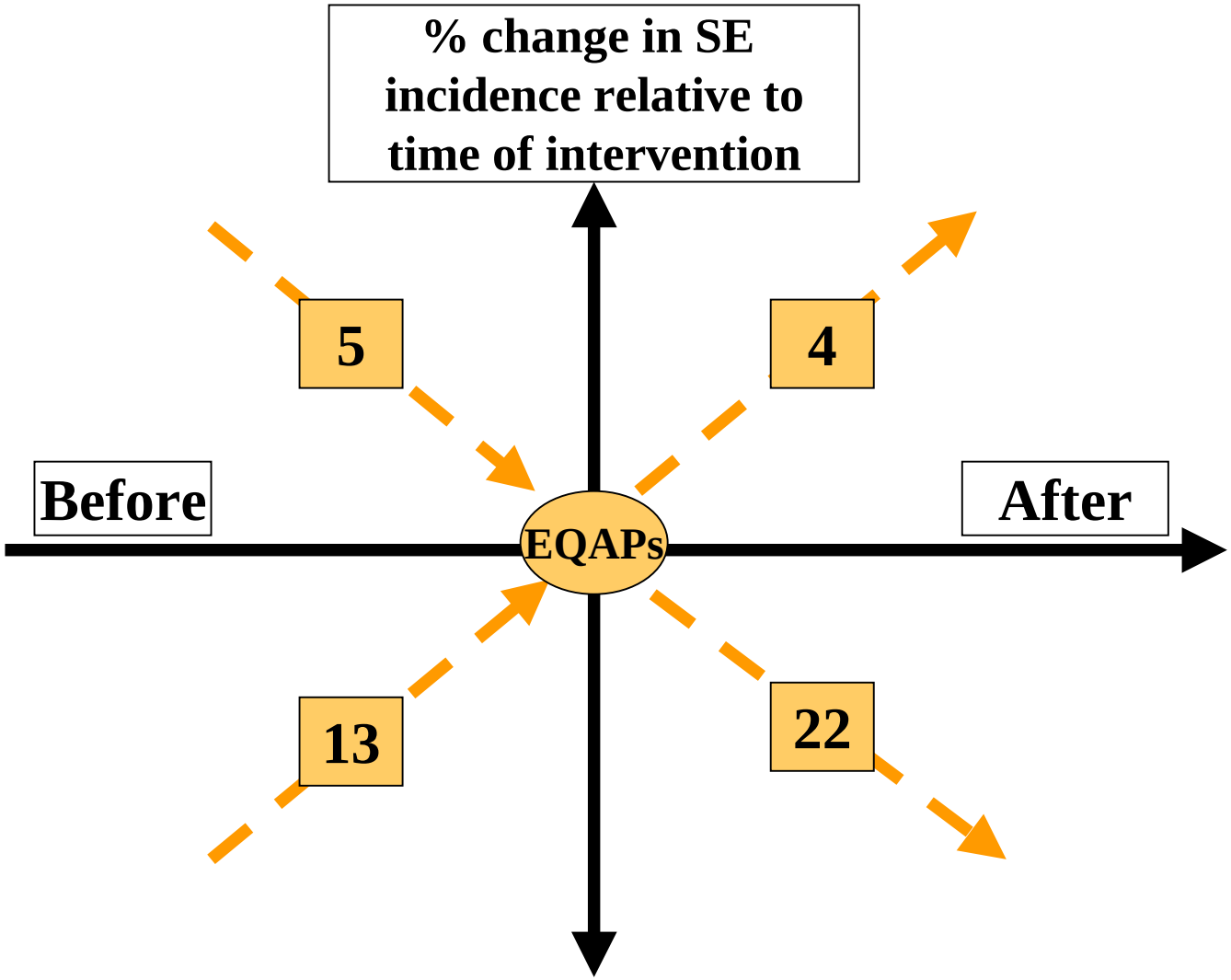
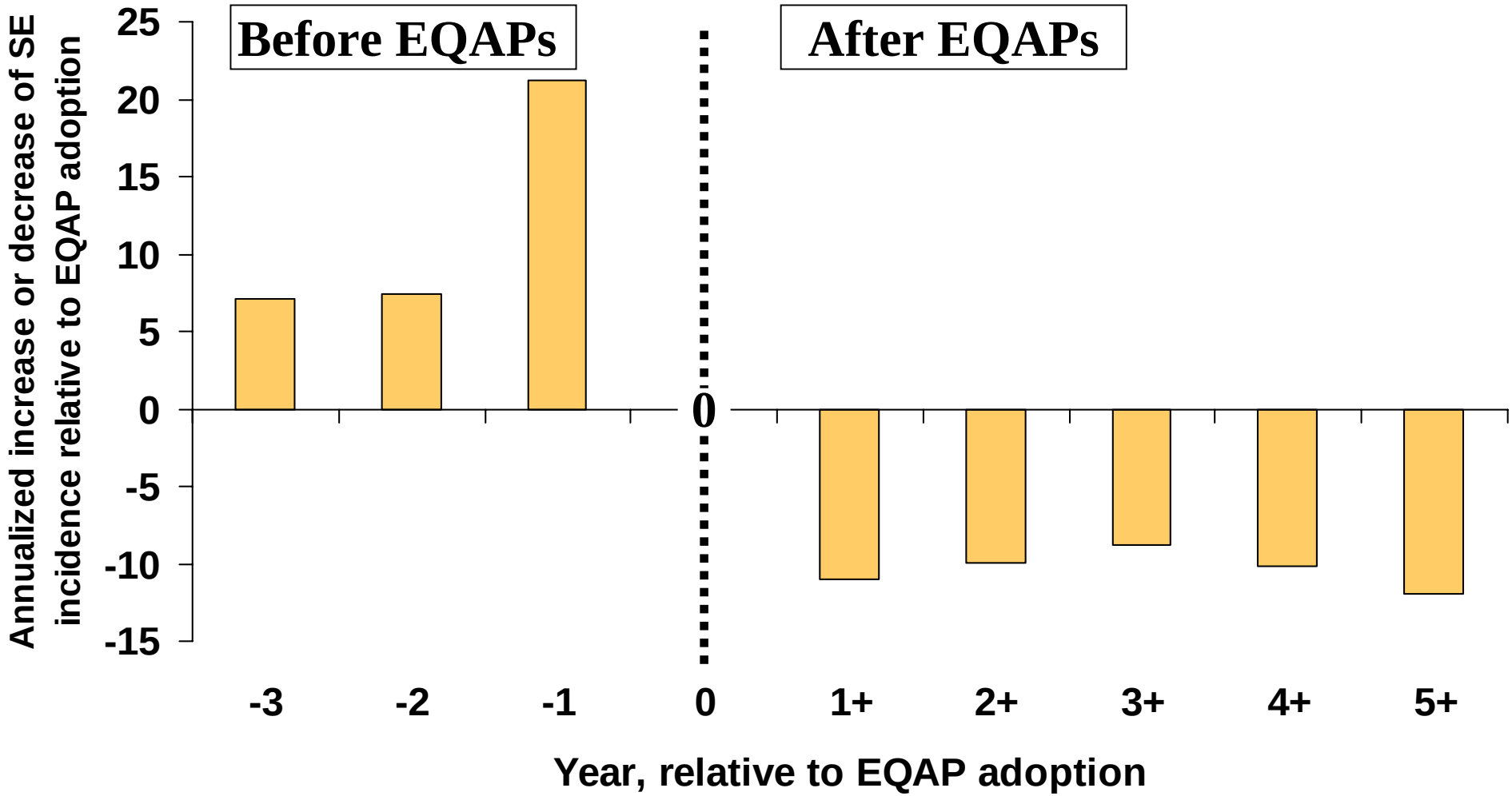
Framework for Analysis



Annualized Changes in SE Incidence (Slopes) before & after adoption of EQAPs



Annualized Change in Incidence of SE in relation to adoption of EQAPs.



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Multivariate Model for Change in SE Incidence After EQAP Adoption.

- **The model included.**
  - **% Of eggs under EQAPs.**
  - **Traceback investigations.**
  - **Population at high risk for SE.**
  - **Retail price for table eggs.**
  - **Regions…**
- **For each 10% increase in eggs produced under EQAPs there was an associated 2% decrease of the change in SE incidence relative to EQAP adoption.**

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Conclusions and Recommendations.

- **This change point analysis suggests that the impact of EQAPs was:**
  - **Apparent within the first year after program adoption.**
  - **Associated with sustained decrease in SE incidence for at least 5 years.**
  - **Proportional to the fraction of eggs produced under EQAP in the state.**
- **Strategies to increase participation by farms in existing EQAPs and for more states to adopt EQAPs are needed.**

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