HSOAC | HOMELAND SECURITY OPERATIONAL ANALYSIS CENTER
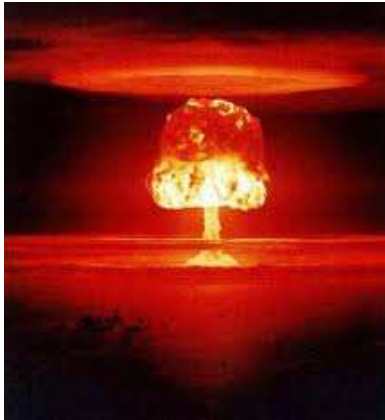
Overview of the
Homeland Security National Risk Characterization

Overview

- Why compare risks?

- Can you compare risks?

- How can you compare risks?

DHS Programs Address Many Hazards

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Stated goals of DHS Strategic Planning Motivated Comparative Risk Assessment

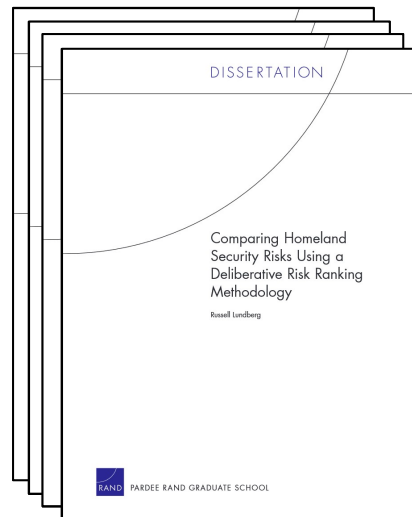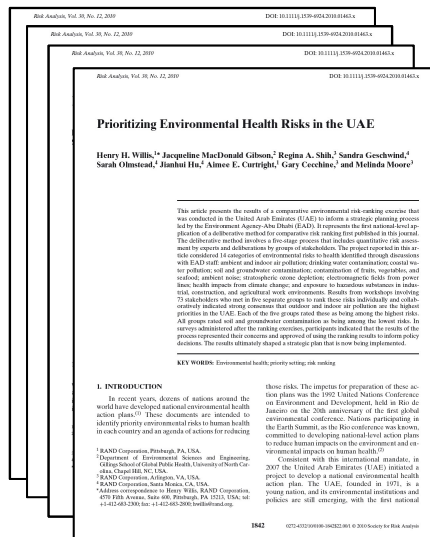- Inform development of Department's Future Years Homeland Security Program by identifying opportunities to address mitigatable risk for select threats and hazards

- Prepare strategic-level observations to inform Departmental strategic guidance documents

- Identify topics/issues for the Department's Analytic Agenda over the next 5 years

HSNRC used a repeatable analytic framework to support strategic analysis

- **Analytic framework**
  - **Incorporates existing risk and programmatic data, including descriptions of data gaps and uncertainty**
  - **Describes threats and hazards using analytic framework**
  - **Incorporates leadership review of framework, data, and results**

- **Outcomes**
  - **Analytic framework that informs decisionmaking**
  - **Results generated from a deliberative-analytic process, not simply deliberation**
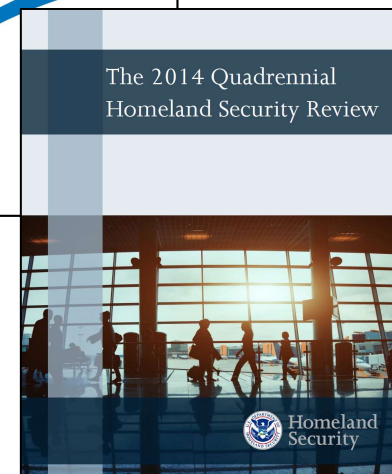
Framework Builds on Deliberative Risk Analysis Literature

**Papers in *Risk Analysis*
and other journals**

Government Analyses

Dissertations
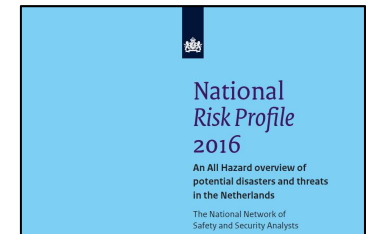
Process Builds on Two Fundamental Goals

- **Risk analysis requires both science and judgment**

  - **Assessments should be based best available science**

  - **Judgments should be captured using validated social science methods**

Homeland Security National Risk Characterization

Risk Assessment Methodology

Henry H. Willis, Mary Tighe, Andrew Lauland, Liisa Ecola, Shoshana R. Shelton, Meagan L. Smith, John G. Rivers, Kristin J. Leuschner, Terry Marsh, Daniel M. Gerstein

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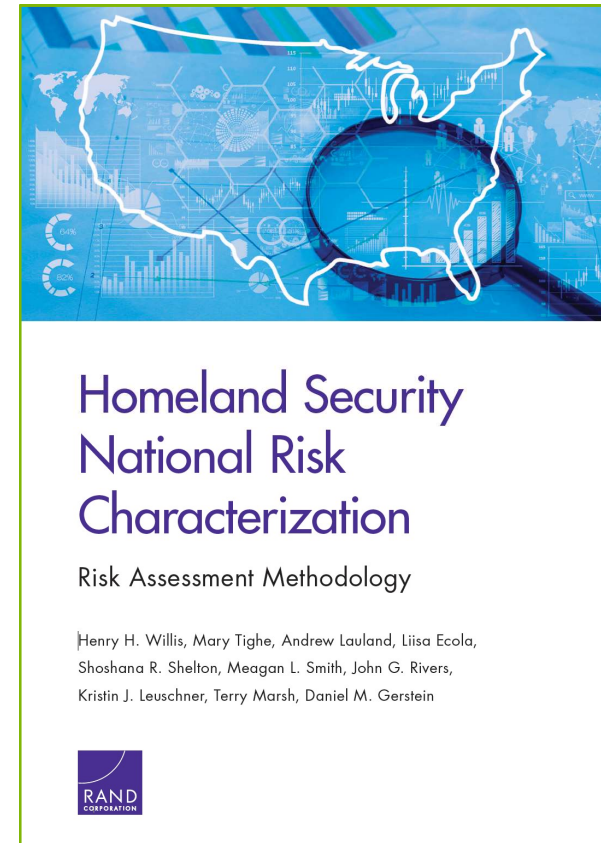
Willis et al., 2018

Using the HSNRC to Inform Priorities

HSNRC Tasks

- Literature from prior assessments
- Department deliberation on scope of threats, hazards, and attributes
- Peer/expert review of risk summary sheets

Inputs

Outcomes
- Vetted risk summary sheets to inform discussion of risk management priorities
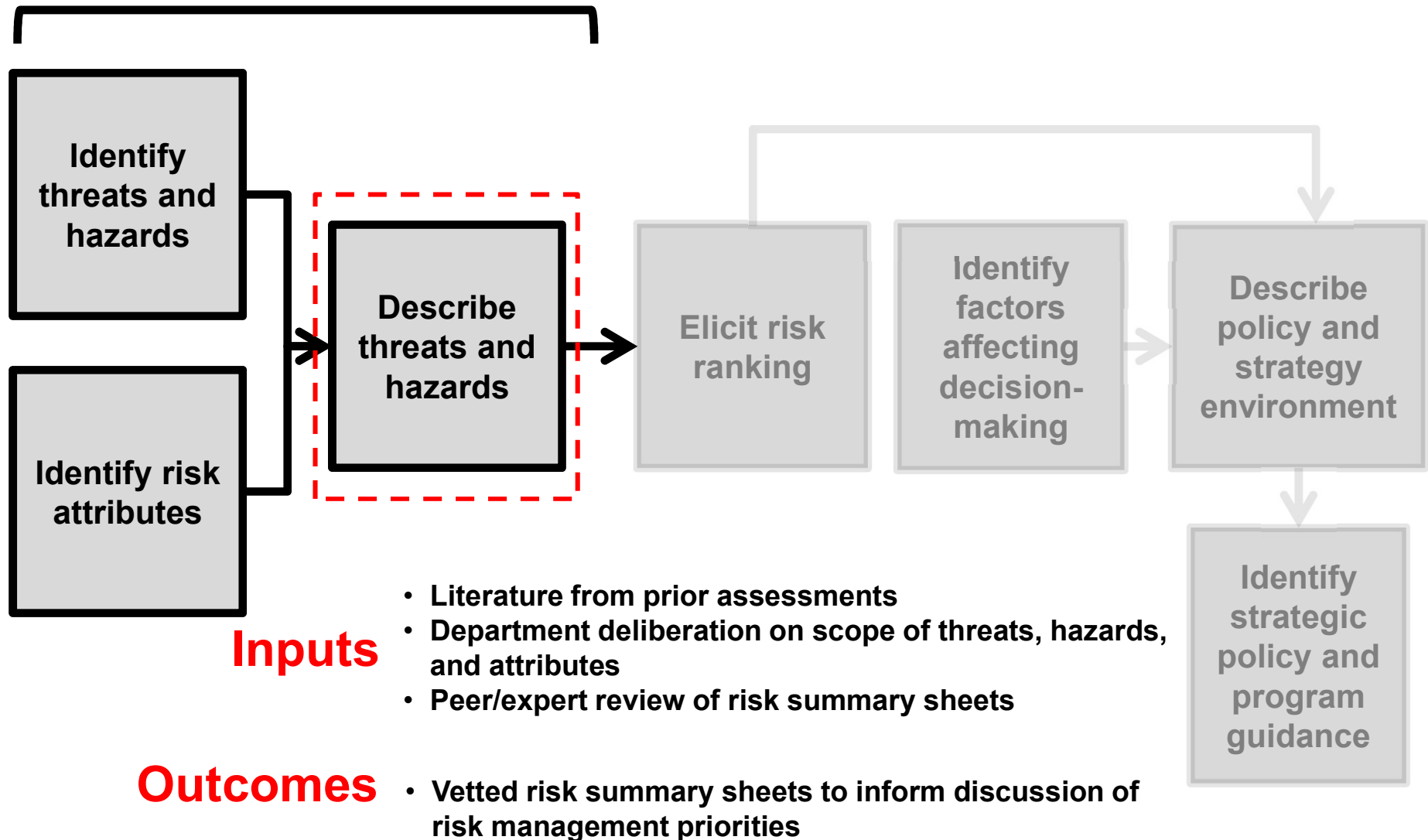
Hazards for HSNRC identified using a three-step process

- **Step 1: Generate a list of hazards to be considered**
  - Reviewed the 2014 QHSR to identify the Department's stated strategic priorities
  - Reviewed hazards identified in prior HSNRC, SNRA, and review of both
  - Combined some hazards into aggregate categories

- **Step 2: Screen hazards to identify those that are**
  - Exogenous to the homeland security enterprise
  - Both discrete events and persistent phenomena
  - Related to DHS strategic priorities
  - Threats and hazards that DHS is charged with mitigating
  - Source of a significant risk to the nation

- **Step 3: Select a set of hazards to be included based on screening**

Threats and hazards analyzed

Terrorist Threats
- Attack on leadership
- Attacks targeting critical infrastructure (e.g., hazardous transport, airplane/airport, bridges, dams, refineries, seaports)
- Biological weapon attack
- Chemical weapon attack
- Electro-magnetic pulse
- Nuclear attack
- Radiological attack
- Small arms/explosive attack on populations

Cyber Threats
- Attack on critical infrastructure networks
- Attack that disrupts a government network
- Attack that steals sensitive government data

Infrastructure Hazards
- Technical failure or industrial accident of critical infrastructure caused by human error or age

Natural Hazards
- Drought
- Earthquake
- Flooding
- Hurricane
- Space Weather
- Tsunami
- Volcano
- Wildfire

Health Hazards
- Transnational and multi-state communicable disease
- Food animal disease outbreak
- Agricultural plant disease outbreak

Illegal Activities
- Counterfeit goods
- Human trafficking
- Illegal migration
- Mass migration
- Transnational drug trafficking

Threats and hazards described using attributes that affect perceptions of risk

- **Attributes should:**
  - Describe each impact category used in selecting threats and hazards
  - Be measurable and operationally relevant
  - Describe uncertainty about threats and hazards

- **Selection of set of attributes balanced three criteria:**
  - Completeness, to assure full description of risk
  - Uniqueness, to avoid double counting of impacts
  - Conciseness, to facilitate analysis

Selected Attributes Covered Six Consequence Categories

Homeland Security National Risk Characterization

Risk Assessment Methodology

Henry H. Willis, Mary Tighe, Andrew Lauland, Liisa Ecola,
Shoshana R. Shelton, Meagan L. Smith, John G. Rivers,
Kristin J. Leuschner, Terry Marsh, Daniel M. Gerstein

RAND CORPORATION
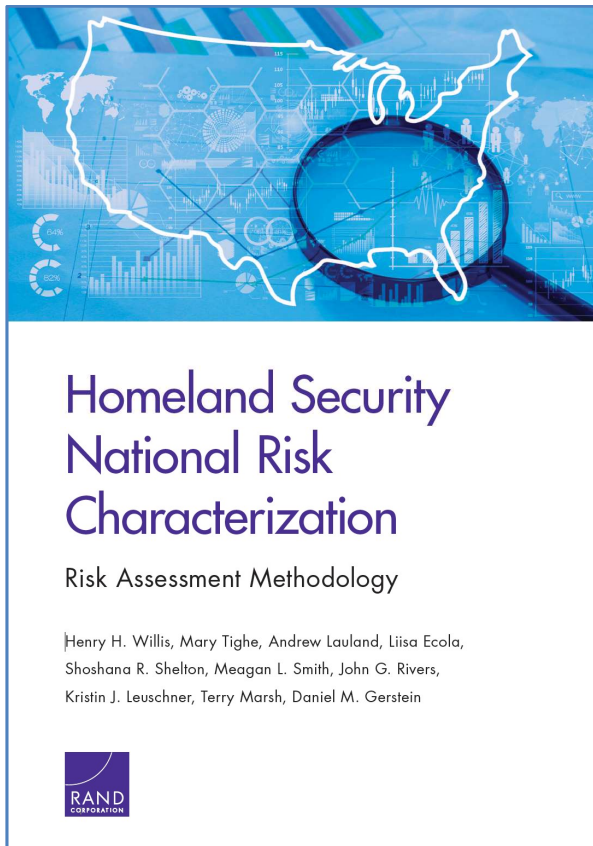
Willis et al., 2018

- Economic damage

- Deaths and injuries

- Environmental damage

- Critical infrastructure disruption

- Wellbeing

- National Essential Functions

More Difficult to Value

Using the HSNRC to Inform Priorities

HSNRC Tasks

Ways HSNRC Could Inform Priorities

- Identify threats and hazards
- Identify risk attributes
- Describe threats and hazards
- Elicit risk ranking
- Identify factors affecting decision-making
- Describe policy and strategy environment
- Identify strategic policy and program guidance

Inputs
- Risk summary sheets for threats and hazards
- Literature on risk ranking processes
- Facilitated discussions with steering group

Outcomes
Results describe:
- Consensus on high and low risks
- Disagreement about concerns of risk
- Reasons for disagreement

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Materials Provide Foundation for a Structured Elicitation of Concerns

Individual Rankings

Group Discussion and Ranking

Final Rankings

1. First ranking
2. Calculated
3. Revised

Groups of 8-20 people
4. Group ranking

5. Final

Allow dissent from group ranking

Workshop process lasted 5 – 6 hours
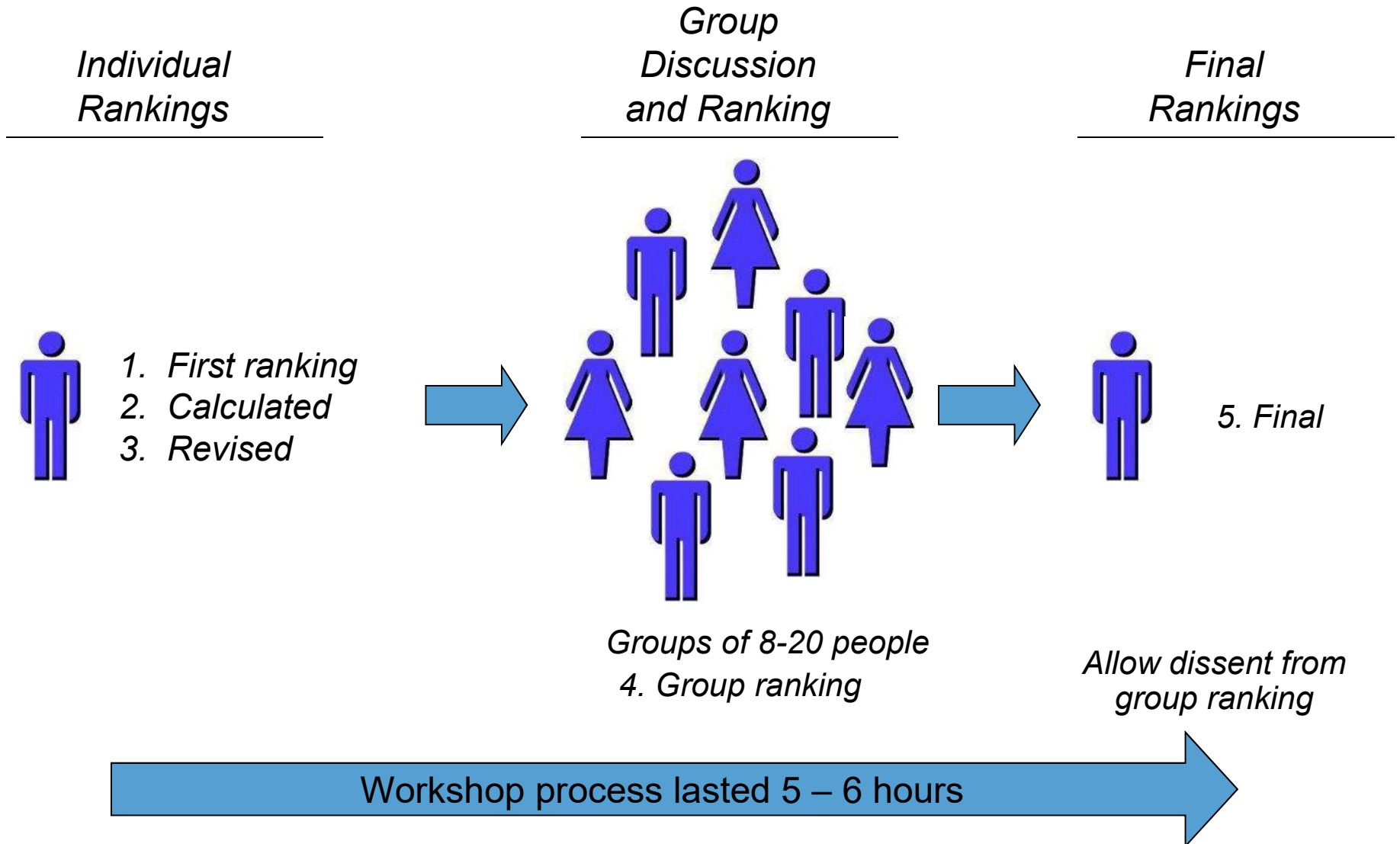
Prior Work Validates Effectiveness of Elicitation Approach

- Evaluated empirically multiple times in multiple contexts
  - 200+ risk managers
  - 100+ lay public participants
  - U.S., China, U.K., and UAE
  - Health & Safety, Ecology & Environment, and Homeland Security

- Method reliably captures concerns for use in setting priorities
  - Increase incorporation of data in judgments
  - Reduce disagreement about definitions and data
  - Potentially reduce influence of judgment and decisionmaking biases

We Demonstrated This Approach Using Ten Illustrative Hazards Using Two Methods

- **Terrorism**
  - Nuclear detonation
  - Anthrax attacks
  - IED attacks
  - Cyber attacks

- **Accidents**
  - Oil spills
  - Industrial gas release

- **Natural disasters**
  - Earthquakes
  - Hurricanes
  - Pandemic influenza
  - Tornados

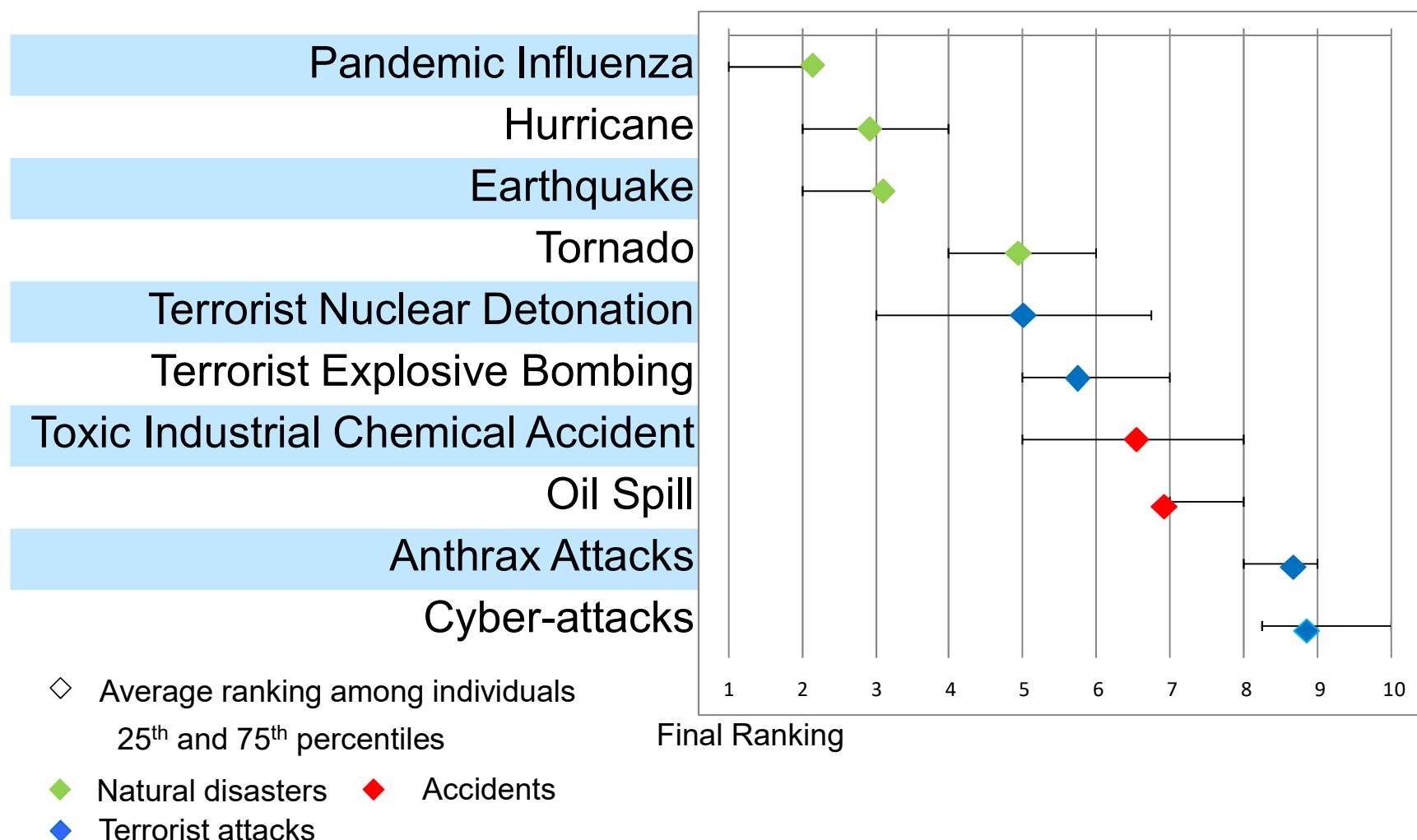# *Participants in Three Focus Groups Cover a Range of Characteristics*

- **Non-representative convenience sample**

- **Participants solicited online or through school PTAs (N=26)**

- **Three sessions**
  - **Pittsburgh (n=8)**
  - **L.A. (n=9)**
  - **L.A. (n=9)**

Characteristics	Number (total=26)	Percent
Race		
White	14	54%
Black	7	27%
Other	5	19%
Age		
20s	4	15%
30s	6	23%
40s	6	23%
50s	7	27%
60s or more	3	12%
Education		
High school diploma	4	15%
Some college	5	19%
Bachelors	10	38%
Post-graduate degree	7	27%
Gender		
Male	14	54%
Female	12	46%

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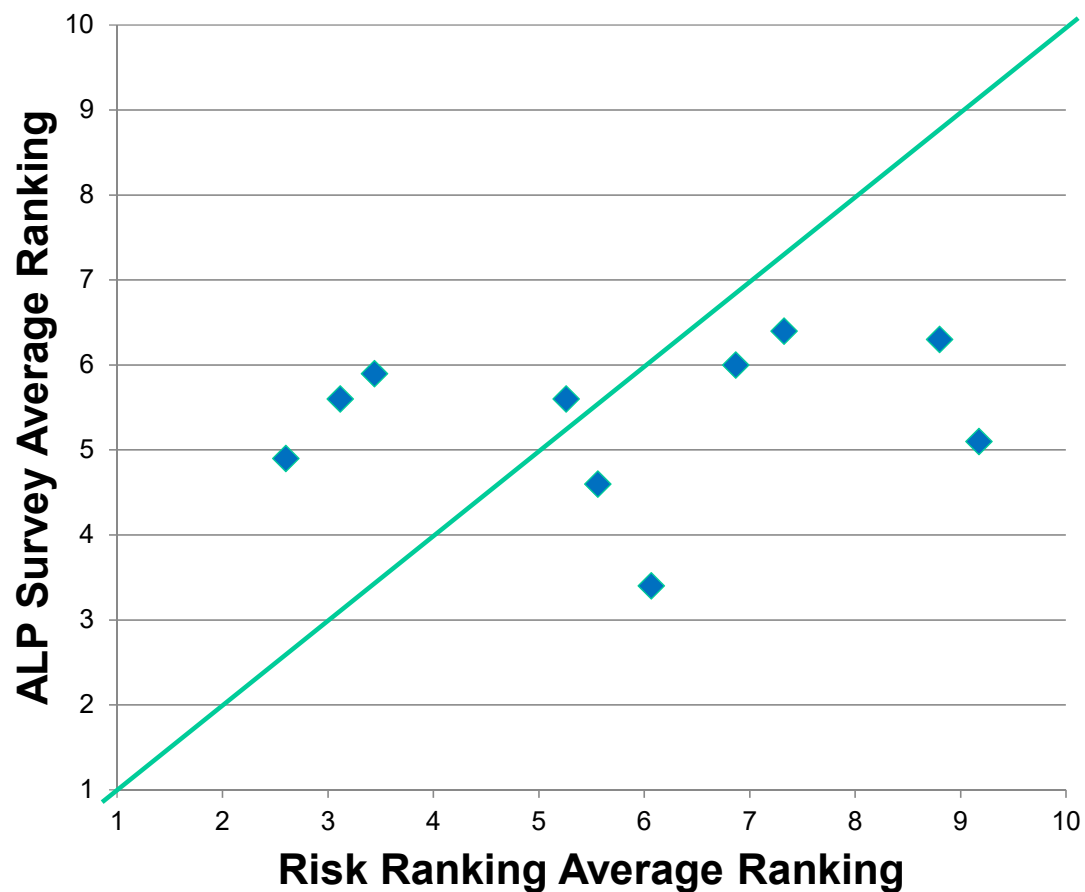
Survey - RAND American Life Panel

- **Internet panel (N=528) selected and weighted to be nationally representative**
- **Repeated panel**
  - **- Questions on homeland security only a portion**
- **Homeland Security questions in panel answered between 5/6 and 5/21/2013**
- **Presented respondents with a narrative summary and data table**
- **Asked to rate concern and rank hazards**

Workshops Generated Rankings Reflecting Concerns of Participants About Risks

Pandemic Influenza
Hurricane
Earthquake
Tornado
Terrorist Nuclear Detonation
Terrorist Explosive Bombing
Toxic Industrial Chemical Accident
Oil Spill
Anthrax Attacks
Cyber-attacks

Final Ranking (1 2 3 4 5 6 7 8 9 10)

◇ Average ranking among individuals
   25th and 75th percentiles

◆ Natural disasters   ◆ Accidents
◆ Terrorist attacks

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Rankings from Two Methods Were Very Different

Results Capture the Difference Between Thinking Fast and Slow

- **Survey results reflect less information than risk ranking**
  - **Less consensus**
  - **Less differentiation of risks**
  - **Lower correlation with attributes of risks**

- **Survey results vary from risk ranking in expected ways**
  - **More correlated with personal exposure/history**
  - **More concern for terrorist risks**

Completed Work Provides a Foundation for Comparative Risk Analysis

- Comparing national security risks from natural disasters, accidents and terrorism appears to be feasible

- Approach provides a proven way to integrate science and judgments into homeland security policy

- Suggests effective communication and decision processes may be able to moderate effects of heuristics and biases…

                              …but it is very hard to do!

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Proposed attributes for health, safety and security

Attribute	Units
Deaths	Order of magnitude number of deaths, described as both average per year and greatest number in a single episode
Injuries	Order of magnitude number of injuries and illnesses, described as both average per year and greatest number in a single episode
Well-being: Loss of confidence in societal and personal health, safety and/or security	Qualitative assessment of the expected impact on perceptions that government can provide desired security, described as greatest impact in a single episode (Low/Medium/High)

Proposed attributes for economic impact

Attribute	Units
Economic damages	Order of magnitude dollars, described as both average annual impact and greatest impact in a single episode
Greatest critical or lifeline infrastructure effects from a single episode	Qualitative constructed scale reflecting duration and number of affected customers (Low/Medium/High)

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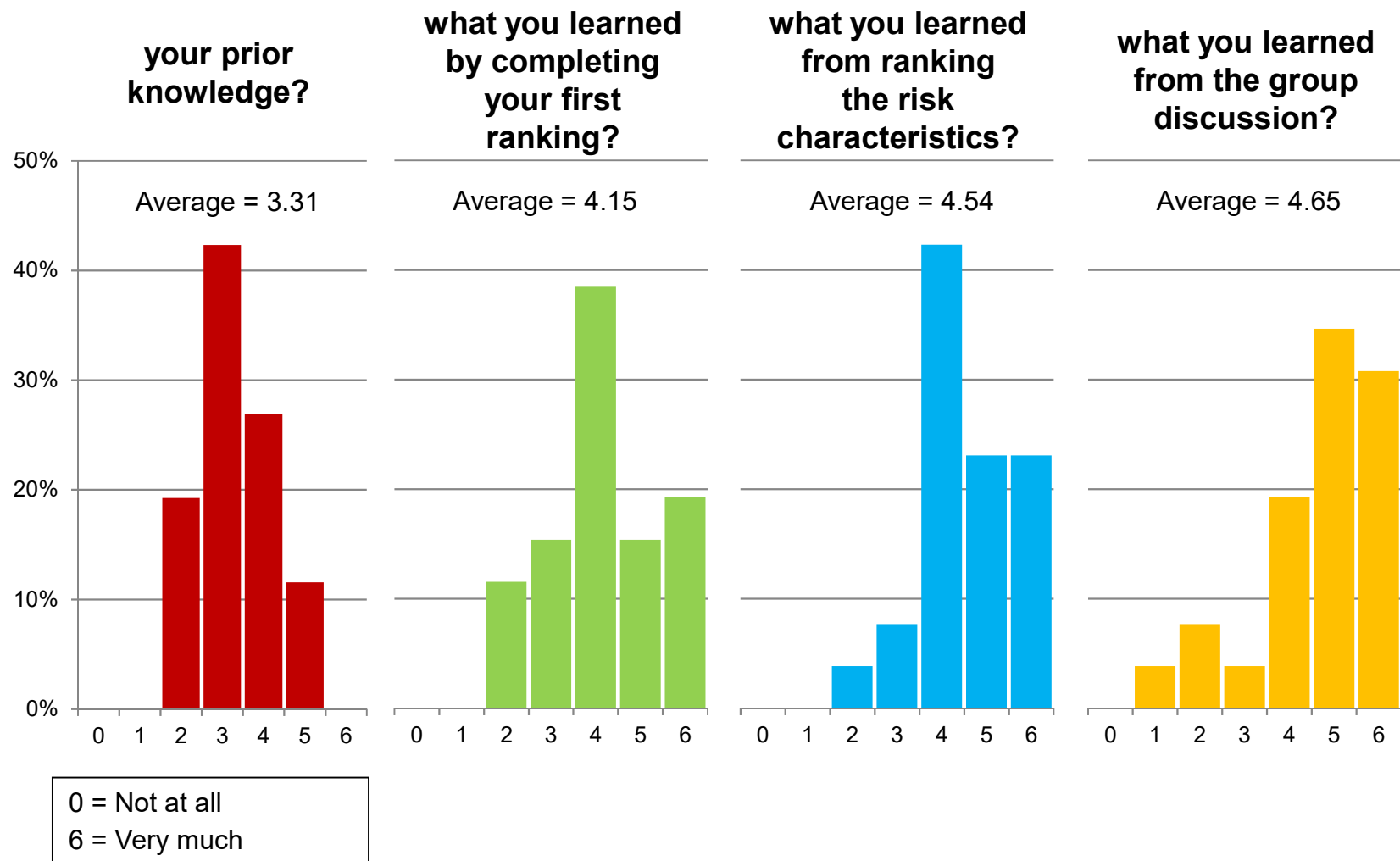# Proposed attributes for environmental and governance impacts

Attribute	Units
Greatest environmental damage in a single episode	Qualitative constructed scale accounting for effects on species, ecosystems and viewscapes that reflects time required for remediation and geographic extent of damage (Low/Medium/High)
Greatest disruption of National Essential Functions in a single episode	Qualitative constructed scale accounting for the population affected and duration of disruptions (Low/Medium/High)

Proposed attributes describing uncertainty

Attribute	Units
Frequency of occurrence	Qualitative frequency ranging from daily to millennially
Precision	Qualitative aggregated assessment of precision in estimates across all attributes (Low/Medium/High)
Predictability	Constructed, qualitative scale reflecting the amount of warning for a single episode and the ability to estimate annual impacts. (Low/Medium/High)

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Participants Relied on Many Information Sources

How much is your current knowledge of Homeland Security risks based on...

your prior knowledge?	what you learned by completing your first ranking?	what you learned from ranking the risk characteristics?	what you learned from the group discussion?
Average = 3.31	Average = 4.15	Average = 4.54	Average = 4.65

0 = Not at all
6 = Very much

Correlations Among Participants Rankings Suggest People Learned About Risks

Average Correlations	Oct. 13 (Pitt.)	Nov. 30 (LA)	Dec. 1 (LA)
Among First Rankings	0.29	0.44	0.15
Among Final Rankings	0.77	0.54	0.54

Expert- Env.
Initial
$r_s = 0.17\text{-}0.52$

Final
$r_s = 0.45\text{-}0.93$

Public- Env.
Initial
$r_s = 0.39$

Final
$r_s = 0.87$

Public- H&S
Initial
$r_s = 0.59$

Final
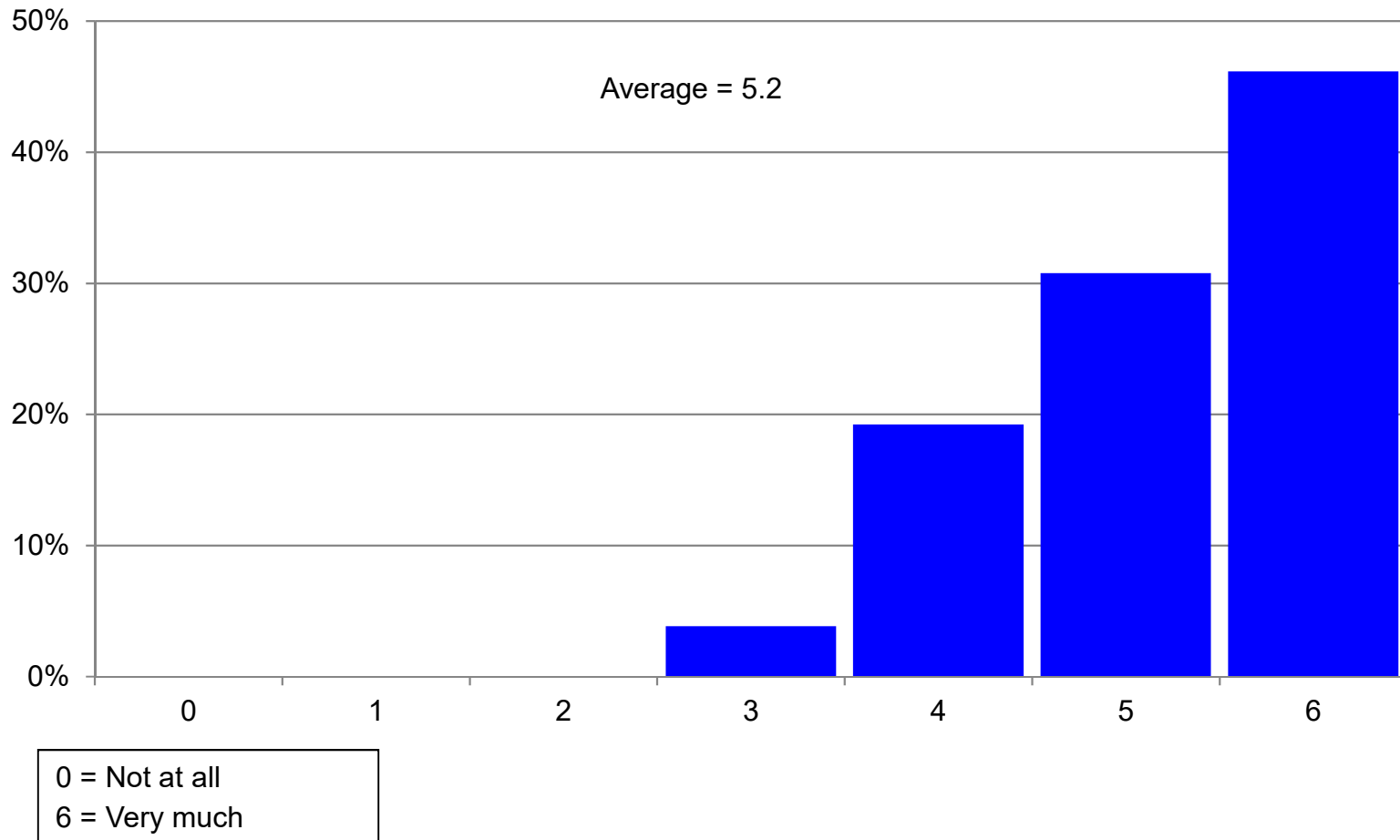$r_s = 0.86$

Results are consistent with experimental validation

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Participants Viewed Group Discussions As Open and Engaging

To what extent did the group consider and discuss different points of view and encourage each member to express his or her opinion?

Average = 5.2

0 = Not at all
6 = Very much

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Regression Analysis Supports Conclusion That Final Rankings Reflect More Than Group Consensus

$\beta = 0.66$

Person A

Wald Chi-Sq = 80

First Ranking → Group Ranking → Final Ranking

$\beta = 0.36$
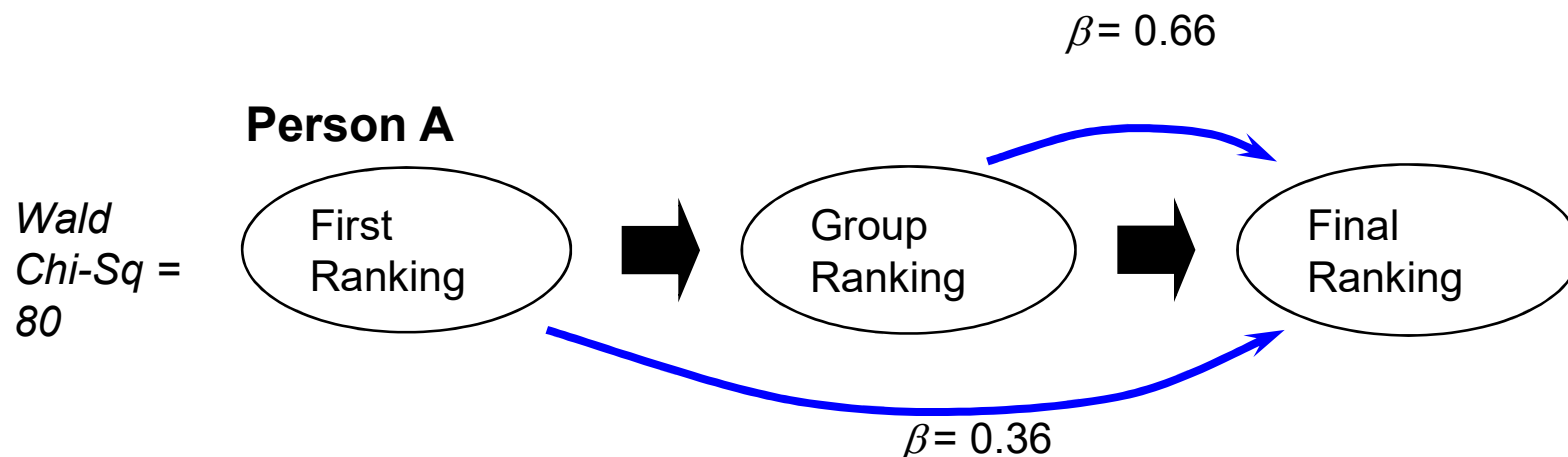
- **First and Group rankings explain a participant's Final ranking well**

- **Participants rely heavily on their group's ranking**

- **But, many also rely on their first ranking**

Regression Analysis Supports Conclusion That Final Rankings Reflect More Than Group Consensus

$\beta = 0.66$

Person A

Wald Chi-Sq = 80

First Ranking → Group Ranking → Final Ranking

$\beta = 0.36$
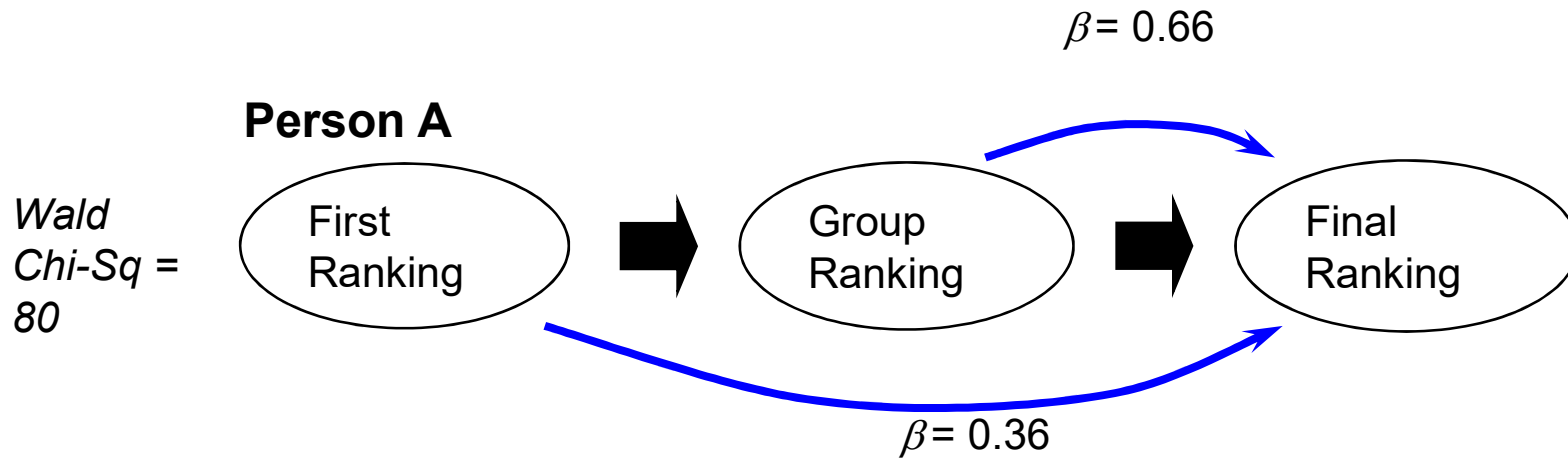
| Mean b_i	Environmental.- Expert	Environmental - Public	Health and Safety
Individual Ranking	.39	0.28	0.29
Group Ranking	.65	0.73	0.65

Results are consistent with past studies

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Participants Supported Using the Rankings to Develop Risk Management Policies

How satisfied or dissatisfied are you with your group's risk ranking?

Average = 4.8

0 = Very dissatisfied
6 = Very satisfied
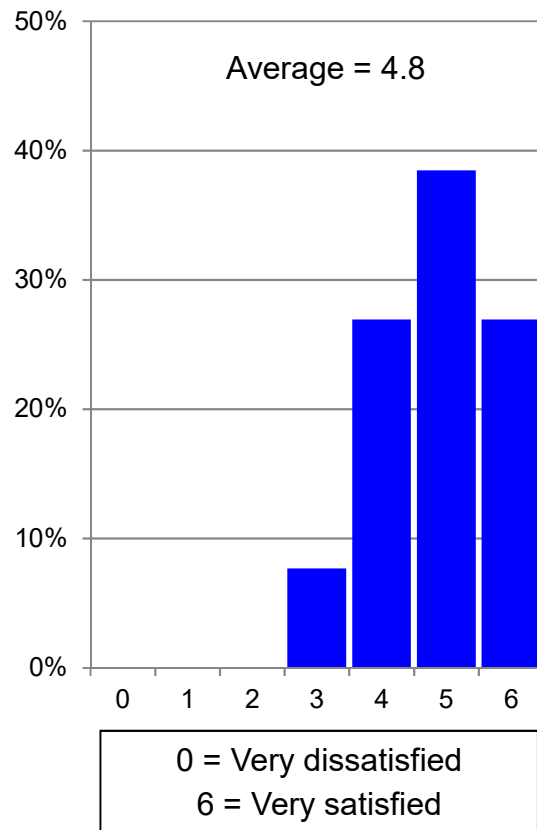
To what extent is the group's risk ranking representative of your concerns about these risks?

Average = 4.3

0 = Not very representative
6 = Very representative
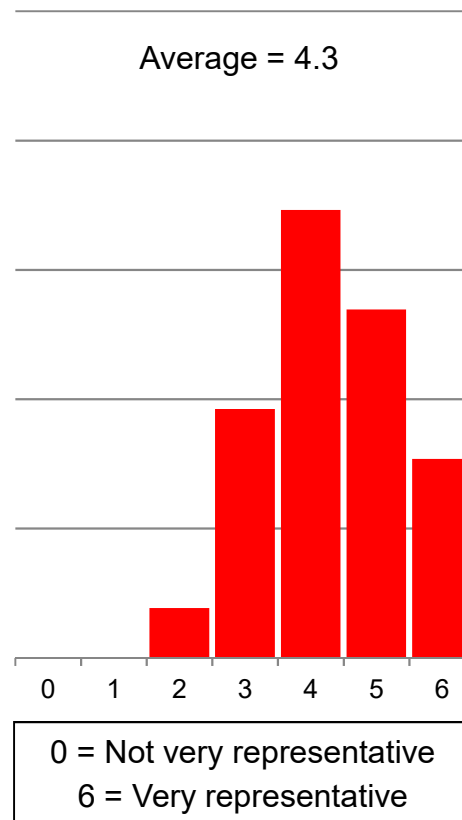
How strongly would you approve of these rankings being used in making decisions in a real organization like DHS?

Average = 4.5

0 = Strongly disapprove
6 = Strongly approve

RAND
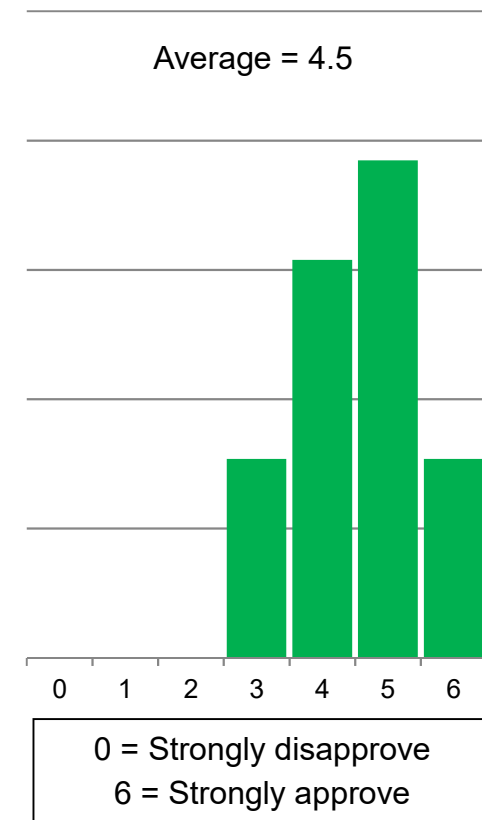
Less Consensus in Survey than Deliberative Method (as Shown Using Standard Deviation)
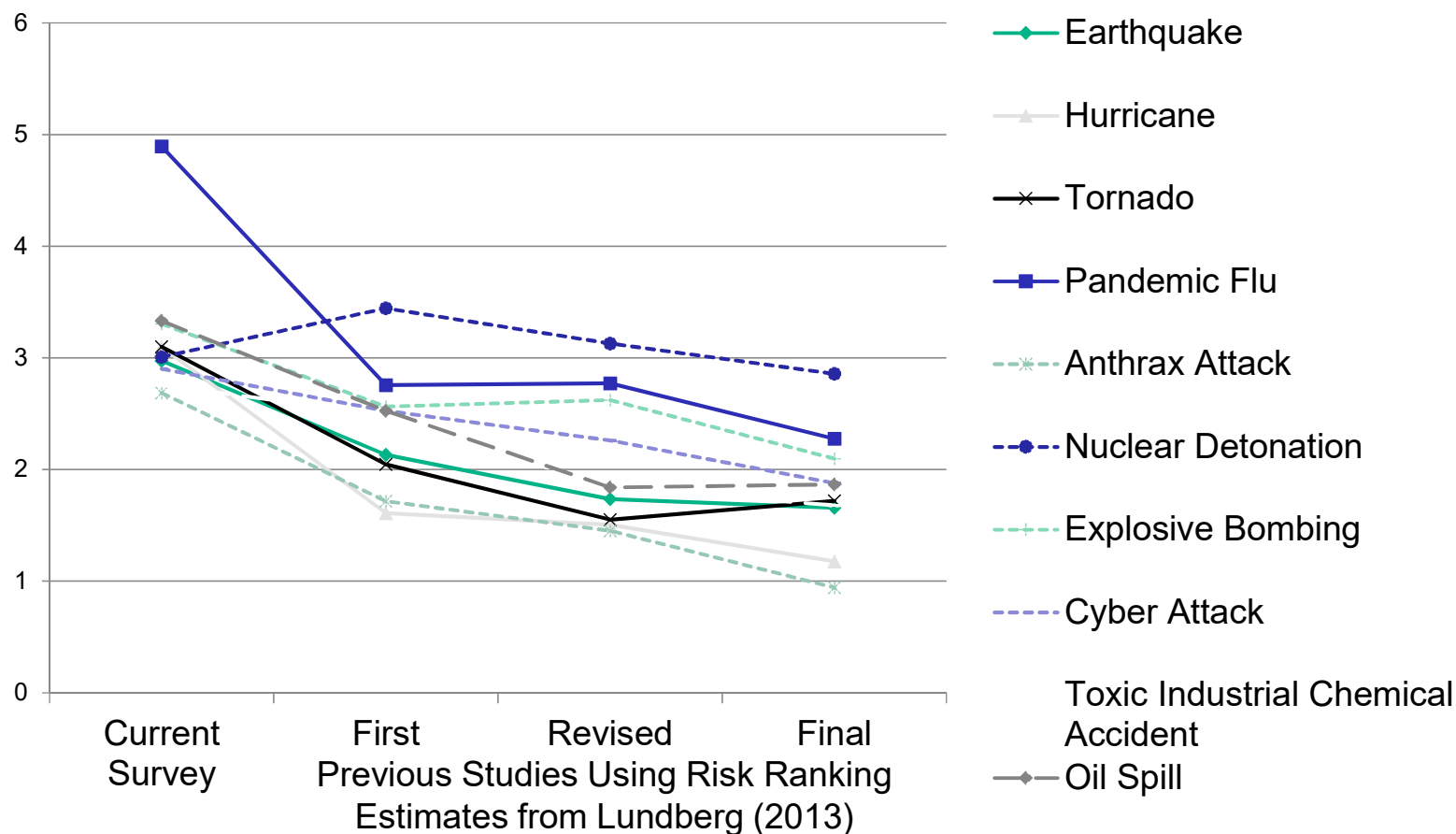
Survey Respondents Were More Concerned About Human-Induced Risks

	Risk Ranking	ALP Survey	Difference
Pandemic Flu	2.6	4.9	-2.3
Hurricane	3.1	5.6	-2.5
Earthquake	3.4	6.0	-2.6
Tornado	5.3	5.6	-0.3
Nuclear Detonation	5.6	4.7	0.9
Explosive Bombing	6.1	3.3	2.8
Toxic Industrial Chemical Accident	6.9	6.1	0.8
Oil Spill	7.3	6.5	0.8
Anthrax Attack	8.8	6.5	2.3
Cyber-attack	9.2	5.0	4.2

Survey Ranks Less Correlated with Attributes

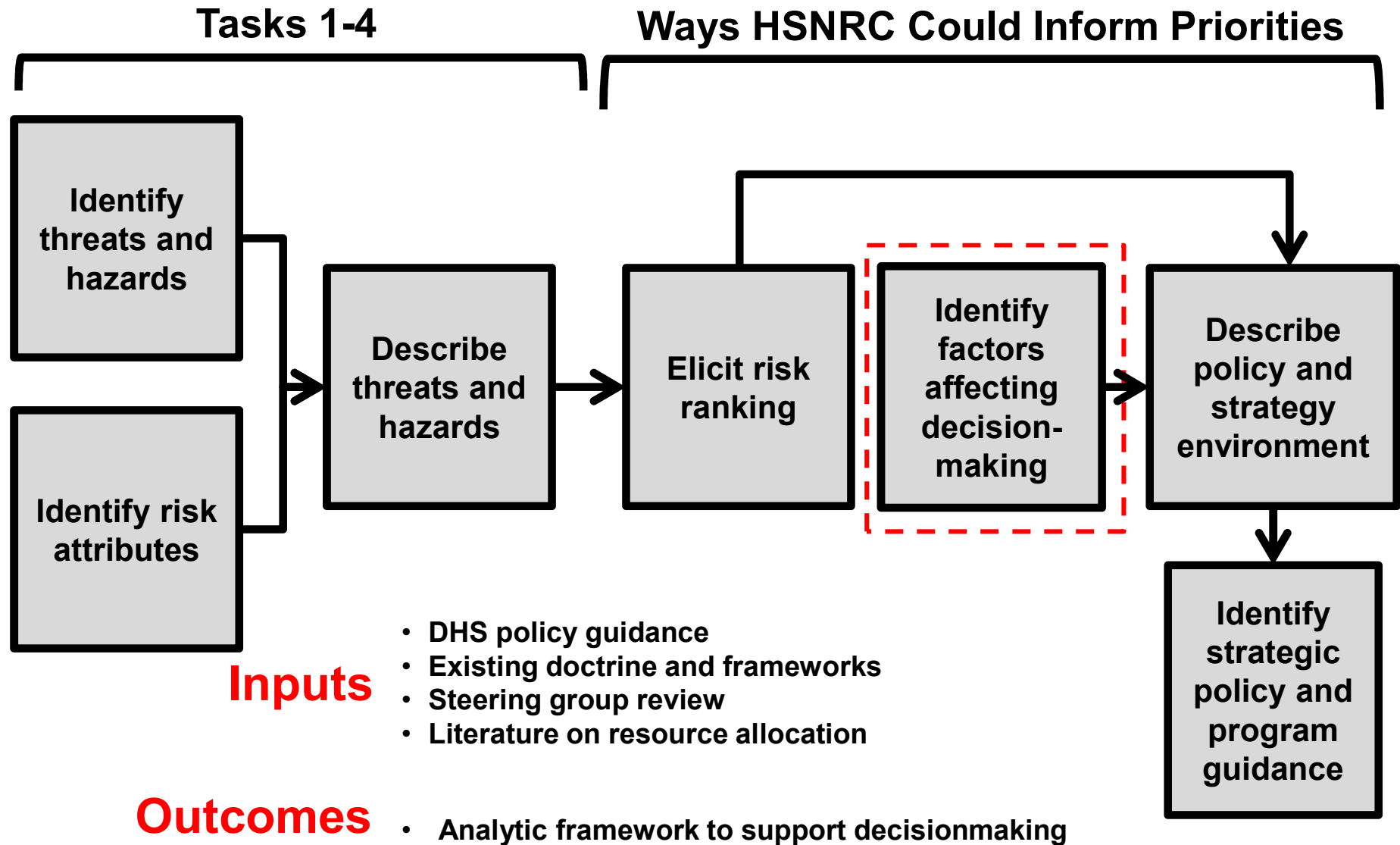| Spearman Correlation between Reported Ranking and Ranking Based on One Attribute	ALP Survey	Risk Ranking	Difference
Average lives lost per year	0.35	0.83	-0.48
Greatest lives lost in a single event	0.17	0.58	-0.41
Average more severe injuries/illnesses	0.24	0.88	-0.64
Average less severe injuries/illnesses	-0.08	0.85	-0.93
Psychological consequences	0.07	0.75	-0.68
Average economic damages per year	0.14	0.87	-0.73
Greatest economic damages in a single event	-0.01	0.38	-0.39
Duration of economic damages	-0.34	0.51	-0.85
Size of area affected	0.30	0.30	0.00
Average environmental damage per year	-0.41	0.12	-0.53
Average individuals displaced per year	-0.02	0.23	-0.25
Disruption of government operations	0.54	0.35	0.19
Natural/human-induced	0.18	-0.78	0.96
Ability of individuals to control their exposure	0.42	-0.10	0.52
Delay between exposure and health effects	-0.26	0.04	-0.30
Scientific understanding	-0.43	-0.47	0.04
Combined uncertainty	0.13	-0.46	0.59

Respondents Were More Concerned About Risks To Which They Had Been Exposed

Hazard	Average Concern (regression coef. of exposure)	Average Rank (regression coef. of exposure)
Explosive Bombing	-0.6, p=0.000, n=90	-0.8, p=0.003, n=90
Nuclear Detonation	-1.6, p=0.000, n=13	-1.8, p=0.002, n=13
Pandemic Flu	-0.8, p=0.000, n=56	-1.6, p=0.000, n=56
Cyber-attack	-0.9, p=0.000, n=36	-1.4, p=0.004, n=36
Hurricane	-1.4, p=0.000, n=149	-2.9, p=0.000, n=149
Tornado	-0.9, p=0.000, n=80	-1.3, p=0.006, n=80
Earthquake	-1.0, p=0.000, n=76	-1.7, p=0.000, n=76
Toxic Industrial Chemical Accident	-1.6, p=0.000, n=24	-0.9, p=0.197, n=24
Oil Spill	-0.9, p=0.000, n=79	-1.9, p=0.000, n=79
Anthrax Attack	-2.0, p=0.000, n=12	-2.2, p=0.027, n=12

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Using the HSNRC to Inform Priorities

Tasks 1-4

Ways HSNRC Could Inform Priorities

- DHS policy guidance
- Existing doctrine and frameworks
- Steering group review
- Literature on resource allocation

Inputs

Outcomes
- Analytic framework to support decisionmaking

Using the HSNRC to Inform Priorities

Tasks 1-4

Ways HSNRC Could Inform Priorities

Inputs
- Results from HSNRC and other strategic analysis
- Coarse mapping of enacted and FYHSP budgets
- Coarse mapping to programs/capabilities
- Observations on seams in capabilities and authorities

Outcomes
- Description of factors that affect strategy and policy decisionmaking about threats and hazards

Using the HSNRC to Inform Priorities

Tasks 1-4

Ways HSNRC Could Inform Priorities

Identify threats and hazards

Identify risk attributes

Describe threats and hazards

Elicit risk ranking

Identify factors affecting decision-making

Describe policy and strategy environment

Identify strategic policy and program guidance

Inputs
- Descriptions of policy and strategy environment
- Literature on priority setting processes
- Facilitated discussions with steering group

Outcomes
- Threats and hazards for further mitigation
- Observations to guide strategic guidance
- Topics for further analysis