

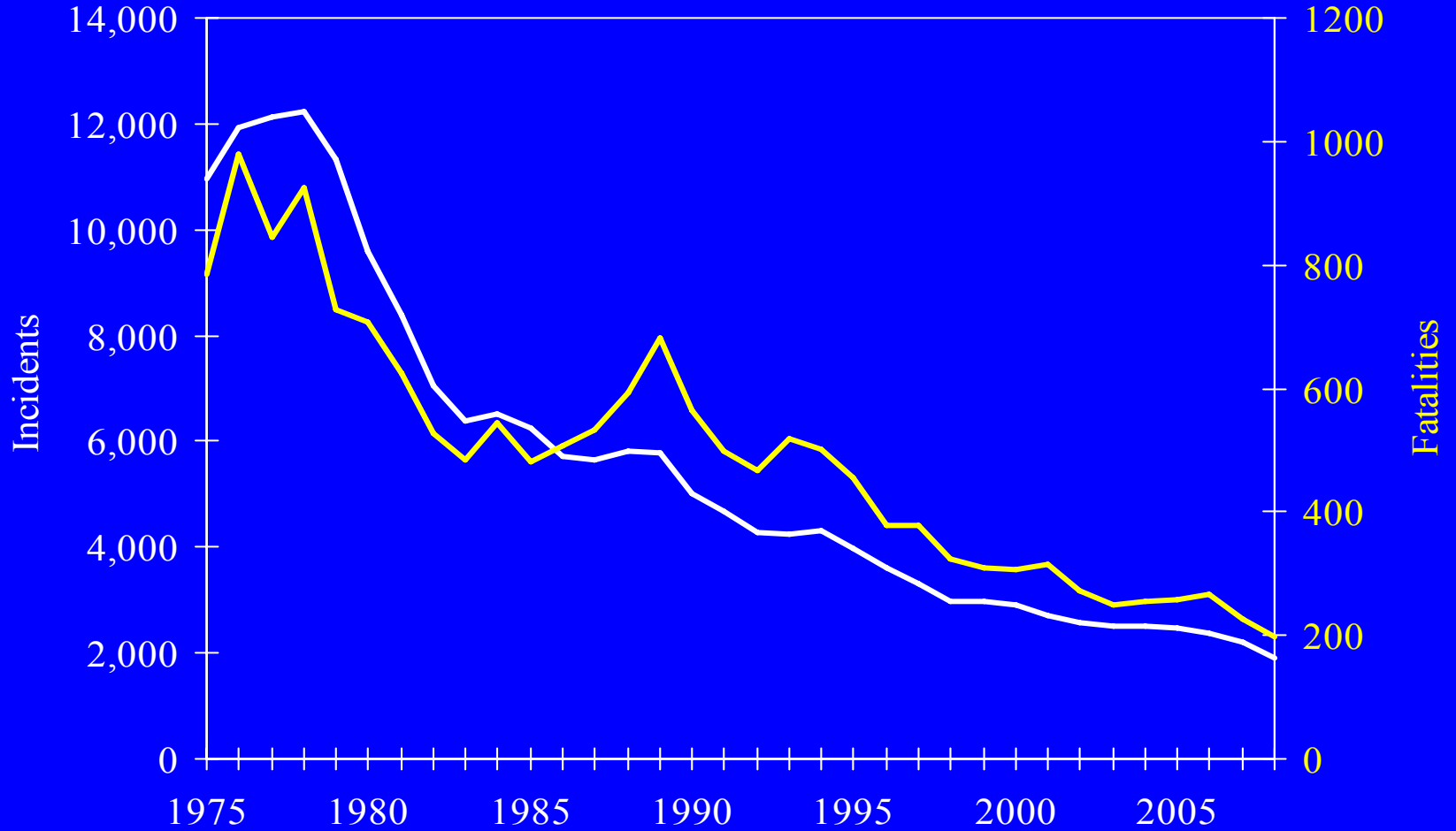
# Why has Safety Improved at Rail-Highway Grade Crossings?

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## Two papers:

- Shannon Mok and Ian Savage (2005) “Why has safety improved at rail-highway grade crossings?” *Risk Analysis* 25(4):867-881
- Ian Savage (2006) “Does public education improve rail-highway crossing safety?” *Accident Analysis and Prevention* 38(2):310-316

# Motor Vehicle Incidents and Fatalities at Public Crossings



# Many Possible Explanations:

- Crossing closures
- Active Warning Devices installed
- Public education campaign
- Ditch lights installed
- Highway safety in general has improved
- But, rail traffic has increased
- And, highway traffic has substantially increased

Most of these effects are highly correlated

# Regression analysis required:

- Macro level analysis – very different from “micro” analysis of individual crossings
- Incidents involving *motor vehicles at public crossings*
- Initial analysis will use annual data for 49 states (no HI, DC) from 1975 to 2001
- FRA/FHWA data
- Negative binomial regression

# Regression analysis:

- Two regressions:
  - number of incidents
  - fatalities in these incidents
- Exposure variable
  - Number of Crossings

# Functional Form:

Count of incidents / fatalities =

$$e^{(\beta \ln \text{crossings} + \gamma \ln \text{other variables})} + \varepsilon$$

# Explanatory Variables in Logs:

- Highway traffic (state non-Interstate highway AADT)
- State average daily trains per crossing
- Proportion of crossings with active warning devices in state
- State highway fatal crash (or fatality) rate elsewhere on highway system



## Other Explanatory Variables:

- Dummy variable = 1 if *Operation Lifesaver* is active in state (it spread across the nation between 1972 and 1986)
- Proportion of locomotives fitted with “ditch lights.” Assumed fitted at constant rate between September 1995 (announcement of rule) and December 1997
- State dummy variables (with Georgia as “base” state)

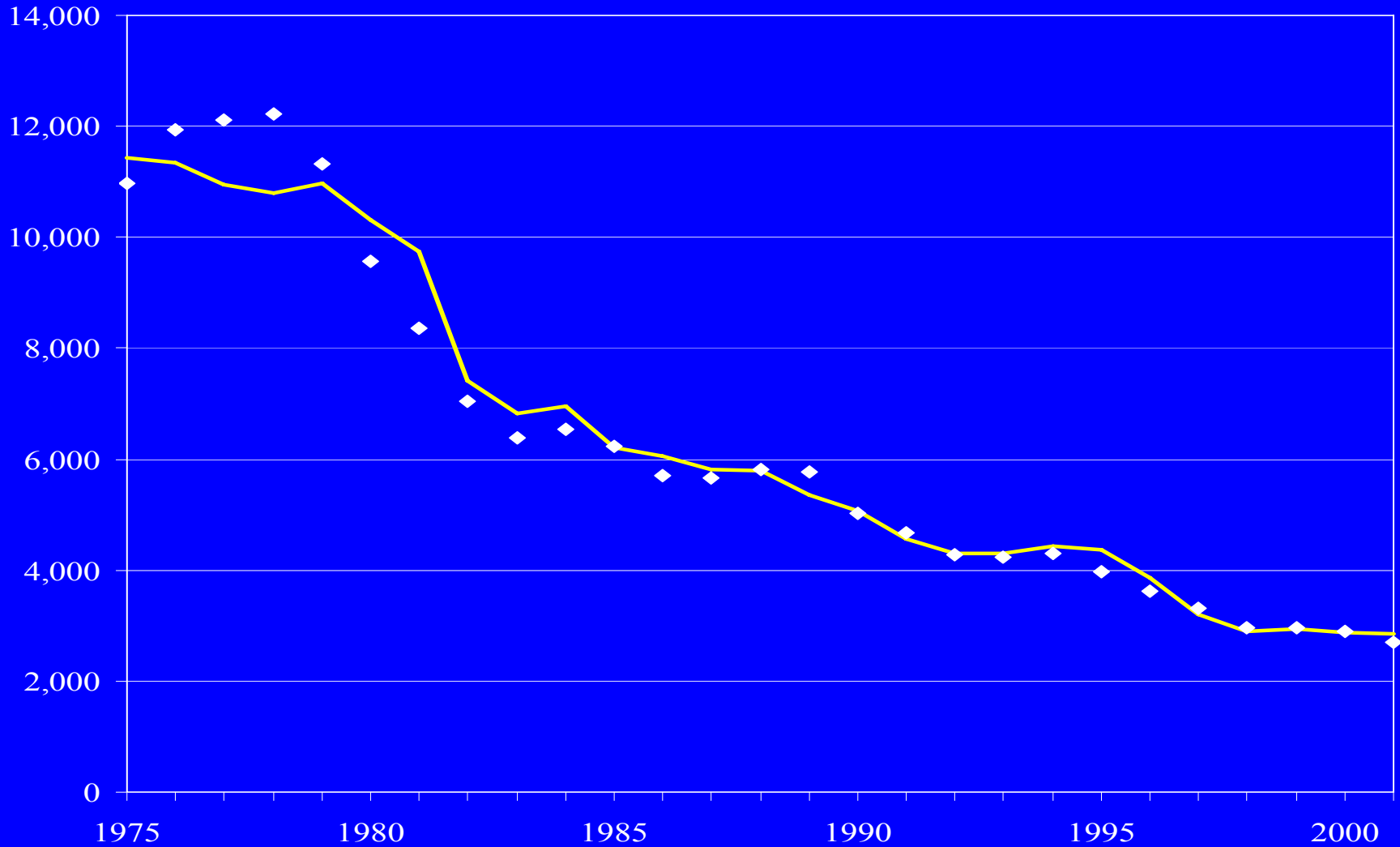
## **Incidents: 10,971 (1975) to 2,695 (2001)**

<b>Change in Annual Incidents</b>	<b>( 8,276 )</b>
<b>Crossing Closures</b>	<b>( 1,040 )</b>
<b>Increased Highway Traffic</b>	<b>89</b>
<b>Increased Train Traffic</b>	<b>556</b>
<b>Increased Lights/Gates</b>	<b>( 1,786 )</b>
<b>General Highway Safety Improvement</b>	<b>( 3,913 )</b>
<b>Operation Lifesaver</b>	<b>( 1,455 )</b>
<b>Ditch Lights</b>	<b>( 1,279 )</b>
<b>Cross-product Terms</b>	<b>259</b>
<b>Not Explained</b>	<b>294</b>

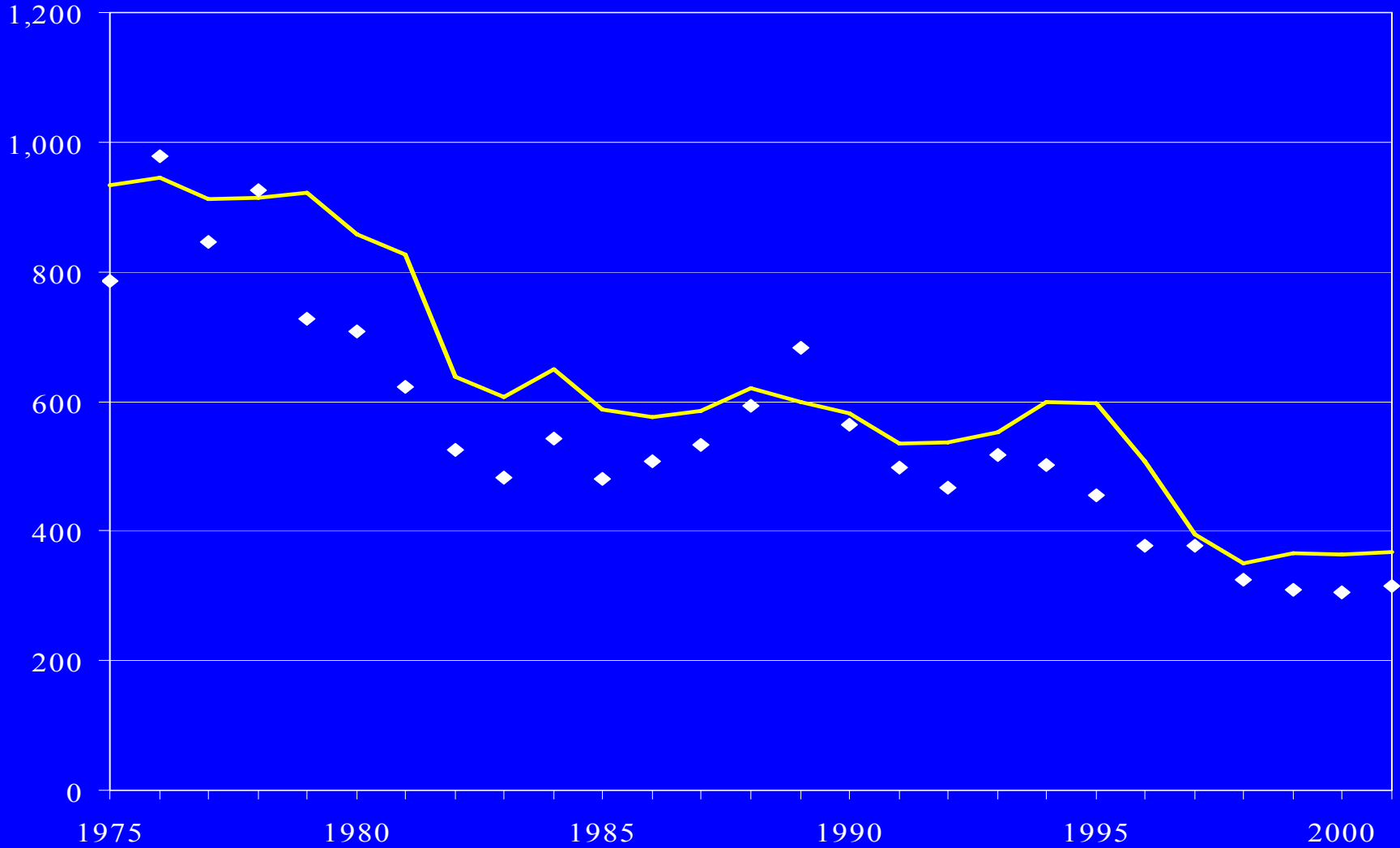
## Fatalities: 786 (1975) to 315 (2001)

<b>Change in Annual Fatalities</b>	( 471 )
<b>Crossing Closures</b>	( 60 )
<b>Increased Highway Traffic</b>	201
<b>Increased Train Traffic</b>	157
<b>Increased Lights/Gates</b>	( 115 )
<b>General Highway Safety Improvement</b>	( 305 )
<b>Operation Lifesaver</b>	( 164 )
<b>Ditch Lights</b>	( 268 )
<b>Cross-product Terms</b>	( 12 )
<b>Not Explained</b>	95

# HR Incidents: Actual versus Predicted



# HR Fatalities: Actual versus Predicted



# Discussion:

- General safety improvements on highways dominate
- Ditch lights appear to be very effective. Incidents down 29%, fatalities by 44%. But other initiatives occurred at the same time?
- Installation of active warning devices is effective

# Discussion – Section 130:

- Expenditure 1975 to 2001: \$8.5bn at current prices – a capital expenditure, plus additional annual maintenance
- 1,746 incidents and 115 lives saved each year over life of equipment
- Cost-benefit analysis over 30 years at 7% discount rate
- Valuation of lives and injuries at standard DOT/FRA levels prevailing before 2008
- Time saving from not having to slow down and look for a train

# Discussion - Section 130:

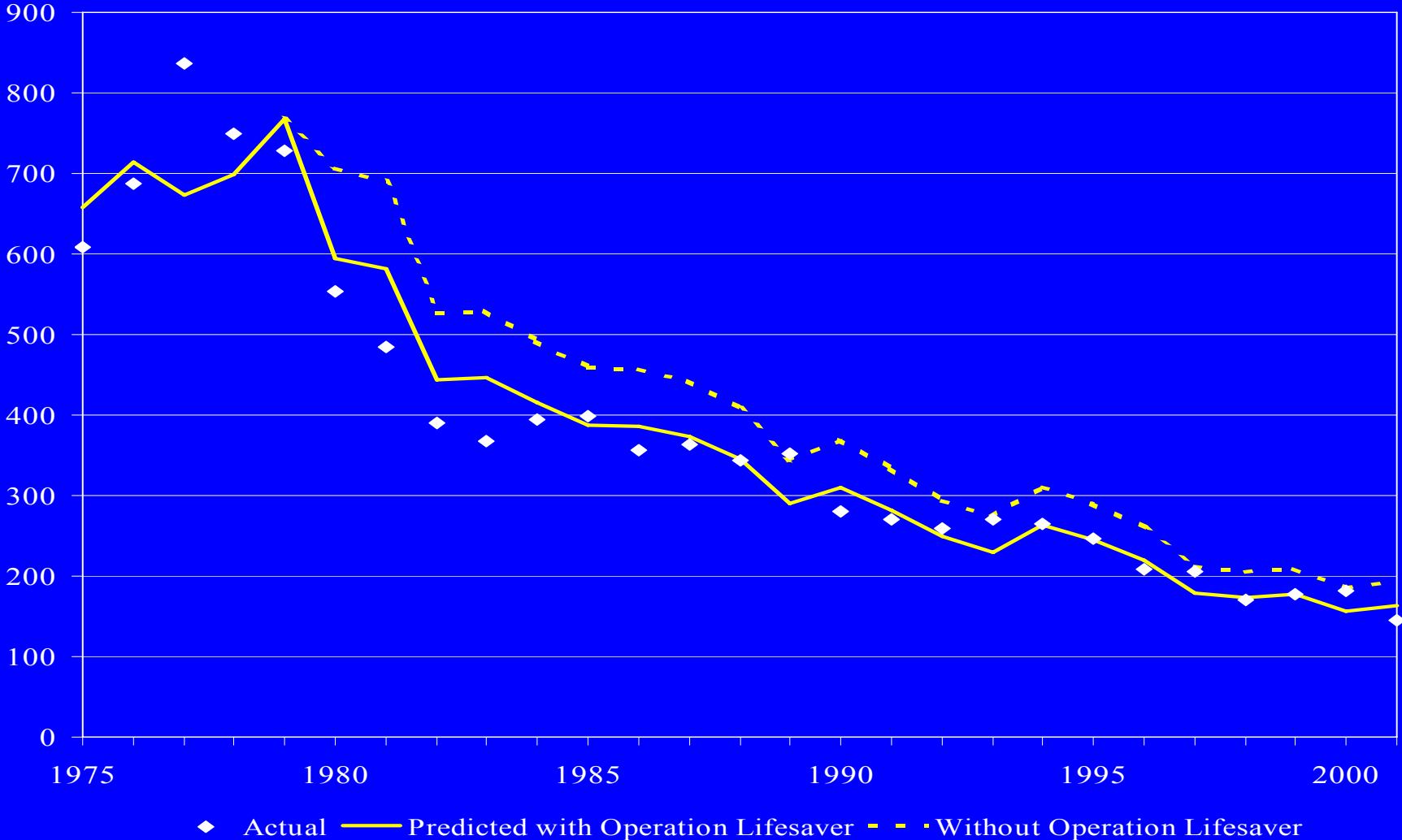
	PV \$m
Reduced Fatalities	4,582
Reduced Serious Injuries	7,453
Reduced Moderate Injuries	154
Reduced Property Damage	321
Time Saving	6,199
<b>Total Benefits</b>	<b>18,710</b>
Section 130 Expenditures	(8,475)
Additional Maintenance	( 557)
<b>Benefit-Cost Ratio</b>	<b>2.07</b>



## Discussion – *Operation Lifesaver*:

- Introducing *Operation Lifesaver* reduces incidents by 15%, fatalities by 19%
- Regression is multiplicative
- Risk was much higher, in general, when the programs started (1972-1986) compared with today

# Indiana HR Incidents: Actual versus Predicted Operation Lifesaver Active From 1980



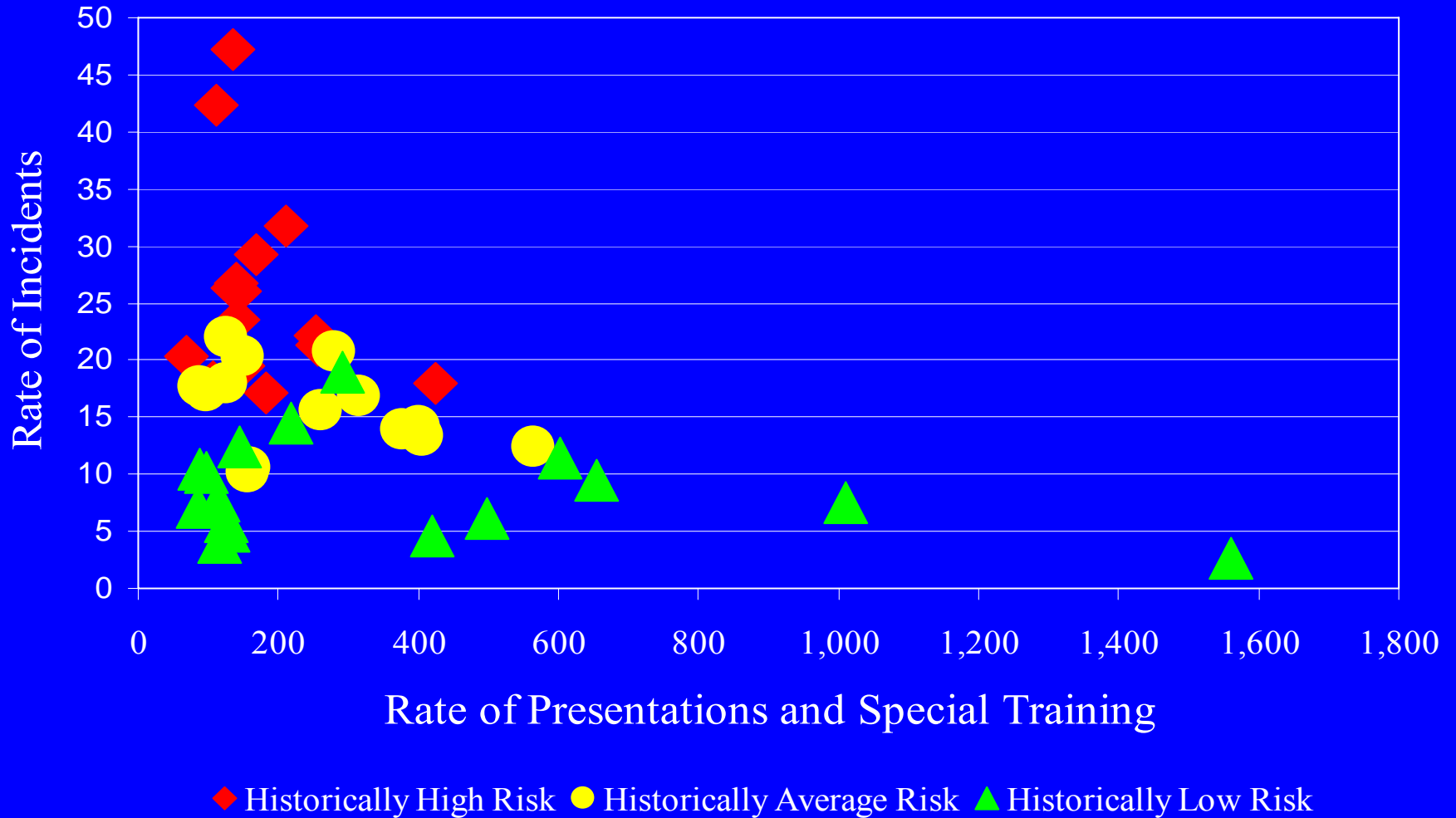
## Discussion – *Operation Lifesaver*:

- Initial implementation saved 1,455 incidents and 164 lives per year
- If *Operation Lifesaver* ceased today, when risk is lower, 500 additional incidents and 75 extra fatalities per year
- Compare with the annual cost of *Operation Lifesaver* of less than \$6 million

## Further Analysis of *Operation Lifesaver*:

- Initial analysis (Mok and Savage, 2005) had:
  - data on 49 states from 1975 to 2001
  - existence of *Operation Lifesaver* in state represented by a 0-1 dummy variable
- Follow-up paper (Savage, 2006) has:
  - data on 46 states from 1996 to 2002
  - *Operation Lifesaver* activity in a state represented by number of presentations and special training events per 1,000 crossings

## Annual Incidents and OL Presentations per 1000 Crossings by State 1996-2002



## Further Analysis of *Operation Lifesaver*:

- Activity varies markedly between states, and between years for some states
- *Operation Lifesaver* assisted in cleaning up data:
  - 3 States (AZ, MA, VA) dropped entirely
  - 14 observations from 11 states missing
  - 16 observations from 9 states questionable
  - 292 out of possible 343 observations used
- Other variables the same as the original analysis

## Further Analysis of *Operation Lifesaver*:

- Point elasticity between *Operation Lifesaver* activity in a state and number of incidents is -0.11
- Effect on number of fatalities statistically indeterminate – deaths are quite rare and concentrated in only a few states making analysis difficult

# In Conclusion:

- Risk has reduced considerably despite increased rail and highway traffic
- Backdrop of improved highway safety in general
- Engineering is important – Section 130 and Ditch Lights
- So is education – *Operation Lifesaver*. Findings consistent with NCHRP Report 470 (2002) which found public confusion regarding crossing signage and conduct
- . . .if only we had some more data on enforcement



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