Developing Societal Outcome Indicators for Weather-Ready Nation

Final Presentation

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Background

- Develop a set of societal outcome metrics for WRN

- Pilot test the methods, data sources, and metrics

- Focus the effort on a set of to-be-selected WRN products or projects

Original Project Tasks

- Identify a set of WRN projects or products as test cases (5 total)
- Develop a simplified logic model for each project or product
- Develop metrics for each product/project
- Collect pilot data for a subset of the metrics
- Refine the metrics based on the pilot data
- Develop a plan for collecting data for other metrics
- Write a report

Project Modifications

- Created one simplified logic model to represent all WRN

- Developed "higher level" metrics
  – Not just for the 5 projects/products

- Collected pilot data for all metrics
  – Leveraged existing sources

- No plan for collecting data for other metrics
  – Collected more data
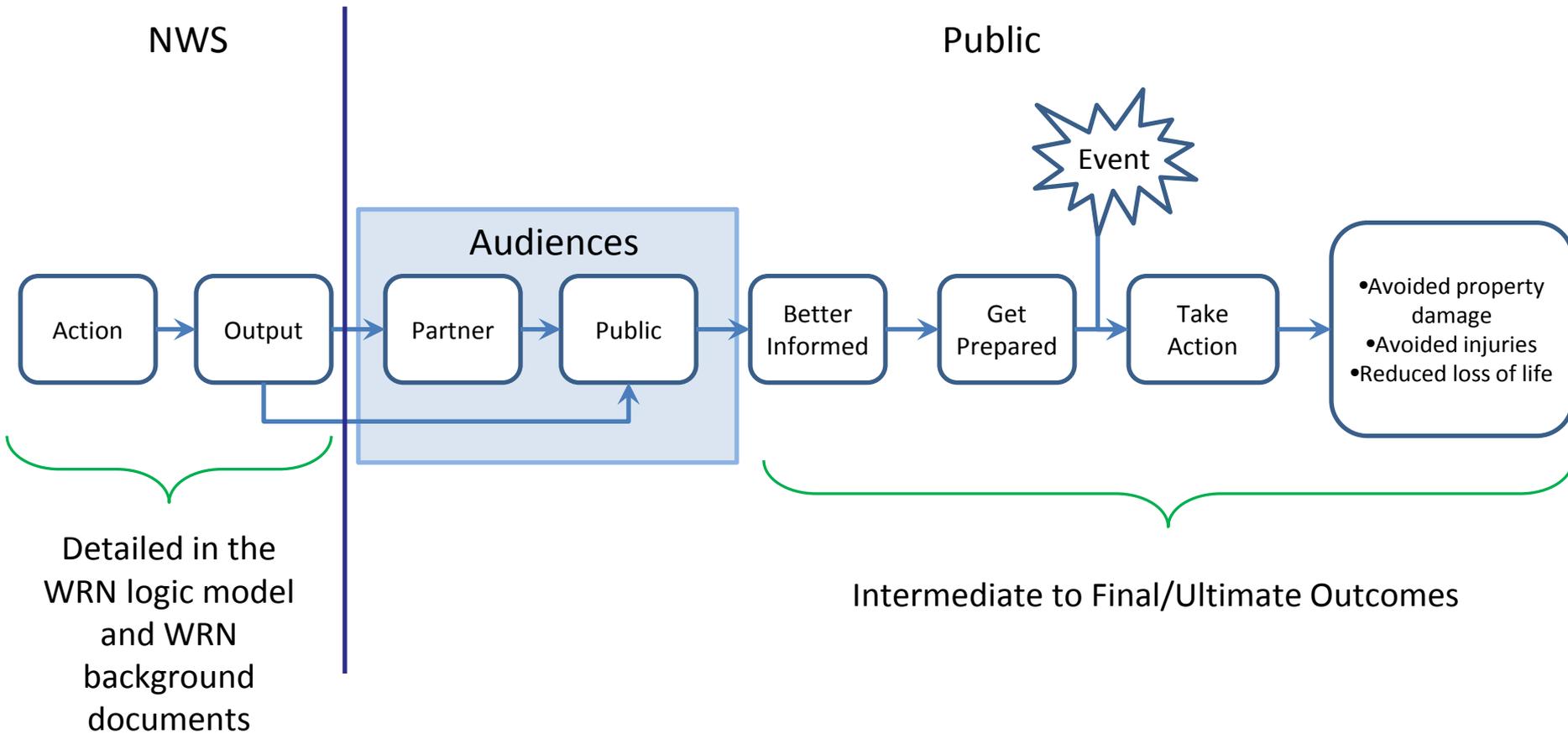
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Products and Projects

Selected

- The Watch, Warning, Advisory system
- Storm Ready Program
- WRN Ambassadors
- Impact-Based Decision Support Services (IDSS) Pilot Projects
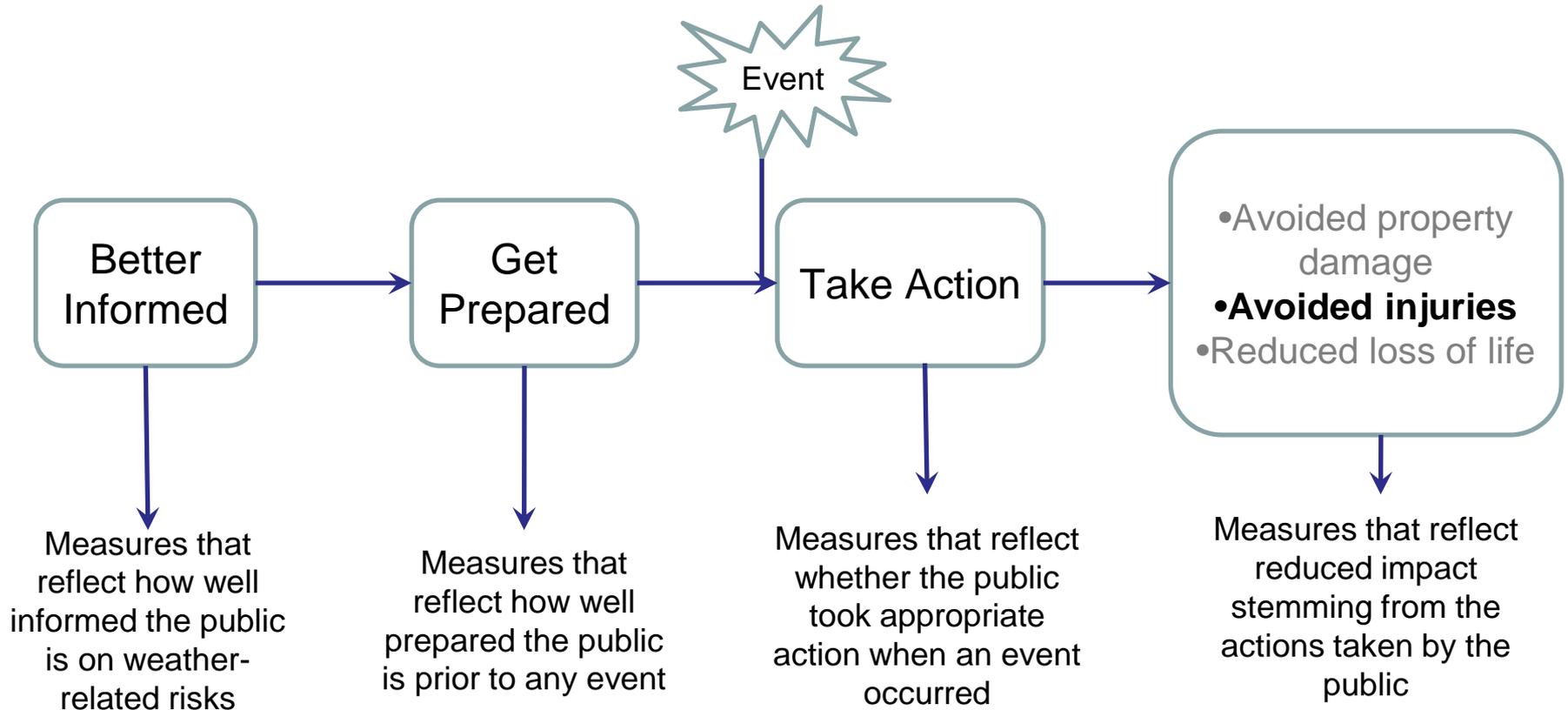- Awareness Weeks (Seasonal Awareness Campaigns)

What we did and found

- Performed interviews with staff involved in each project/product

- Finding: Societal outcomes from each were generated by the same basic process

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Simplified Logic Model

NWS

Public

Audiences

Action → Output → Partner → Public → Better Informed → Get Prepared → Take Action → •Avoided property damage •Avoided injuries •Reduced loss of life

Event

Detailed in the WRN logic model and WRN background documents

Intermediate to Final/Ultimate Outcomes

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Categories for Outcome Measures

Event

| Better Informed | → | Get Prepared | → | Take Action | → | •Avoided property damage
•**Avoided injuries**
•Reduced loss of life |

Measures that reflect how well informed the public is on weather-related risks

Measures that reflect how well prepared the public is prior to any event

Measures that reflect whether the public took appropriate action when an event occurred

Measures that reflect reduced impact stemming from the actions taken by the public
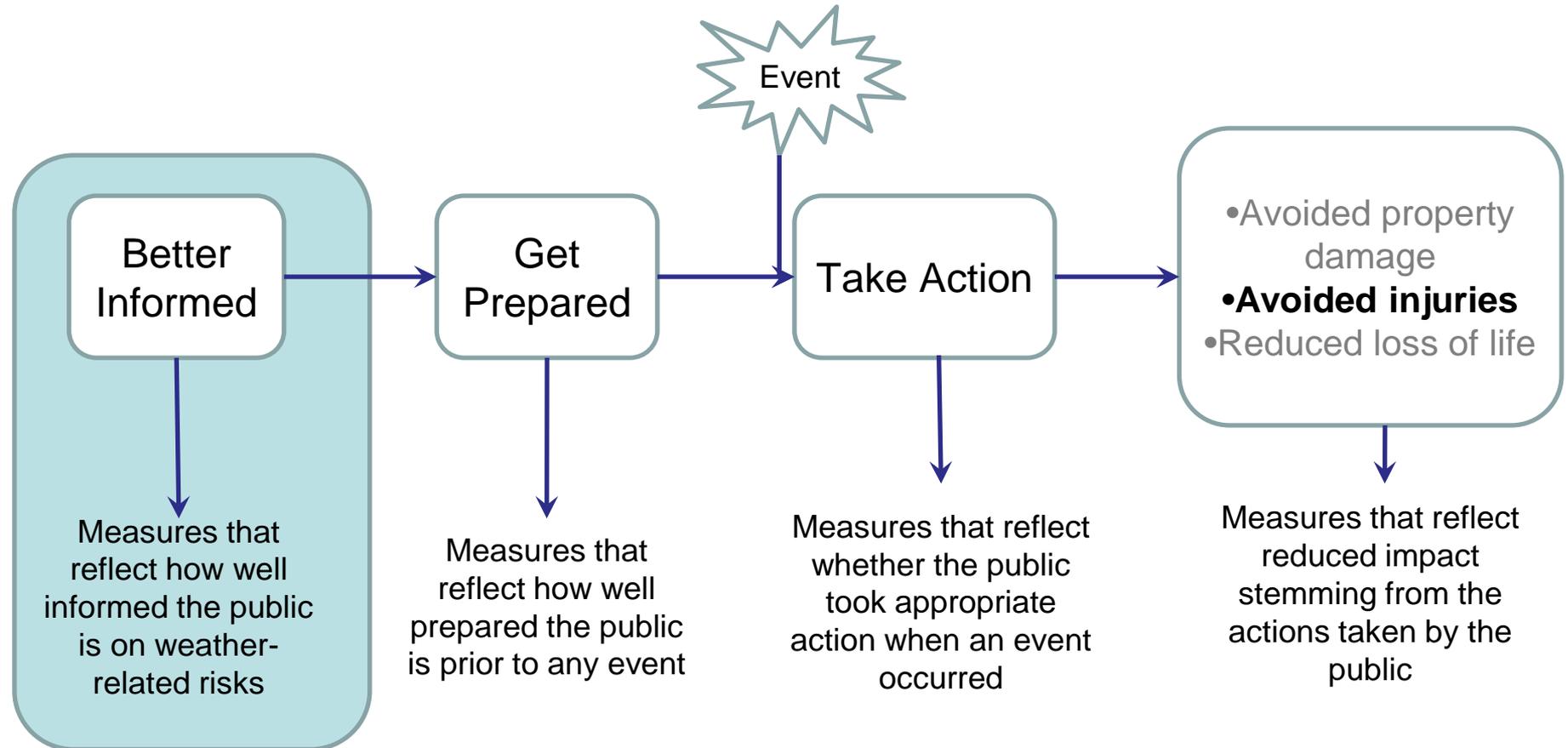
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Types of events

- ~~Coastal flood (including storm surge)~~
- Flash flood
- Heat and excessive heat
- ~~Hurricane and tropical storm~~
- Severe thunderstorm and tornado
- Winter storm/winter weather.

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Data Sources and Methods

Metric Category	Data Source	Method
Better Informed	• NWS web site pop-up survey • NWS online panel	• Tabulate survey data collected by NWS
Get Prepared	• NWS web site pop-up survey • NWS online panel	• Tabulate survey data collected by NWS
Take Action	• NWS Quick Response Surveys (implemented for this project)	• Tabulate survey data we collect
Avoided Injuries	• NWS Storm Data combined with Census Bureau data	• Perform statistical analysis

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Better Informed:
Potential Survey Questions

- **Knowledge of weather-related events** – *"How would you rate your current knowledge of {EVENT TYPE}-related events on a scale of 1 to 10, where 1 means "very low knowledge" and 10 means "very high knowledge" (i.e., an expert)?"*

- **NWS contributes to understanding of dangers of weather related events** – *"How would you rate the extent to which the information provided by NWS has contributed to your understanding of the dangers of {EVENT TYPE}-related events on a scale of 1 to 10, where 1 means "not at all" and 10 means "significantly"?"*

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Pop-up Survey and Online Panel

- Data are collected quarterly
- Pop-up survey on NWS website
  - 0.01% of visitors
- Online panel
  - Matched to national demographic characteristics

Event Type	Calendar Year 2015	Calendar Year 2016
Winter weather	5/9/15 – 7/5/15	1/14/16 – 4/4/16
Flash floods	7/6/15 – 10/6/15	1/14/16 – 4/4/16
Severe thunderstorms	7/6/15 – 10/6/15	-
Extreme heat	10/7/15 – 1/13/16	-

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Pop-up and Online Panel: Pros and Cons

Pop-up survey

- Large number of responses
- Skewed to those who go to NWS website
- Less costly

Online Panel

- Fewer responses
- Representative of US population
- Higher cost

Better Informed: Results

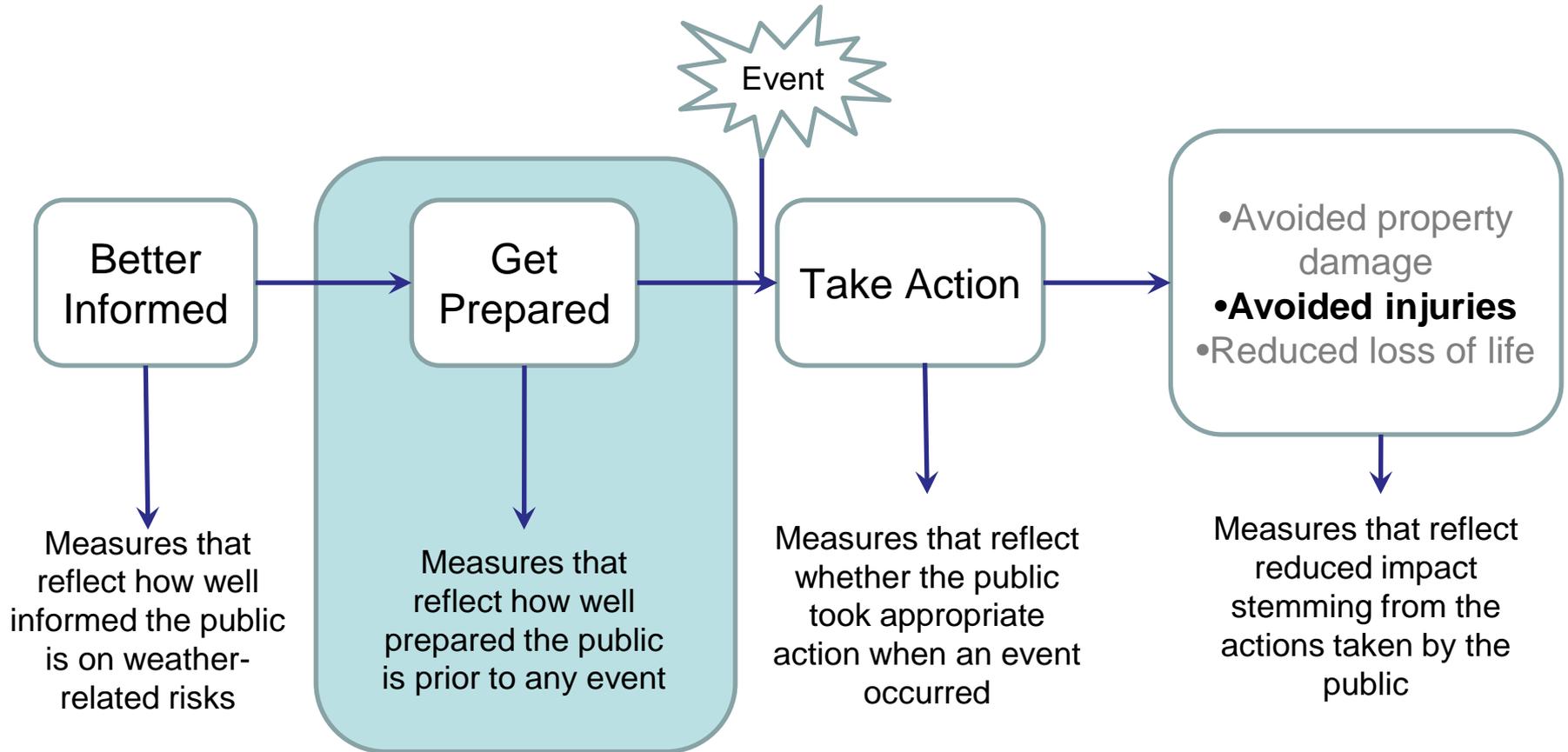| Event Type	2015 Data Collection		2016 Data Collection	
	Website Survey	**Online Panel**	**Website Survey**	**Online Panel**
Winter Weather	80 (n = 3,669)	79 (n = 214)	82 (n = 4,771)	72 (n = 246)
Flash Floods	76 (n = 1,420)	76 (n = 152)	75 (n = 6,204)	70 (n = 487)
Severe Thunderstorms	-	-	-	-
Extreme Heat	63 (n = 4,771)	65 (n = 246)	-	-

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Better Informed: Proposed Metric

Metric	Collection Approach	Question in Survey	Calculation
Public rating of the extent to which NWS contributes to its understanding of weather dangers	NWS website survey, collected once per year over a three-month period	How would you rate the extent to which the information provided by NWS has contributed to your understanding of the dangers of {EVENT TYPE}-related events on a scale of 1 to 10, where 1 means "not at all" and 10 means "significantly"?	Average score from survey where the score is calculated for each respondent as the respondent's rating minus one divided by 9 and then multiplied by 100.

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Better Informed: Operational implications

- NWS will need to continue to collect data on this question at regular intervals
  - At least quarterly, rotating the weather event type
  - Using the pop-up survey
  - Assess demographic changes

- ERG recommends collecting data on the same event types each year
  - Provides a time series for specific weather types

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Get Prepared: Data Source

- Pop-up survey and online panel

- Same details as "Better Informed"

Get Prepared:
Potential Survey Questions

- Have a safety plan?
  - Yes/No

- Have an emergency kit?
  - Yes/No

- Items in the kit?
  - Select from a list

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Get Prepared: Results

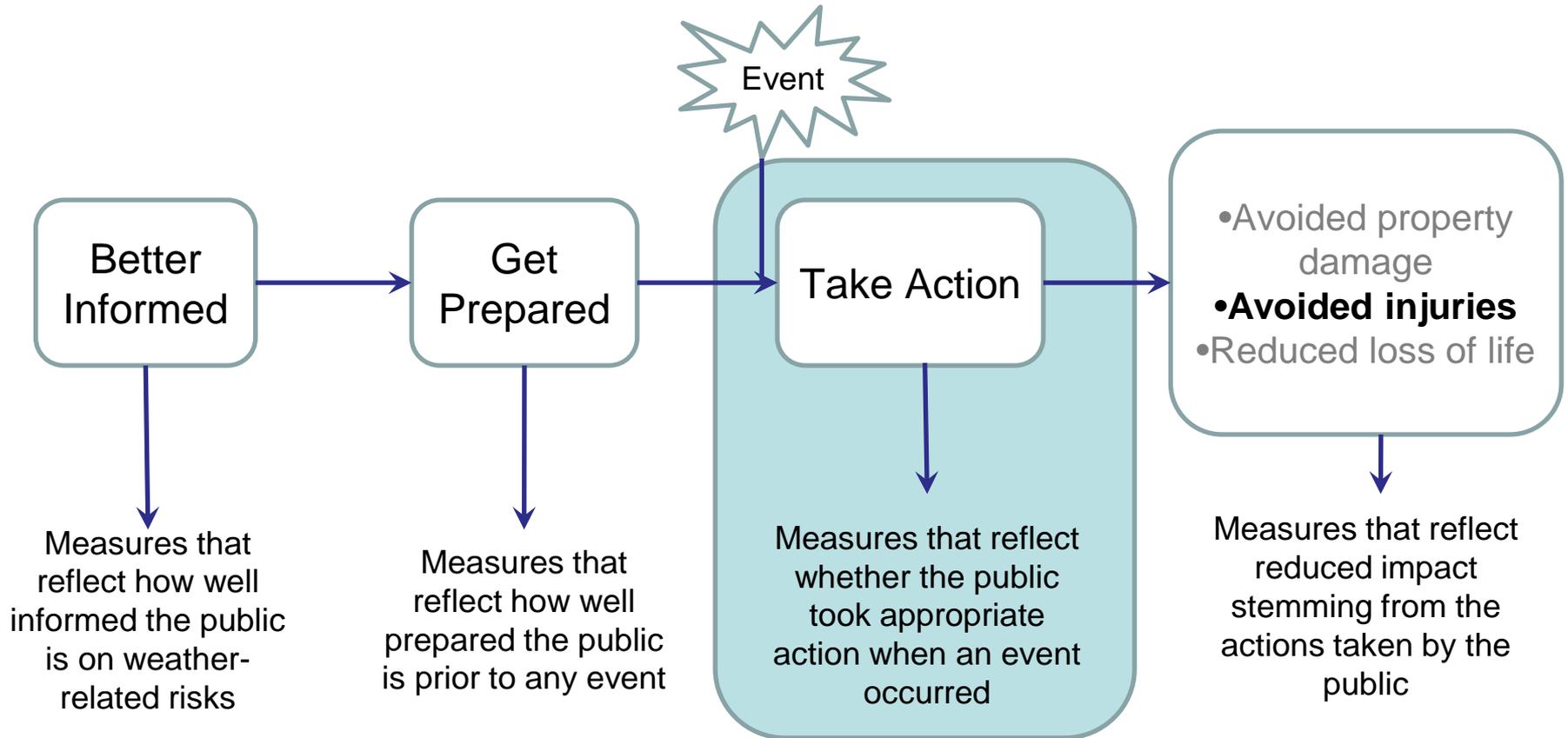| Weather Event Type and Survey Time Frame	Website Survey	Online Panel Survey	Significant Difference Between Website and Panel Surveys?
Winter Weather			
May – July 2015 Survey	57% (n = 3,132)	41% (n = 120)	Yes
January – April 2016 Survey	59% (n = 3,669)	44% (n = 214)	Yes
Statistical difference between survey time frames?	No	No	-
Flash Floods			
July – October 2015 Survey	31% (n = 3,743)	41% (n = 101)	Yes
January – April 2016 Survey	23% (n = 1,420)	31% (n = 152)	Yes
Statistical difference between survey time frames?	Yes	No	-

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Get Prepared:
Proposed Metric

Metric	Collection Approach	Question in Survey	Calculation
Percent of public that has an emergency preparedness kit	NWS website survey, collected once per year over a three-month period	Do you have a {EVENT TYPE} emergency preparedness kit for your vehicle? (Yes/No)".	Percentage that answer yes to the question.

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Get Prepared:
Operational Implications

- Continue to collect the data from the pop-up survey
  - Quarterly with rotation of weather event
  - Assess for demographic changes

- Collect data for the same set of events each year to provide a time series

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Take Action: Data Source

- NWS Quick Response Surveys

- Cover several event types

- Intended to collect data immediately following issuance of a warning (and subsequent event)

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Take Action:
Data Collections

WFO	Product (Warning Type)	Warning Issuance Date	Survey Dates	Number of Respondents
Slidell	Flash Flood	6/9/15	6/29/15 – 7/1/15	125
Jacksonville	Severe Thunderstorm	6/9/15 – 6/10/15	6/30/15 – 7/1/15	127
Taunton	Tornado	6/23/15	7/1/15 – 7/5/15	128
Phoenix	Extreme Heat	8/15/15	8/24/15 – 8/27/15	160
Sterling	Winter weather/ blizzard	1/21/16 – 1/22/16	2/1/16 – 2/2/16	180

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Take Action:
Survey Questions

- Sought shelter
  - Yes/no

- Continued to do previous activities
  - Yes/No

- Sought shelter as first action
  - Yes/No

- Did nothing as the first action
  - Yes/No

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Take Action:
Results

Data Element	Slidell – Flash Flood	Jacksonville – Severe Thunderstorm	Taunton – Tornado	Phoenix – Extreme Heat	Sterling – Winter Weather
Number of respondents [a]	*125*	*127*	*128*	*160*	*180*
Percentage that sought shelter	26% (n=120)	53% (n=117)	39% (n=126)	78% (n=148)	65% (n=174)
Percentage that continued previous activities	71% (n=120)	65% (n=116)	60% (n=124)	59% (n=147)	49% (n=172)
Percentage that sought shelter as first action	10%	25%	13%	40%	24% (n=177)
Percentage that did nothing as first action	14%	11%	13%	15%	9% (n=177)

[a] This is the number that responded to the question, unless otherwise noted in the cell.

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Take action: proposed metrics

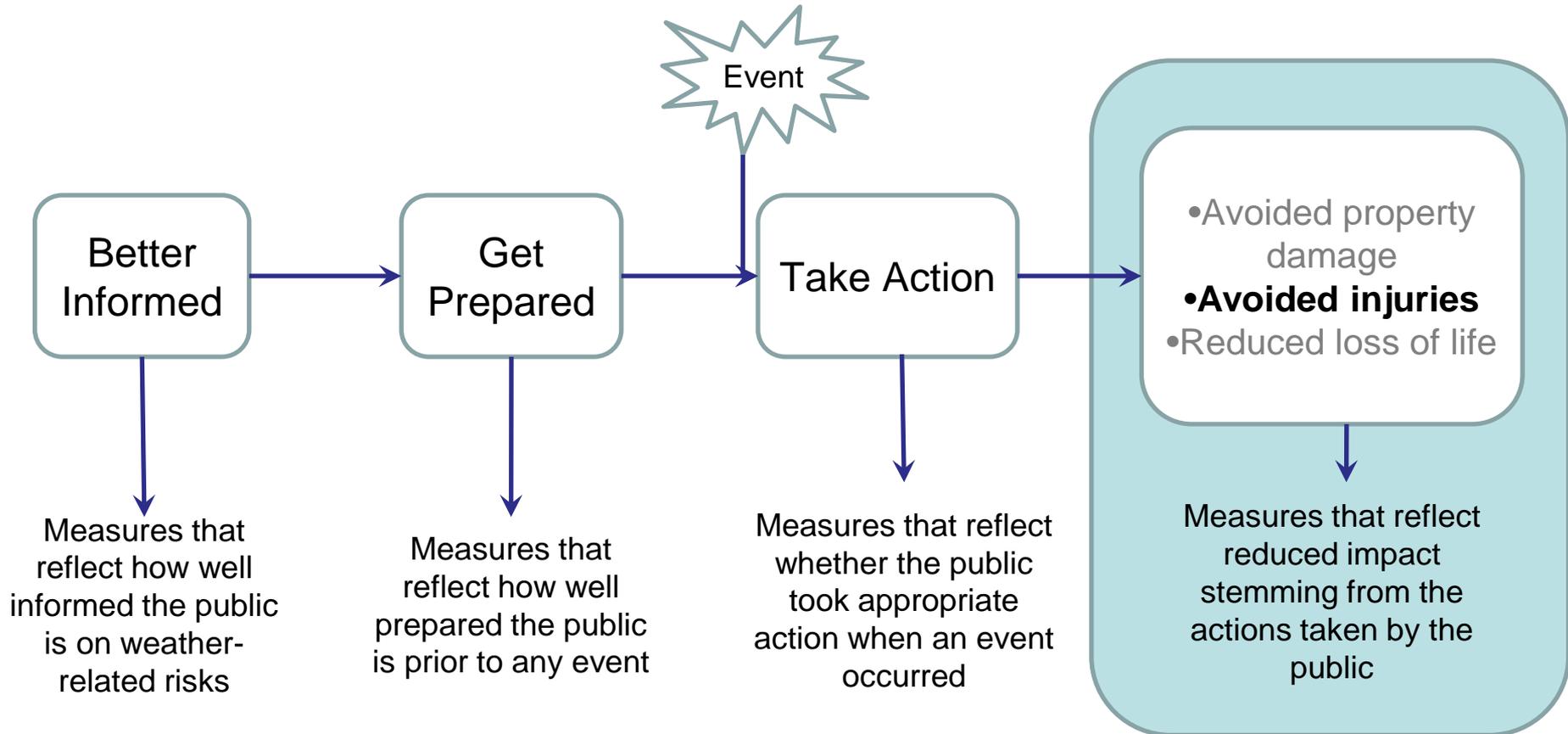| Metric	Collection Approach	Question in Survey	Calculation
Percent of public that altered their previous activities after hearing a warning or who remained vigilant	Survey – online panels implemented for a random selection of warnings issued	Did you take any of the following actions when you received the {EVENT TYPE} (advisory/warning)? Did you continue previous activities? Did you monitor weather forecasts? [a]	Percentage that answer no to the question on continuing previous activities or who answer yes to the question on monitoring weather forecasts.
Percent of public that sought protective shelter as a first action	Survey – online panels implemented for a random selection of warnings issued	Which of the following actions was the first action you took when you received the {EVENT TYPE} warning? Response option: seek shelter [b]	Percentage that select "seek shelter" (or option determined to be seeking shelter).

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Take Action:
Operational Implications

- Collect a total of 328 responses for each event type

- Select 8 warnings for winter weather, severe TS, and flash floods
  - ~42/event

- Select 6 warnings for extreme heat
  - ~55/event

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Take Action: Operational Implications (continued)

- Step 1 – Select WFOs
  - 4 for winter, severe TS, and flash floods
  - 3 for extreme heat
- Step 2 – Select Months
  - Assign WFOs to months
- Step 3 – Select Events
  - Select first two in-scope events
- Step 4 – Implement surveys

Categories for Outcome Measures

```
Better          →    Get          →    Take Action    →    •Avoided property
Informed             Prepared                                 damage
                                                           •Avoided injuries
                                                           •Reduced loss of life
```

Event

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Avoided Injuries: Overview

- Compare an "expected" number of injuries to the actual number that occur for weather events
  - Expected should be based on data prior to the events
  - Expected = what we'd expect if NWS had not improved its provision of information
- If expected exceeds actual then NWS has improved
- Logic was vetted with NOAA Chief Economist
- The key is developing that estimate of expected injuries

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Avoided Injuries: Estimating Expected Value

- Develop a statistical model for baseline period that relates injuries to factors that we would expect to explain them
  - Baseline: 2007-2011
  - Small number of injuries for each event, several are zero
- Use the estimated model to predict the number of injuries for events in a "measurement period"
  - 2012-2013

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Avoided Injuries: Baseline Statistical Model

- Zero-inflated Poisson model
  - Lots of zeros and "count" data
- Dependent variable: number of injuries
- Independent variables (factors that help explain the number of injuries):
  - Total county population
  - Population density
  - County income
  - Avg. age of housing stock
  - Severity
  - Year-to-year trends
  - NWS region

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Avoided Injuries: Results (2012-2013)

Event	Number of Events Used in Analysis	Actual Number of Injuries Among Events Used	Predicted Number of Injuries Using Baseline Model	Estimated Avoided Injuries
Thunder-storms	13,172	276	339.4	63.4
Flash Floods	3,451	20	26.8	6.8
Winter Weather	2,284	99	155.1	56.1

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Avoided Injuries: Assessment

- Concerns
  - Complex design
  - Several events have zero injuries
  - Data reported by WFOs
  - Some events are excluded from analysis
  - No measure of severity for winter and flash floods
  - Not guaranteed to be positive value
  - Needs continual updating

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Summary of Data for Metrics

Category	Metric	Winter Weather	Flash Flood	Severe Thunder-storm	Extreme Heat
Better informed	Public rating of the extent to which NWS contributes to its understanding of weather dangers	2015: 80 2016: 82	2015: 76 2016: 75	-	2015: 63
Get prepared	Percent of public that has an emergency preparedness kit	2015: 57% 2016: 59%	2015: 31% 2016: 23%	-	-
Take action	Percent of public that altered their previous activities after hearing a warning [c]	51%	29%	35%	41%
Take action	Percentage of public that sought protective shelter as a first action	24%	10%	25%	40%
Avoided Injuries	Number of avoided injuries (2012-2013)	56	7	53	-

Recommendations

- Collect data on the "better informed," "get prepared," and "take action" metrics, but not the "avoided injuries" metric.

- Focus on the four weather event types that we have focused on in this report, tracking data for each type separately.

- For the "better informed" metric, ERG recommends tracking the metric we referred to as "Public rating of the extent to which NWS contributes to its understanding of weather dangers."

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Recommendations (continued)

- For the "get prepared" metric, ERG recommends tracking the metric we referred to as "Percent of public that has an emergency preparedness kit."

- For the "take action" metric, ERG recommends tracking two metrics: "Percent of public that altered their previous activities after hearing a warning or who remain vigilant" and "Percentage of public that sought protective shelter as a first action."

- NWS should perform additional research into ERG's proposed simplified logic model.

- NWS should perform further research into the avoided injuries modeling approach.