The Impact of Weather and Tornadoes

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Weather Dependent Businesses

- 20 – 40% of the economy is weather dependent, in that cost or demand is strongly influenced by weather
- The most weather dependent industries include energy, agriculture, transportation and tourism

Other Weather Impacts

- Wages: employees require a salary premium to live in areas with bad weather (clouds, snow, cold winters)
- Disrupt production, transportation very significant in a On Demand, Just-in-Time world
- May affect worker productivity, by as much as 10% of GDP (Seasonal Affective Disorder)

Severe and Extreme Weather in the U.S.

Hazard		Years
Hurricanes	2280 fatalities	1940-2004
Tornadoes	6443 fatalities	1940-2004
Floods	6917 fatalities	1940-2004
Lightning	8987 fatalities	1940-2004
Heat	2596 fatalities	1986-2004
Cold & Winter	1269 fatalities	1988-2004
All Hazards	$12 billion per year	1994-2003

Value of Weather Forecasts and Warnings

- The value of forecasts depends on the accuracy of the forecast and the action that people will take upon receiving the forecast
- A forecast for a costly event may not be very valuable, if there is little which can be done upon receipt of the forecast (Snow plowing, severe thunderstorms

Components of Forecast Value

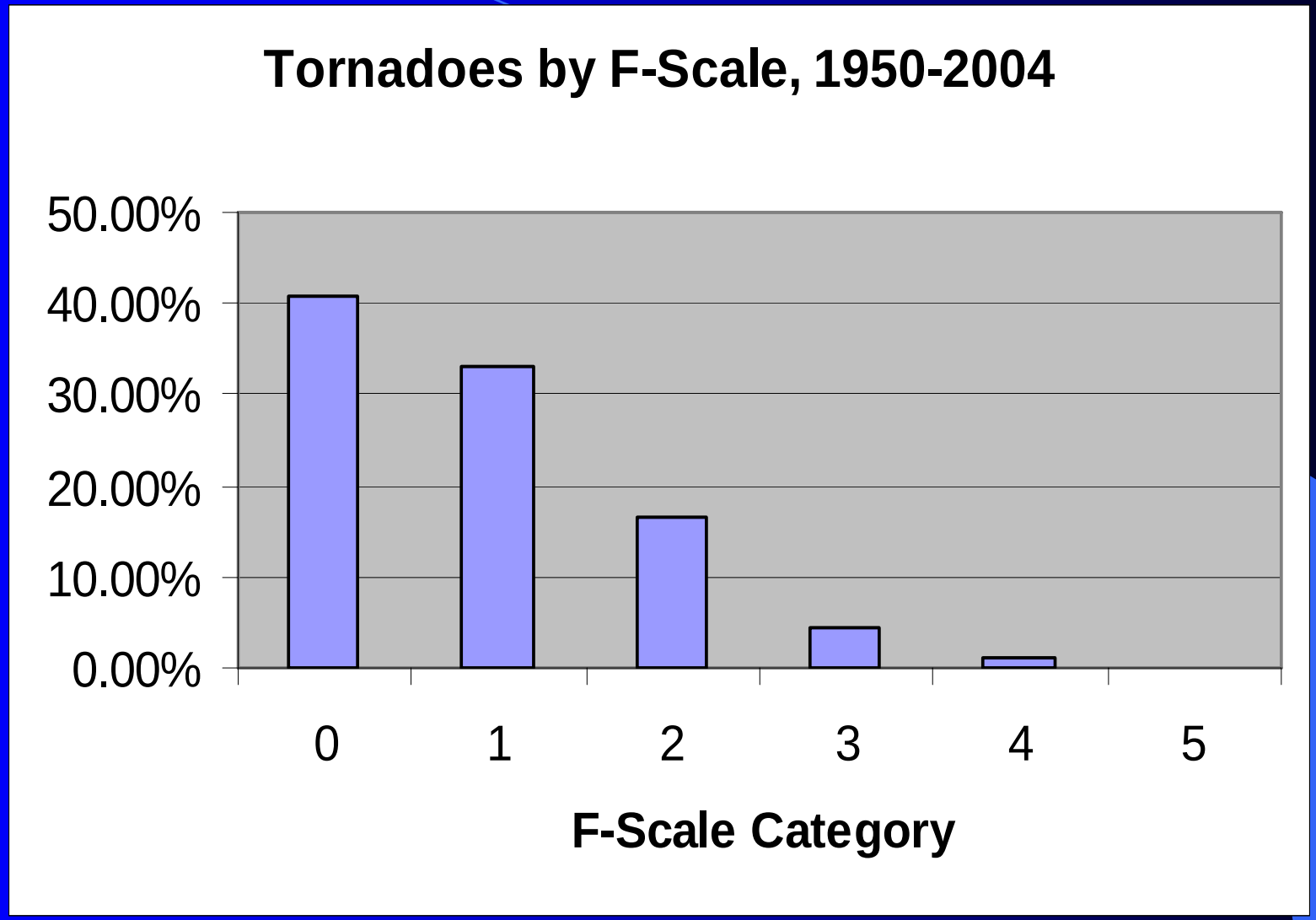
- "hit" and false alarm probabilities
- frequency of weather event
- losses avoided if use forecast to prepare
- false alarm costs – cost of preparations when event doesn't occur

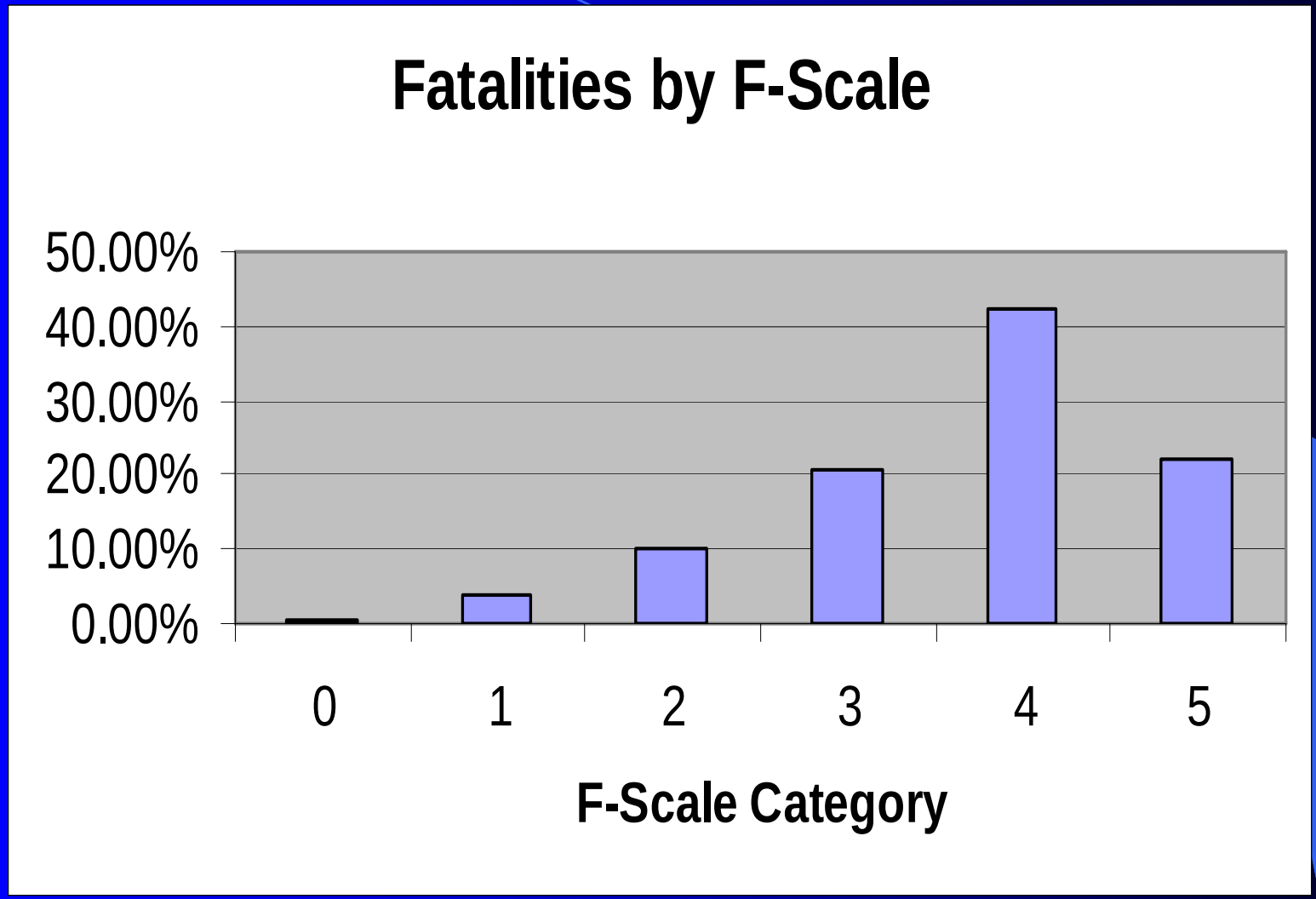
Some Characteristics of Tornado Casualties

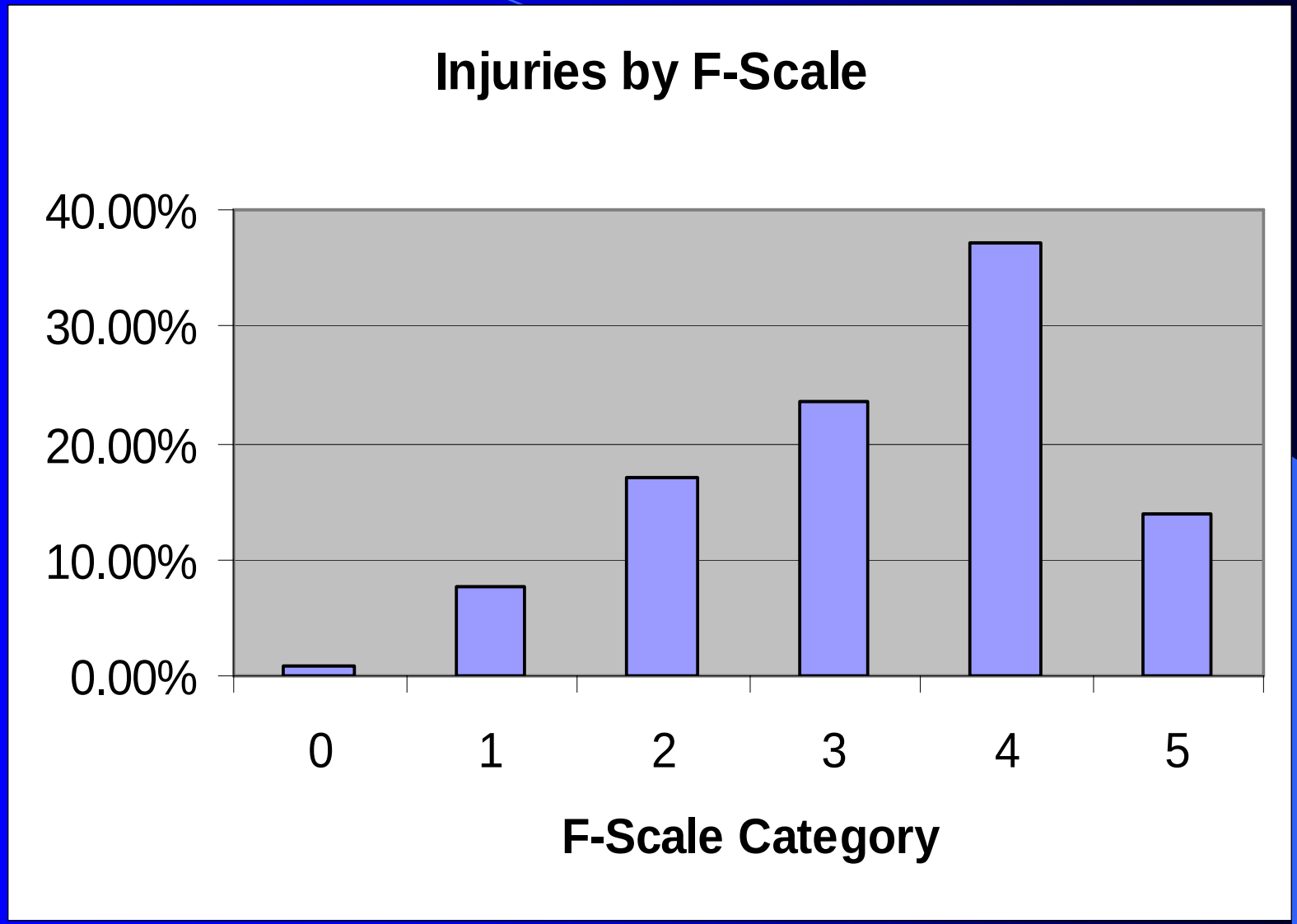
1. Few tornadoes produce casualties

- 47,000 Tornadoes 1950-2004
- 1231 (2.6%) killer tornadoes
- 98 (.2%) killed 10 or more persons
- 6385 (13.5%) injury tornadoes
- 150 (.3%) injured 100 or more persons

2. Violent Tornadoes Produce Most of the Casualties


Tornadoes by F-Scale, 1950-2004
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
0
1
2
3
4
5
F-Scale Category

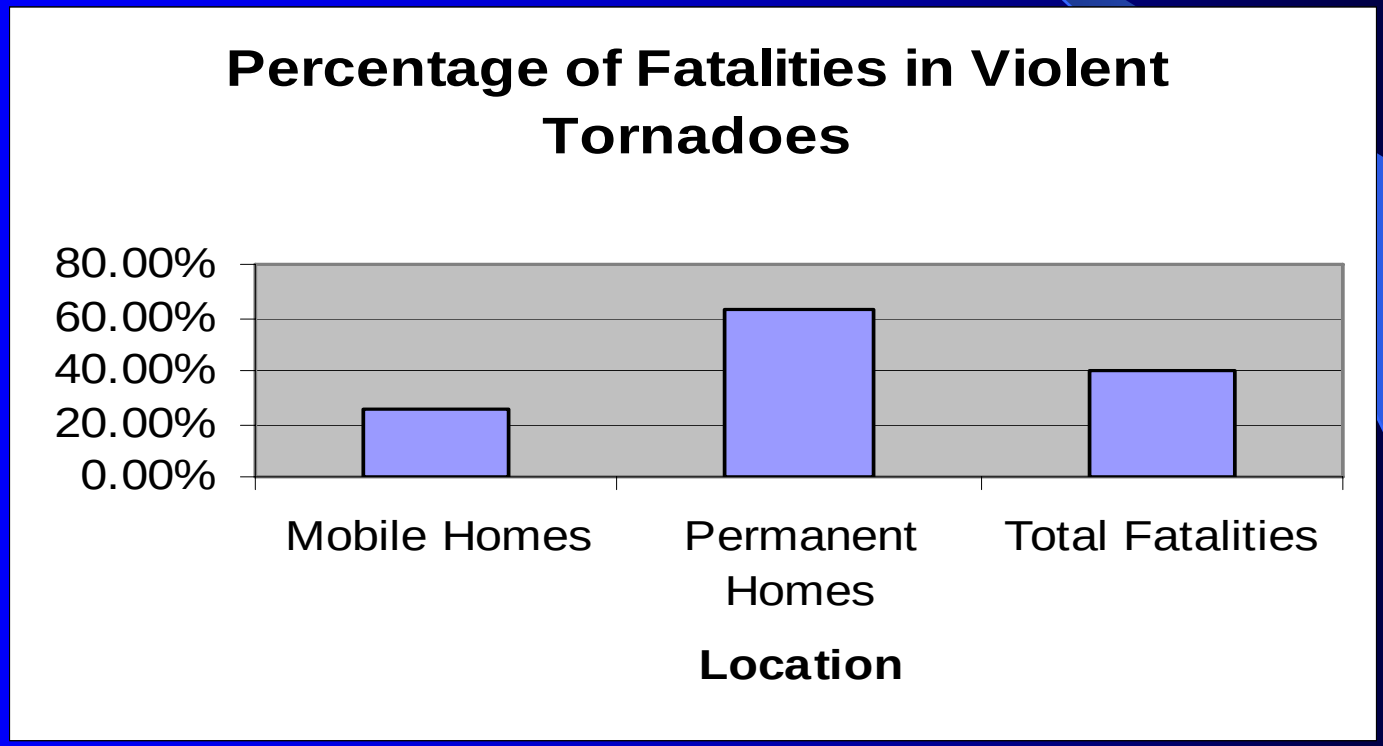

Fatalities by F-Scale
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
0
1
2
3
4
5
F-Scale Category


Injuries by F-Scale
40.00%
30.00%
20.00%
10.00%
0.00%
0
1
2
3
4
5
F-Scale Category

3. Mobile Homes are Vulnerable

- 40.3% of tornado fatalities between 1985 and 2004 occurred in mobile homes
- Mobile homes comprised 7.5% of housing stock in 2000
- Fatality rate about ten times higher than permanent homes

4. Permanent Home Residents Mainly at risk from Violent Tornadoes



5. Businesses are relatively safe

Between 1985 and 2004, only 5.2% of tornado fatalities occurred in businesses.

An F4 tornado destroyed the Parsons Manufacturing Company's facility in July 2004, but none of the 150 workers or one job applicant at the plant were injured thanks to three above ground storm shelters in the plant. The company also had a NOAA Weather Radio and conducted regular tornado drills.

6. Tornadoes at Night are Dangerous

- Fatalities, 1986-2002

64% lower for a tornado between 6AM-6PM than Midnight-6AM

40% lower for a tornado between 6PM-Midnight than Midnight-6AM

- Injuries, 1986-2002

43% lower for a tornado between 6AM-6PM than Midnight-6AM

38% lower for a tornado between 6PM-Midnight than Midnight-6AM

7. Tornadoes on weekends are more dangerous

- Fatalities

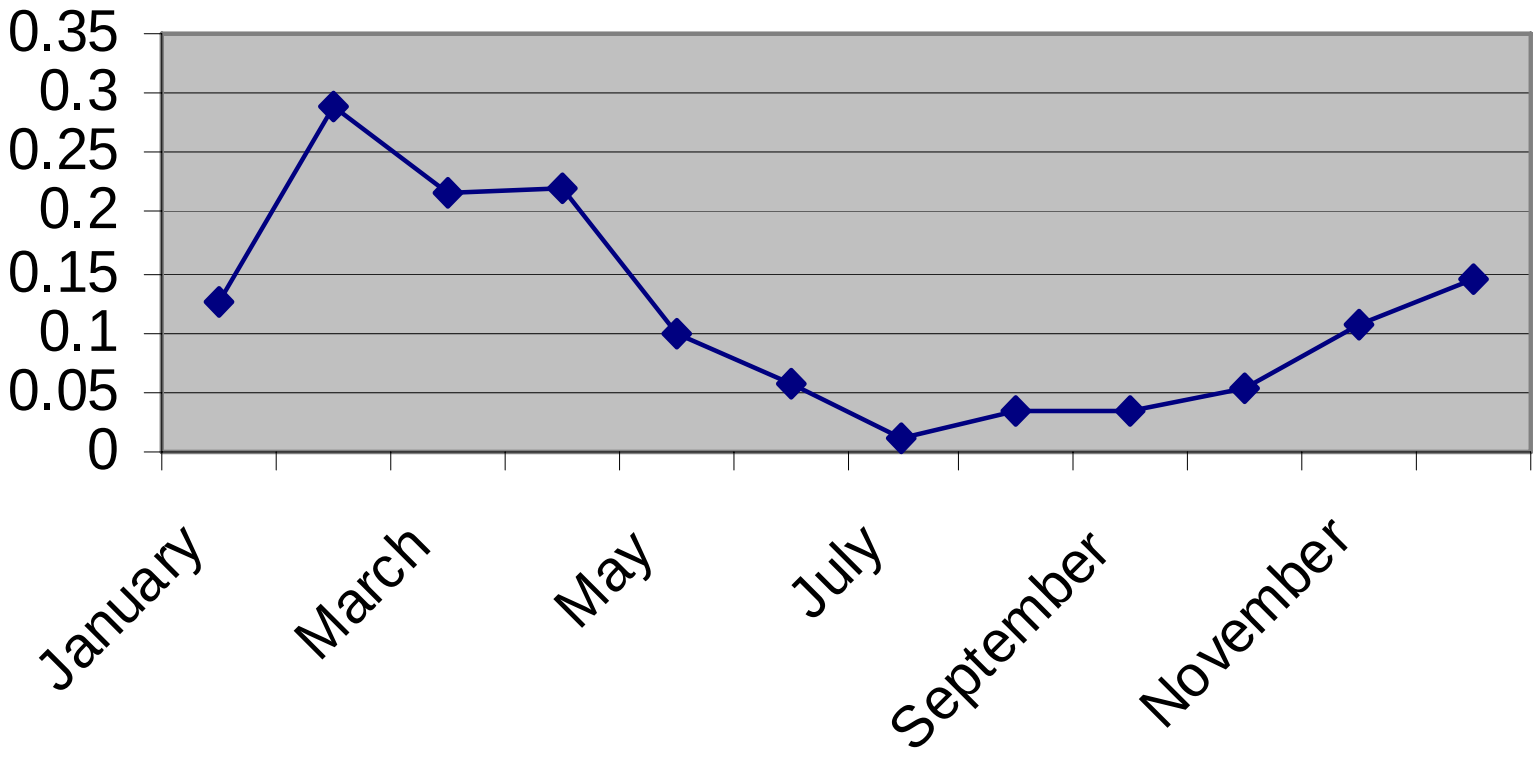
70% higher on a weekend than weekday

- Injuries

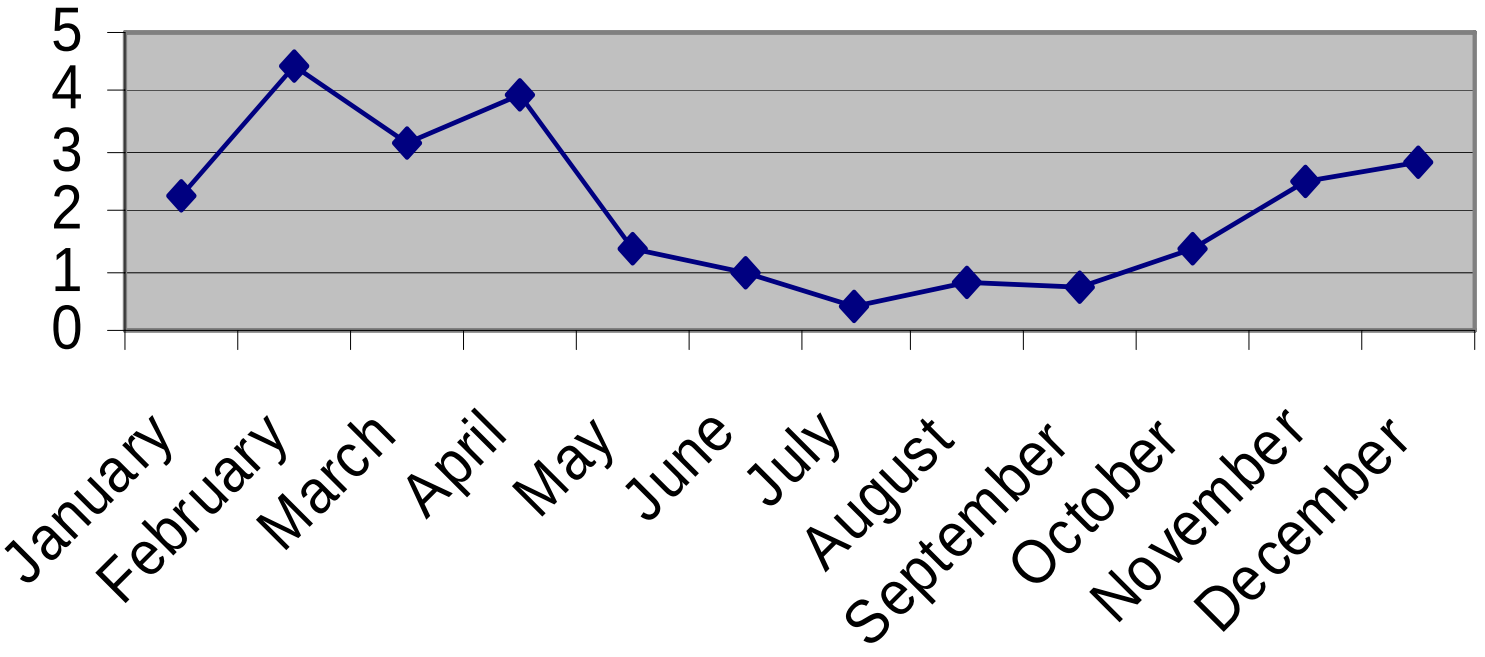
15% higher on a weekend than weekday

8. Tornadoes in off-season more dangerous

Fatalities per Tornado by Month, 1950-2003



Injuries per Tornado by Month, 1950-2003



Risk factors for November 2005 Evansville Tornado

- Struck a mobile home park
- At night
- On a weekend
- Outside the normal tornado season

Four adverse risk factors!

Insights on How to Reduce Casualties

1. Installation of Doppler Radar

Radars installed 1992-1997

Reduced fatalities 45%, injuries 40% compared to already low rates in late 1980s

Between 1992 and 2004, Doppler radar prevented an estimated 330 fatalities and over 7800 injuries

2. Better Warnings, Protection for Mobile Home Residents

- Offers biggest opportunity to further reduce casualties
- Based on a $2,000 cost per unit, the cost per life saved for tornado shelters in mobile homes is less than $10 million in most tornado prone states
- Why do businesses do better than mobile home parks protecting customers?

3. Shelters in permanent homes are not cost effective

- To illustrate, over one million single family homes in Oklahoma
- About five tornado fatalities per year, and only about 30% of fatalities occur in permanent homes
- Tornadoes are too infrequent and permanent homes already provide too much protection

4. Improved Tornado Warnings

- Time of day effects provide indirect evidence that warnings save lives
- Direct analysis of the lead time on warnings shows that a warning with a 6-10 minute lead time reduces fatalities 41% and injuries 47% compared to no warning
- Continuing to increase the Probability of Detection will reduce casualties further

4. Improved Warnings, continued

- High casualties at night suggest importance of improving warning process at night
- NOAA Weather Radio, Storm Ready Communities
- Residents of mobile homes particularly need warnings at night

4. Improved Warnings, continued

- National Weather Service issues tornado warnings currently for counties
- Counties are large relative to tornado damage paths
- Polygon tornado warnings should improve response to warnings, reduce casualties

5. Improve Tornado Awareness in Off Season

- Casualties much higher in “off season” months, suggests residents may be less aware of threat
- Watch, warning performance in off season?
- Can awareness of tornado threat days in off season be increased?

6. Identify Violent Tornadoes

- Violent tornadoes produce most fatalities, particularly in permanent homes
- But are infrequent enough not worth building shelters to harden targets
- Evacuate vs. Shelter in place decision for fires
- Can watches or warnings be refined to identify violent tornadoes?

7. Are there tornado tracks?

- Alerting mobile home parks, schools and other vulnerable targets can reduce casualties
- Locating these buildings in local areas of low risk is another option
- Can improved observation of storms, paths lead to insight about existence of tornado tracks?

Conclusion

- Detailed knowledge of weather impacts is crucial in identifying cost effective ways warnings and forecasts can reduce impacts
- Tornado warnings provide great value to society
- Producing additional value to society involves a back-and-forth interaction between social science and meteorology