

# National Weather Service Hazard Simplification:

Public Survey

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## **Final Report**

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# Executive Summary

## Overview

The NWS has embarked on an effort to simplify and enhance its watch, warning, and advisory (WWA) products, since both prior social science research and NWS service assessments have demonstrated that many members of the public, and even some NWS partners, do not understand the distinctions among the terms used in the different WWA products or their intent. Since 2013, ERG has supported the NWS in conducting a coordinated plan of research (see Figure ES-1) to assess the current WWA warning system and discern where change could be feasible and beneficial. This report summarizes ERG’s work at implementing one aspect of this coordinated plan: a series of public surveys to assess the current system relative to a set of potential new messages to convey weather-related risks to the public.

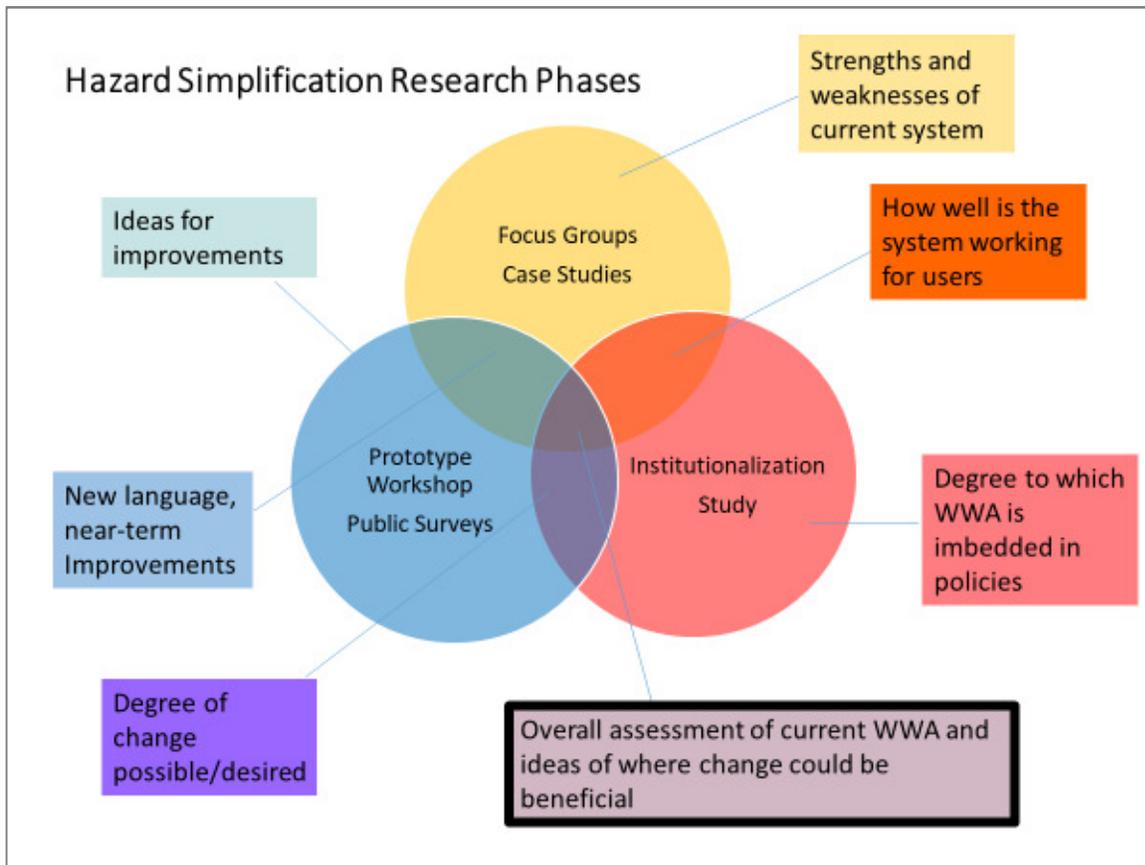


Figure ES-1. Hazard Simplification Project Research Phases

ERG implemented a set of seven public surveys in February and March of 2018 covering six distinct weather hazards:<sup>1</sup>

- Winter weather – mild regions

<sup>1</sup> The winter weather survey was split into two distinct geographic regions to allow customization of the messages presented to respondents.

- Winter weather – cold regions
- Thunderstorms
- Tornadoes
- Coastal flooding
- Flash flooding
- Areal flooding

Table ES-1 summarizes the specifications for each survey (including states where the samples were drawn), the dates each survey was in the field, and total number of respondents. Overall, the seven surveys resulted in the collection of 7,492 total responses.

**Table ES-1. Summary of Survey Specification, Implementation Dates, and Sample Sizes**

Weather Hazard	Survey Parameters	Dates	Respondents
Winter weather – mild climates	<ul style="list-style-type: none"> <li>• VA, NC, KY, TN, SC, GA, AL, MS, AR, MO, NE, OK</li> <li>• Adults aged 20+</li> <li>• No state with more than 200 responses</li> </ul>	2/5/18 – 2/7/18; 2/15/18 – 2/16/18	1,410
Winter weather – cold climates	<ul style="list-style-type: none"> <li>• ME, NH, VT, MA, RI, CT, NY, PA, MI, WI, MN, CO, WY, MT, ID</li> <li>• Adults aged 20+</li> <li>• No state with more than 150 responses</li> </ul>	2/2/18 – 2/5/18; 2/15/18 – 2/16/18	1,298
Thunderstorms	<ul style="list-style-type: none"> <li>• All U.S. States and Washington DC</li> <li>• Adults aged 20+</li> <li>• No more than 65% as women</li> <li>• No state with more than 100 responses</li> </ul>	2/20/18 – 2/22/18	1,501
Tornadoes	<ul style="list-style-type: none"> <li>• AL, AR, GA, IA, IL, IN, KS, KY, LA, MO, MN, MS, NC, NE, OK, SC, TN, TX</li> <li>• Adults aged 20+</li> <li>• No more than 65% as women</li> <li>• No state with more than 80 responses</li> </ul>	2/20/18 – 2/22/18	700
Coastal flooding	<ul style="list-style-type: none"> <li>• ME, NH, MA, RI, CT, NY, NJ, MD, DE, VA, NC, SC, GA, FL, AL, MS, LA, TX</li> <li>• Must live within 10 miles of the coast</li> <li>• Adults aged 20+</li> <li>• No more than 65% as women</li> <li>• No state with more than 60 responses</li> </ul>	3/2/18 – 3/12/18	690
Flash flooding	<ul style="list-style-type: none"> <li>• TX, MS, AR, AL, TN, KY, MO, IA, IL, MI, IN, OH, PA, NY, NJ, CT, MA, NC, VA, MD, WV, WI</li> <li>• Adults aged 20+</li> <li>• No more than 65% as women</li> <li>• No state with more than 60 responses</li> </ul>	3/2/18 – 3/7/18	841
Areal flooding	<ul style="list-style-type: none"> <li>• TX, MS, AR, AL, TN, KY, MO, IA, IL, IN, OH, PA, NY, NJ, CT, MA, NC, VA, MD, WV, CA (south of San Francisco), AZ, OK, KS</li> <li>• Adults aged 20+</li> <li>• No more than 65% as women</li> <li>• No state with more than 80 responses</li> </ul>	3/2/18 – 3/12/18	1,052

The surveys were all similar in design and content and varied in terms of hazard-specific content. There were two key components to each survey:

- Knowledge of the current terms being used – A set of questions that asked respondents about their understanding of the terms currently being used by NWS.
- Prototype testing scenarios – NWS and ERG developed a set of alternatives (prototypes) to the current messages in use; alternatives were developed for four different current messages: watch, advisory, warning, and emergency.

The results and associated conclusions from these two aspects are summarized in this Executive Summary.

The report provides a summary of the collected data for the seven surveys, focusing on the areas listed above, and draws some conclusions based on these data. As we noted above, the public survey was one component of a larger research agenda and certainly not an endpoint for NWS' Hazard Simplification work. As we recommend below, further work should be done to translate the results here, along with the inputs from other research, to develop a revised prototype.

## Current Knowledge

The current knowledge questions in each survey acted as a “test” of respondents’ understanding of the terms currently used by NWS; in other words, each question had a correct response.<sup>2</sup>

**For the most part, knowledge of the current terms in use is relatively low.** The surveys we implemented tested 21 separate terms (three in each survey). Of those 21 terms, in eight cases the percentage of respondents who answered correctly was between 40 and 49 percent. In nine cases, the percentage who answered correctly was 50 percent or more, but never more than 70.6 percent; in three of those nine that were above 50 percent the percentage was between 50 and 60 percent. Finally, in four cases, the percentage who answered correctly was less than 30 percent.

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<sup>2</sup> In the two winter weather surveys, which were implemented first, we provided respondents with the term (e.g., “winter storm warning”) in the question and asked them to select from three definitions as response options. Following analysis of these results, NWS and ERG decided to alter the format for subsequent surveys. For the five remaining surveys, we provided the respondent with a definition in the question text and allowed them to select from terms as response options.

**Table ES-2. Summary of Current Knowledge Questions**

Survey	Term Tested	Percentage Correct	Term Tested	Percentage Correct	Term Tested	Percentage Correct
<b>Winter Weather, Mild</b>	Winter Storm Warning	43.1%	Winter Weather Advisory	14.5%	Winter Storm Watch	70.6%
<b>Winter Weather, Cold</b>	Winter Storm Warning	43.8%	Winter Storm Advisory	17.4%	Winter Storm Watch	68.9%
<b>Thunderstorms</b>	Severe Thunderstorm Watch	43.5%	Significant Weather Advisory	24.3%	Severe Thunderstorm Warning	56.8%
<b>Tornadoes</b>	Tornado Watch	67.3%	Tornado Warning	70.6%	Tornado Emergency	28.9%
<b>Coastal Flooding</b>	Coastal Flood Watch	41.6%	Coastal Flood Advisory	44.4%	Coastal Flood Warning	55.6%
<b>Flash Flooding</b>	Flood Watch	50.0%	Flash Flood Warning	64.5%	Flash Flood Emergency	62.2%
<b>Areal Flooding</b>	Flood Watch	44.4%	Flood Advisory	42.6%	Flood Warning	43.6%

### Prototype Testing

The prototype testing component of each survey formed the largest set of questions answered by each respondent. As noted, NWS and ERG developed a set of prototypes to act as alternative to the current system. Table ES-3 provides a summary of the general structure for each prototype (and the current system); the specific terms used in each hazard are provided in the hazard-specific sections of this report.

**Table ES-3. Prototypes and Their Associated Levels**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	X Watch	X Outlook	X Notice	Possible X Event	Possible X Conditions
Advisory level	X Advisory	X Warning	X Alert	Moderate X Warning	Level Orange X Event
Warning level	X Warning	X Warning	X Warning	Severe X Warning	Level Red X Warning
Emergency level	X Emergency	X Warning	X Emergency	Extreme X Warning	Level Purple X Warning

Note: The “X” is a placeholder for hazard-specific description. For example, for winter weather, the watch level becomes “Winter Weather Watch.”

The prototype testing involved providing respondents with a scenario that reflected an evolving weather event and prompting the respondents with messages using either the current system or one of the four new prototypes. The scenarios reflected upgrades or downgrades in risk over time, and each of the weather hazards had between one and three scenarios. Within each scenario, respondents saw four separate prompts. The first prompt was always a baseline prompt and was the same for all scenarios

within a weather hazard (i.e., the baseline did not include prototype-specific language). The second prompt was always a “watch-level” prompt and included prototype specific language. The third and fourth prompts provided the upgrades and downgrades that reflected real-life situations and also included prototype-specific language. For example, in the winter weather survey (mild or cold climates), the “warning with an upgrade” scenario involved a baseline prompt, a watch-level prompt, a warning-level prompt, and then an emergency-level prompt.

The prompts included a description of the situation and a prototype-based (or current system) message. Following each prompt, we asked respondents the action they would take. The actions usually included five options:<sup>3</sup> do nothing, monitor, prepare, take some action, or take protective action. The descriptions of these actions were specific to each hazard. We also asked respondents the likelihood they would take specific responses: monitoring, preparing, and taking action; e.g., respondents were asked “how likely are you to ... monitor weather forecasts closely.” Respondents could select a value between one (very unlikely) and five (very likely). Whereas the “action taken” question makes the respondent select one action, the “likelihood” questions allow the respondent to indicate the degree to which they would take three specific actions.

Thus, there are four total questions that each respondent answered following a prompt:

- Action taken (do nothing, monitor, prepare, take some action, take protective action)
- Likelihood of monitoring (scale of 1 to 5)
- Likelihood of preparing (scale of 1 to 5)
- Likelihood of acting (scale of 1 to 5)

The analyses we perform in this report to assess the prototypes are based on these data.

In implementing the surveys, respondents were asked to respond to two separate scenarios; that is, they experience two prototype sequences. At the start of the survey, respondents were first randomly assigned a prototype and an upgrade/downgrade scenario for their first sequence; they were then randomly assigned to a second prototype, different from the first, and an upgrade/downgrade scenario for the second sequence. Thus, respondents never saw the same prototype twice, but could experience the same upgrade/downgrade scenario in both sequences.

To analyze the data, ERG used ordered logistic regression to estimate odds ratios. An ordered logistic analysis correlates a set of ordered response categories (the response variables listed above) with a set of explanatory variables (e.g., the prototype the respondent saw, demographics, responses to other questions) to determine factors that lead to respondents selecting higher or lower categories. The results we present are phrased in terms of odds ratios for the included variables. Odds ratios reflect the increased probability of being in a “higher” response category for increased values of the variable. For example, we estimated odds ratios associated with seeing Prototypes 1 – 4 relative to seeing the current system; thus, our results allow us to make statements such as “those who saw prototype 1 were 1.5 times more likely to select a more protective action than those who saw the current system wording.” In

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<sup>3</sup> Flash flooding, however, included only four actions by excluding the “prepare” action.

that example, the odds ratio is the value 1.5. The key value in an odds ratio is 1.0; estimates below 1.0 reflect decreased probabilities of being in higher categories and values above 1.0 reflect increased probabilities of being in higher categories.<sup>4</sup> The statistical significance of an odds ratio is judged by comparing the value to 1.0; values that are significantly different than one are considered statistically significant.

We estimated odds ratios for each prototype for each response variable at three different WWA prompts for each scenario we included in a survey.<sup>5</sup> Over the seven surveys, this resulted in estimating a total of 204 odds ratios for *each prototype*. Table ES-4 summarizes the percentages of those estimates for each prototype that were significantly above 1.0 and significantly less than 1.0; odds ratios above 1.0 indicate the prototype outperformed the current system and those below 1.0 indicate the prototype underperformed the current system.

**Table ES-4. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: All Surveys Combined**

<b>Prototype</b>	<b>Significantly Greater Than 1.0 (Outperformed the Current System)</b>	<b>Significantly Less Than 1.0 (Unperformed the Current System)</b>
Prototype 1	7.8%	26.5%
Prototype 2	20.1%	9.8%
Prototype 3	10.8%	22.1%
Prototype 4	20.6%	7.8%
Total Number of Estimates [a]	204	204

[a] This is the total for each prototype.

Based on the data in Table ES-4, we can draw the following conclusions.

**Prototypes 2 and 4 performed the best overall relative to the current system.** However, these two prototypes only outperformed the current system in one of every five estimates and were outperformed by the current system in slightly less than one on ten estimates. Thus, although Prototype 2 and 4 were the best performers, the results were not overwhelming.

**Prototypes 1 and 3 performed poorly compared to the current system.** Prototype 1 was outperformed by the current system in one of four estimated models and Prototype 3 was outperformed in one of five (approximately) estimated models. These two prototypes also outperformed the current system in one of ten models we estimated. Thus, as above, the result that these two were the worst performers was not overwhelming.

<sup>4</sup> By design, odds ratios are never less than zero.

<sup>5</sup> As a reminder, the scenarios in each survey involved a baseline prompt, a watch prompt, and then two following prompts that reflected upgrades and downgrades over time. Statistical models and their associated odds ratios were estimated for the watch level and the following two prompts within each scenario for each response variable.

**The best/worst performing prototypes varied to some degree across the hazards.**<sup>6</sup> As noted above, Prototypes 2 and 4 were the best performers (relative to the current system) and Prototypes 1 and 3 were the worst performers. This was mirrored in some hazards such as winter weather mild, coastal flooding, and areal flooding. However, Prototype 3 was the best performer in winter weather cold (one in five estimates were better than the current system); despite that, Prototype 3 also had an almost equal number of cases where it was outperformed by the current system in that survey. In thunderstorms, Prototypes 2 and 4 were outperformed more often by the current system than vice versa. Nevertheless, Prototypes 2 and 4 were usually the best performers in a survey or were usually at least as good as the other prototypes.

**Headlines Matter.** The construction of Prototype 1 was designed to test whether respondents would react to the headline words (e.g., “Severe Thunderstorm Warning”) or to the information that was being provided along with the headline. The poor performance of Prototype 1 relative to Prototypes 2 and 4, however, indicates that the headline matters.

Table ES-5 breaks down the percentages from Table ES-4 by prompt level and Table ES-6 breaks down those same percentage by protective response.

**Table ES-5. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: All Surveys Combined**

Prototype	Watch		Advisory		Warning		Emergency	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0.0%	46.9%	33.3%	0.0%	4.7%	9.4%	3.6%	35.7%
Prototype 2	18.8%	18.8%	33.3%	0.0%	7.8%	6.3%	32.1%	0.0%
Prototype 3	1.6%	20.3%	8.3%	33.3%	17.2%	29.7%	25.0%	0.0%
Prototype 4	0.0%	23.4%	27.8%	0.0%	39.1%	0.0%	25.0%	3.6%
Total Number of Estimates [a]	64		36		64		28	

[a] This is the total for each prototype.

**Table ES-6. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: All Surveys Combined**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	10.4%	31.3%	4.2%	16.7%	14.3%	26.2%	5.6%	22.2%
Prototype 2	20.8%	12.5%	8.3%	6.3%	21.4%	9.5%	27.8%	5.6%
Prototype 3	12.5%	31.3%	8.3%	18.8%	11.9%	16.7%	13.0%	24.1%
Prototype 4	29.2%	10.4%	18.8%	6.3%	16.7%	9.5%	22.2%	7.4%
Total Number of Estimates [a]	48		48		42		54	

[a] This is the total for each prototype.

<sup>6</sup> The data to support this conclusion appear summary tables in Section 12.2.

Based on the data in Table ES-5 and Table ES-6, we can draw a few more conclusions.

**The term “advisory” was outperformed by Prototypes 1, 2, and 4.** Our analyses indicated that the current system never outperformed Prototypes 1, 2, and 4 at the advisory level; those three prototypes outperformed the current system at the advisory level in approximately one-third of the estimated odds ratios. Prototype 3 used the term “moderate” and tended to be outperformed by the current system.

**The prompt level matters for which prototype was most effective.** The general result that Prototype 2 and 4 were the best performers was not consistently found at each prompt level. At the watch level, Prototype 2 was the best performer, but Prototype 4 *never* outperformed the current system. At the advisory level, Prototype 1 joined Prototype 2 and 4 as strong performers with each outperforming the current system in one of three models that were estimated. At the warning level, Prototype 4 was the strongest performer. Finally, at the emergency level, Prototypes 2 – 4 outperformed the current system.

**Prototype 2 and 4 are both more effective than the current system at compelling action.** For both the “action taken” and the likelihood of acting response variables, Prototype 2 and 4 were the strongest performers.

**Prototype 4 was the most effective at increasing monitoring by respondents.** Prototype 2 was not as effective at increasing monitoring.

**Prototype 2 was more effective at increasing preparation by respondents.** However, Prototype 4 was not ineffective at increasing preparation, but was not as effective as it was in other areas or as effective as Prototype 2.

## Recommendations

Based on the analyses and the conclusion above, we can make the following recommendations:

**Develop a prototype that combines the most effective aspects of Prototypes 2 and 4.** Table ES-7 highlights the prompt levels where Prototypes 2 and 4 were effective (if both are highlighted, they were both effective at that level). Combining the two will be challenging and not straightforward since Prototype 2 varies the noun in the message while Prototype 4 varies the adjectives used to describe the term warning.

**Table ES-7. Prototypes 2 and 4 Highlighting Prompts Where Each Performed Well**

Level	Current System	Prototype 2	Prototype 4
Watch level	Watch	Notice	Possible
Advisory level	Advisory	Alert	Orange
Warning level	Warning	Warning	Red
Emergency level	Emergency	Emergency	Purple

**Consider alterations to any new prototype that takes into account the effectiveness for specific hazards.** As we have noted in Section 12.2, the effectiveness of the prototypes varied to some degree across hazards. Thus, any final prototype should take into account nuances of when the tested prototypes were effective and not effective.

**Once a new candidate prototype is developed, NWS should have discussions with partners and forecasters.** The survey results indicate what terms tested best, but further research should be done to assess operational feasibility. By necessity, the testing approach in this survey tested the terms individually and not part of a larger risk messaging system. This should take into account other institutional aspects not considered as part of this specific project.

**Implement changes slowly.** ERG recommends that NWS consider implementing any new prototype as an experimental/parallel system, to further test it in different situations and in the context of hazards not included in this effort.

## 1.0 Introduction and Overview

NOAA's National Weather Service (NWS) forecasts hazardous weather situations and issues warnings, watches, advisories (WWA) and other information products to convey the threats posed by these events. These products are intended to help communities prepare for and respond to hazardous weather to protect people's lives and property. The products are communicated to the public through websites, smart phones, television programs, radio broadcasts, and NOAA Weather radio. NWS customers include weather professionals, transportation and aviation officials, emergency management personnel, public works departments, broadcast meteorologists and other media, and the public.

The NWS has embarked on an effort to simplify and enhance its WWA products, since both prior social science research and NWS service assessments have demonstrated that many members of the public, and even some NWS partners, don't understand the distinctions among the terms used in the different WWA products or their intent. Since 2013, ERG has supported the NWS in conducting a coordinated plan of research (see Figure 1) to assess the current WWA warning system and discern where change could be feasible and beneficial.

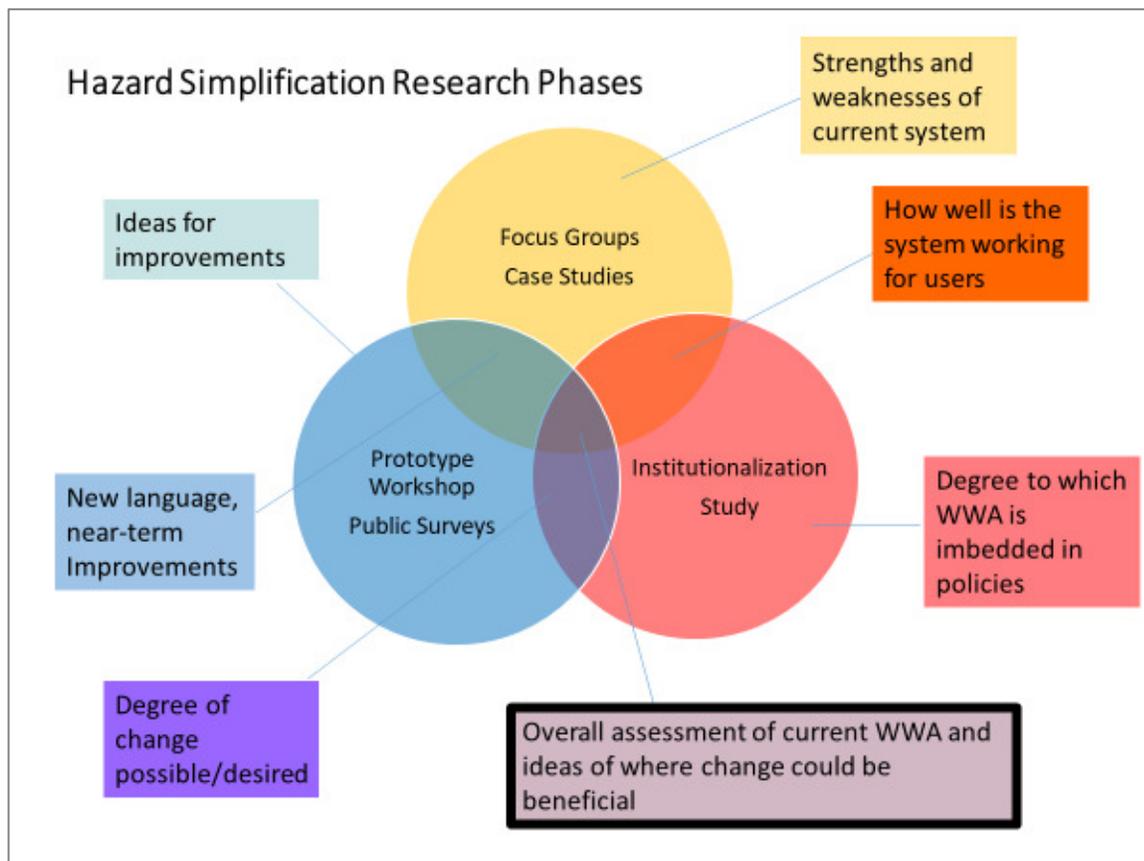


Figure 1. Hazard Simplification Project Research Phases

This research encompassed the following phases:

- **Phase I: Focus Groups.** In the summer of 2014, ERG conducted focus groups with emergency managers, broadcast meteorologists, NWS Weather Forecast Office (WFO) staff, and the public. The focus groups explored the current understanding and utility of the WWA system and possible enhancements to a new or modified system (ICR Reference Number 201103-0690-001, 3/14/14). This work indicated that there is a spectrum of understanding of the current WWA system and a difference of opinion on how much change is needed or desired to enhance the present system. It also showed considerable support for enhancing the current WWA system with simple explanatory language that could convey threats, impacts, and/or desired actions, as well as the use of a color scale to convey threat levels.
- **Phase II: Case Studies.** In 2015, ERG designed a research instrument to collect more than 700 case studies from respondents internal to the NWS and external to the agency documenting perceived strengths and weaknesses of the current system. The case studies revealed that NWS forecasters and media respondents, in general, desire more change to the current system than the emergency management respondents. Nearly three-fourths of the emergency management respondents praised the current system. Also, there is a perception that members of the public (and even some NWS partners) do not understand the WWA terms. The case studies also showed general support for changing WWA to an impacts-based system or incorporating impacts into WWA criteria, as well as simplifying and reducing the number of WWA products, improving formatting, and using concise, easy-to-understand language. There was no consensus that any of the individual WWA terms should be eliminated or replaced, but respondents were generally more supportive of maintaining the “warning” term than the other terms.
- **Phase III: Stakeholder Workshop.** In 2015, ERG collaborated with the NWS to design and facilitate a stakeholder workshop in Kansas City with NWS forecasters, media representatives, emergency managers, and social scientists to brainstorm alternative language to the current WWA system and develop possible “prototypes” of a new system to communicate WWA information. The prototypes that emerged from the workshop ranged from changing the system altogether (such as by replacing current WWA products with colors, tiers, impact messaging, and actionable phrases) to simply enhancing the present system by maintaining the WWA construct but changing the word advisory and not issuing warnings for certain hazards. While the workshop’s charge was for participants to consider possible new *language* for the current WWA system, the groups also presented more than just language considerations in their prototypes—venturing into conceptual, operational, design, delivery, and verification aspects of a warning system, perhaps indicating that it is difficult to separate out the language from the current system—without considering these other factors, all of which work together to convey warning messaging.
- **Phase III: Testbeds.** ERG tested one of three of the Kansas City workshop prototypes as part of the 2016 Hazardous Weather Testbed at NOAA’s National Severe Storms Laboratory (NSSL) in Norman, Oklahoma. The testbed environment provided an opportunity to integrate the

workshop prototypes and messaging into the NSSL's Forecasting a Continuum of Environmental Threats (FACETs) project, which creates and displays probabilistic hazard information through graphical threat grids. During the three-week testbed, NWS forecasters, broadcast meteorologists, and emergency managers simulated an integrated warning team to test the prototypes in the context of both past-event and real-time case studies of severe weather. The study revealed that because NWS forecasters are so accustomed to the current WWA system, they struggled with the messaging of the alert-level language phrases and with mapping these phrases to meteorological criteria. From the partner perspective, the study revealed that emergency managers and broadcast meteorologists used different NWS information in different ways, but that both groups relied more on graphical information than textual content. Another key takeaway was that any change to the current system would need to be tested from an operational perspective to gauge the feasibility of the change, as well as to determine forecaster training needs arising from the change.

- **Phase III: Institutionalization Study.** In 2016, ERG designed and deployed a survey to gauge the degree to which types of WWA products or the actual terms “watch,” “warning,” and “advisory” are embedded or “institutionalized” in organizational decision-making, laws, policies, operating procedures, bylaws, or other activities or processes. ERG collected nearly 4,500 responses from 32 sectors (i.e., emergency management/responders, transportation, telecommunications, utilities, etc.). The study found that Advisories were the least institutionalized term, and that, on average, organizations need at least a three-month lead time to incorporate any changes to the current WWA system in their departments (this time does not include time to educate the public and partners on any changes and may not be a realistic timeframe for all organizations).
- **Phase IV: Public Surveys.** Except for the early focus group research described above, much of the ERG social science work over the past several years has focused on assessing partner and organizational use of the current system and degree of change desirable and feasible. Therefore, the final research phase of this project is focused on designing, executing, and analyzing surveys of the U.S. public to get feedback on possible new approaches to presenting hazard warning risk information (based on the prior research) and to understand how they would respond to these alternative approaches.

## 2.0 Message Testing Approach

This section provides an overview of the message testing approach that we used in the survey and the subsequent analyses. We begin by discussing the new messages (prototypes) that were developed as alternatives to the current system (Section 2.1). We then discuss how those prototypes (and the current messages) were presented to the respondents in the survey (Section 2.2) and the questions we used to assess respondents’ protective responses in relation to the current system and the prototypes (Section 2.3). Next, we discuss a set of questions we asked respondents about their knowledge of the current system (Section 2.4). Finally, we provide an overview of the full questionnaire that we developed where the prototypes are tested (Section 2.5).

### 2.1 Prototypes

ERG assisted the NWS in developing a set of prototypes to test under this project. The prototypes are alternatives to the current messages used by NWS. The current system generally consists of three levels of conveying risk: watch, advisory, and warning, though some hazards are different (e.g., hurricanes and tornadoes have just watch/warning). ERG assisted the NWS in developing different levels (two, three, or four tiers) for the new prototypes to compare to the current system. The five prototypes (current system and four alternatives) and their corresponding levels appear in Table 1.

**Table 1. Prototypes and Their Associated Levels**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	X Watch	X Outlook	X Notice	Possible X Event	Possible X Conditions
Advisory level	X Advisory	X Warning	X Alert	Moderate X Warning	Level Orange X Event
Warning level	X Warning	X Warning	X Warning	Severe X Warning	Level Red X Warning
Emergency level	X Emergency	X Warning	X Emergency	Extreme X Warning	Level Purple X Warning

The prototypes can be described as follows:

- **Current system:** This prototype is the current WWA system.
- **Prototype 1: Outlook, Warning, Warning, Warning.** This prototype tests two tiers of warning (rather than the current three-tier), tests an alternative term (“outlook”) for “watch,” and maintains the term “warning,” which people understood in the prior research (described above). By using the same word (“warning” for each level above “watch), this prototype also tests whether people anchor to headlines or information.
- **Prototype 2: Notice, Alert, Warning, Emergency.** This prototype changes the “watch” and “advisory” terms but maintains the “warning” term and adds an “emergency” level. This prototype tests to see if changing the “problem” words improves the overall system.

- **Prototype 3: Possible X Event, (Minor), Moderate, Severe, Extreme Warnings.** This prototype is a larger overhaul of the current system. It changes the word for “watch” to “Possible X Event,” where X is the hazard. The word “warning” is maintained while using adjectives to convey levels of severity. This prototype emphasizes impacts and introduces a more hierarchical scale that uses adjectives to describe escalating risk. Minor is only used for flooding, river and coastal flooding at this time.
- **Prototype 4: Possible X Conditions, Level Orange, Level Red, Level Purple Warnings.** This prototype is also a larger overhaul of the current system. It uses a color scheme (except at the “watch” level) instead of risk-based wording to denote levels, and changes “watch” to “Possible X Conditions,” where X is the hazard.

## 2.2 Scenarios and Prompts

The prototype testing involved providing respondents with a scenario that reflected an evolving weather event and prompting the respondents with messages using either the current system or one of the four new prototypes. The scenarios reflected upgrades or downgrades in the risk over time, and each of the weather hazards had between one and three scenarios. Within each scenario, respondents saw four separate prompts. The first prompt was always a baseline prompt and was the same for all scenarios within a weather hazard (i.e., the baseline did not include prototype-specific language). The second prompt was always a “watch-level” prompt (see Table 1) and included prototype-specific language. The third and fourth prompts provided the upgrades and downgrades that reflected real-life situations. Table 2 summarizes the prompt sequences that are used in each scenario for each weather event. For example, in the winter weather hazard (mild or cold climates), the “warning with upgrade” scenario involves a baseline prompt (not shown in Table 2), a watch-level prompt, a warning-level prompt, and then an emergency-level prompt.

There are four distinct types of scenarios that are used in the surveys:

- Warning with a downgrade –NWS issues a warning and then downgrades the situation (to an advisory) in a subsequent message.
- Warning with an upgrade – NWS issues a warning and then upgrades the situation (to an emergency) in a subsequent message.
- Advisory with an upgrade – NWS issues a warning and then upgrades the situation by issuing a warning in a subsequent message.
- Emergency with a downgrade –NWS issues an emergency and then downgrades the situation (to a warning) in a subsequent message.

**Table 2. Prompt Sequences for Each Upgrade/Downgrade Scenario for Each Weather Event**

Weather Event	Scenario	Prompt Level Sequence [a]		
		Prompt 2	Prompt 3	Prompt 4
Winter – Mild	Warning with upgrade (WU)	Watch	Warning	Emergency
	Warning with downgrade (WD)	Watch	Warning	Advisory
	Advisory with upgrade (AU)	Watch	Advisory	Warning
Winter – Cold	Warning with upgrade (WU)	Watch	Warning	Emergency
	Warning with downgrade (WD)	Watch	Warning	Advisory
	Advisory with upgrade (AU)	Watch	Advisory	Warning
Thunderstorms	Warning with upgrade (WU)	Watch	Warning	Emergency
	Warning with downgrade (WD)	Watch	Warning	Advisory
	Advisory with upgrade (AU)	Watch	Advisory	Warning
Tornadoes	Warning with upgrade (WU)	Watch	Warning	Emergency
Coastal Flooding	Advisory with upgrade (AU)	Watch	Warning	Emergency
	Emergency with downgrade (ED)	Watch	Emergency	Warning
Flash Flooding	Warning with upgrade (WU)	Watch	Warning	Emergency
	Emergency with downgrade (ED)	Watch	Emergency	Warning
River Flooding	Warning with upgrade (WU)	Watch	Warning	Emergency
	Warning with downgrade (WD)	Watch	Warning	Advisory
	Advisory with upgrade (AU)	Watch	Advisory	Warning

[a] Prompt #1 is always a baseline prompt is not prototype-specific.

As mentioned, the scenarios and their prompts are designed to mimic real-life situations. Thus, care was taken in how the prompts were worded and NWS and ERG ensured consistent wording was used across the seven surveys that were implemented. An example of the prompts embedded into a scenario is as follows:<sup>7</sup>

- Prompt #1. While you are at home on a Sunday, during daylight hours, if you were to learn that the NWS is forecasting the potential for 6-10 inches of snow on Wednesday...
- Prompt #2. Now imagine that it is still Sunday and that the NWS has issued a {term} for your local area with the potential for 6-10 inches of snow...
- Prompt #3. Now imagine that it is Monday evening and The NWS has issued a {term} for 6-10 inches of snow starting Wednesday morning through the evening.
- Prompt #4. Now imagine that it is Tuesday evening and that you received the following information. "The NWS has changed their forecast to a WINTER STORM WARNING now expecting 14-18 inches of snow starting on Wednesday morning through the evening."

In implementing the surveys, respondents were asked to respond to two separate scenarios; that is, they experience two prototype sequences.<sup>8</sup> At the start of the survey, respondents were first randomly assigned a prototype and an upgrade/downgrade scenario for their first sequence; they were then randomly assigned to a second prototype, different from the first, and an upgrade/downgrade scenario

<sup>7</sup> The example is taken from the winter weather cold regions survey and in the warning with an upgrade scenario. The prototype language was inserted in place of "{term}" in the prompts.

<sup>8</sup> For ease of exposition, we use the term "prototype" to refer to both the current system and the four new prototypes.

for the second sequence. Thus, respondents never saw the same prototype twice, but could experience the same upgrade/downgrade scenario in both sequences.

Finally, one half of the respondent were randomly selected to see information on how to interpret the current system or the prototype prior to seeing the prompts. This was included to assess whether providing up-front information changed the protective responses.

### 2.3 Protective Response Questions

Following each prompt, respondents were asked a series of questions about how they would react given the information provided. Following each prompt, we asked respondents about the action they would take. The actions usually included five options:<sup>9</sup>

- Do nothing
- Monitor
- Prepare
- Take some action
- Take protective action

The actions were worded to be specific to each hazard and are detailed in the sections where we provide the results. We translated these selected actions to a numeric value from one to five, with the “do nothing” action equal to one and the “taking protective action” equal to five.

We also asked respondents the likelihood they would take specific responses: monitoring, preparing, and taking action; e.g., respondents were asked “how likely are you to ... monitor weather forecasts closely.” Respondents could select a value between one (very unlikely) and five (very likely). This second set of questions covers actions that could be selected by the respondents under the first question on action taken. Whereas the “action taken” question makes the respondent select one action, the “likelihood” questions allow the respondent to indicate the degree to which they would take three specific actions.

Thus, there are four total questions that each respondent answered following a prompt:

- Action taken (do nothing, monitor, prepare, take some action, take protective action)
- Likelihood of monitoring (scale of 1 to 5)
- Likelihood of preparing (scale of 1 to 5)
- Likelihood of acting (scale of 1 to 5)

The analyses we perform in this report are based on these data.

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<sup>9</sup> Flash flooding, however, included only four actions.

## 2.4 Current Knowledge

NWS also asked ERG to include questions to ascertain the extent to which the public understands the current terms used by NWS. In each survey, we tested understanding of three terms; the terms tested in each survey appear in Table 3.

**Table 3. Terms Tested in Current Knowledge Questions**

Survey	Terms Tested		
Winter weather, mild regions	Winter Storm Warning	Winter Weather Advisory	Winter Storm Watch
Winter weather, cold regions	Winter Storm Warning	Winter Storm Advisory	Winter Storm Watch
Thunderstorms	Severe Thunderstorm Watch	Significant Weather Advisory	Severe Thunderstorm Warning
Tornadoes	Tornado Watch	Tornado Warning	Tornado Emergency
Coastal flooding	Coastal Flood Watch	Coastal Flood Advisory	Coastal Flood Warning
Flash flooding	Flood Watch	Flash Flood Warning	Flash Flood Emergency
Areal flooding	Flood Watch	Flood Advisory	Flood Warning

The questions asked in the survey were essentially a test of the respondents' knowledge; that is, each question had a "right" answer. Each respondent was only asked about one term; this was done to ensure the respondents were not answering later questions using a "process of elimination." Additionally, we asked the current knowledge question *prior* to the prototype testing sequence described above.

The current knowledge question had two forms. In the two winter weather surveys, which were implemented first, we provided respondents with the term (e.g., "winter storm warning") in the question and asked them to select from three definitions as response options. Following analysis of these results, NWS and ERG decided to alter the format for subsequent surveys. For the five remaining surveys, we provided the respondent with a definition in the question text and allowed them to select from terms as response options.

We provide summaries of these data in the sections for each survey as background for the analyses we perform on the prototypes.

## 2.5 Questionnaire Overview

The prototype testing process is embedded within a larger survey that asked respondents a number of things. The data that we collected from respondents in other parts of the survey are intended to inform the analyses we perform of the prototypes. A sample of the questionnaire is presented in Appendix A. The questionnaire sequence was as follows:

- A set of key demographics that were used to screen respondents into and within the survey, as well to provide a set of simple questions to begin the survey. These questions covered information related to the respondent's location, household composition, and residence characteristics. In the coastal flooding survey, it was also necessary to ask about distance from the coast.

- A set of general risk and weather-related questions. These questions provide information on how respondents perceive and respond to weather-related risks.
- The current knowledge questions that were described in Section 2.4 above.
- A first prototype testing scenario; see Sections 2.1 - 2.3.
- A second prototype testing scenario; see Sections 2.1 - 2.3.
- A set of questions that ask respondents about their sources of their weather-related information, as well as how often they access that information.
- A final set of demographics to further characterize the sample respondents (e.g., gender, etc.).

### 3.0 Statistical Sampling Approach

This section describes various aspects of the statistical sampling that was used to select representative samples for each of the seven surveys. We begin by discussing the geographic areas that were selected for each survey (Section 3.1). We then discuss the criteria that were used in selecting appropriate sample sizes (Section 3.2). Next, we discuss criteria that were used for including respondents in the survey and limits that were set on the implementation process to ensure well-balanced samples (Section 3.3). Section 3.4 discusses the mode that was used and Section 3.5 summarizes the implementation process in terms of time frames and number of responses. Table 4 provides a summary of the information that is detailed in this section for reference.

**Table 4. Summary of Survey Collection Efforts**

Weather Hazard	Survey Parameters	Dates	Targeted Sample	Collected Sample
Winter weather – mild climates	<ul style="list-style-type: none"> <li>VA, NC, KY, TN, SC, GA, AL, MS, AR, MO, NE, OK</li> <li>Adults aged 20+</li> <li>No state with more than 200 responses</li> </ul>	2/5/18 – 2/7/18; 2/15/18 – 2/16/18 [a]	1,400 [a]	1,410
Winter weather – cold climates	<ul style="list-style-type: none"> <li>ME, NH, VT, MA, RI, CT, NY, PA, MI, WI, MN, CO, WY, MT, ID</li> <li>Adults aged 20+</li> <li>No state with more than 150 responses</li> </ul>	2/2/18 – 2/5/18; 2/15/18 – 2/16/18 [b]	1,300 [b]	1,298
Thunderstorms	<ul style="list-style-type: none"> <li>All U.S. States and Washington DC</li> <li>Adults aged 20+</li> <li>No more than 65% as women</li> <li>No state with more than 100 responses</li> </ul>	2/20/18 – 2/22/18	1,500	1,501
Tornadoes	<ul style="list-style-type: none"> <li>AL, AR, GA, IA, IL, IN, KS, KY, LA, MO, MN, MS, NC, NE, OK, SC, TN, TX</li> <li>Adults aged 20+</li> <li>No more than 65% as women [c]</li> <li>No state with more than 80 responses</li> </ul>	2/20/18 – 2/22/18	700	700
Coastal flooding	<ul style="list-style-type: none"> <li>ME, NH, MA, RI, CT, NY, NJ, MD, DE, VA, NC, SC, GA, FL, AL, MS, LA, TX</li> <li>Must live within 10 miles of the coast</li> <li>Adults aged 20+</li> <li>No more than 65% as women [c]</li> <li>No state with more than 60 responses</li> </ul>	3/2/18 – 3/12/18	700	690
Flash flooding	<ul style="list-style-type: none"> <li>TX, MS, AR, AL, TN, KY, MO, IA, IL, MI, IN, OH, PA, NY, NJ, CT, MA, NC, VA, MD, WV, WI</li> <li>Adults aged 20+</li> <li>No more than 65% as women [c]</li> <li>No state with more than 60 responses</li> </ul>	3/2/18 – 3/7/18	800	841

Weather Hazard	Survey Parameters	Dates	Targeted Sample	Collected Sample
Areal flooding	<ul style="list-style-type: none"> <li>TX, MS, AR, AL, TN, KY, MO, IA, IL, IN, OH, PA, NY, NJ, CT, MA, NC, VA, MD, WV, CA (south of San Francisco), AZ, OK, KS</li> <li>Adults aged 20+</li> <li>No more than 65% as women [c]</li> <li>No state with more than 80 responses</li> </ul>	3/2/18 – 3/12/18	1,000	1,052

[a] Winter mild originally targeted 1,000 respondents in the initial phase (2/5/18 – 2/7/18) and the targeted an additional 400 non-female respondents in a second phase (2/15/18 – 2/16/18) due to the over-representation of women in the first phase.  
[b] Winter cold originally targeted 1,000 respondents in the initial phase (2/2/18 – 2/15/18) and the targeted an additional 300 non-female respondents in a second phase (2/15/18 – 2/16/18) due to the over-representation of women in the first phase.  
[c] ERG asked Qualtrics to limit the percentage of the sample to be no more than 65 percent women due to the nature of the responses to the two winter surveys. As noted above, ERG collected additional non-female responses in both winter surveys to better balance the sample.

### 3.1 Geographic Areas

NWS and ERG worked together to define geographic areas that would be relevant for the specific hazards. The states specified for each hazard are detailed in Table 4.<sup>10</sup> Only the thunderstorms survey included all 50 U.S. states and the District of Columbia. For the other surveys, we used information on the prevalence of each hazard to define a relevant geographic area.

### 3.2 Sample Sizes

The sample sizes for these surveys was primarily determined by available budget; ERG’s budget for this work allowed for a sample of approximately 7,200 respondents. This section describes the allocation of the respondents across the seven surveys and the statistical properties of those allocations.

Table 5 provides the initial sample size allocation for each survey. These initial allocations were based on attaining reasonable statistical precision and power given the fixed total sample (7,200 respondents) for all seven surveys.<sup>11</sup> The goal of this survey was to determine reactions to the five prototypes. To make relevant comparisons, it is necessary to compare the same upgrade/downgrade scenario between prototypes within each hazard (e.g., warning upgrade for prototype 3 compared to a warning upgrade for the current system for winter storms). Thus, the key in assessing precision is to determine the number of respondents for each upgrade/downgrade scenario for each prototype for each hazard.

The original survey design was based on “hazards” rather than specific surveys; four hazards were included in the original design considerations: winter weather, thunderstorms, tornadoes, and flooding.

<sup>10</sup> For the most part, ERG used states to define the areas. For areal flooding, however, we used only counties south of San Francisco for the California portion of the sample; for coastal flooding, we used only respondents who lived within 10 miles of the coast.

<sup>11</sup> As will be discussed, ERG increased the total targeted sample size by 200 respondents to accommodate the statistical criteria.

An equal allocation of the 7,200 respondents across the four hazards would have implied 1,800 respondents per hazard. As the project evolved, however, decisions were made that affected an equal allocation approach:

- The tornadoes survey was only assigned 700 respondents since it only included only one scenario and the “excess” 1,100 respondents (1,800 – 700) were assigned to other hazards.
- The winter weather survey was divided into two separate surveys, one for cold regions and one for milder regions, reflecting the different messages used by NWS in the two types of regions. Given the large areas being covered by winter weather a total of 2,000 respondents (1,000 for each region type) was assigned to winter weather surveys.
- The thunderstorms survey was assigned 2,000 respondents since it covered the entire United States.
- The flooding survey was divided into three separate surveys (areal, flash, and coastal) and 900 respondents were assigned to each by taking the excess from the tornadoes survey and adding in an additional 200 respondents.

These sample sizes allowed for attaining sufficient statistical power and precision to conduct our statistical tests.

During implementation, however, further adjustments were made. The two winter weather surveys were implemented first and following their completion, ERG found that a large percentage of each sample was comprised of women. To adjust, ERG re-allocated sample units from other surveys to allow for collecting more data from male respondents in the winter weather surveys.<sup>12</sup> Additionally, ERG and NWS decided to re-allocate 100 sample units from the flash flooding survey to the areal flooding survey since the flash flooding survey was altered to have only two upgrade/downgrade scenarios. The final allocations and notes related to the re-allocations appear in Table 5.

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<sup>12</sup> We assumed this re-allocation would not harm the statistical properties of the remaining surveys since in designing the surveys we used a “worst-case” assumption on the variance of the reaction questions. Once we had collected the winter weather data, we reviewed the variance of the reaction questions in those surveys and found a smaller variance than our worst-case assumption. We assumed that smaller variance would also be found in the remaining surveys and therefore fewer respondents would be needed in each to meet the statistical needs.

**Table 5. Sample Size Allocations: Initial and Final**

Survey	Initial Allocation	Final Allocation	Notes on Changes from Original to Final
Winter storms, mild regions (3 scenarios)	1,000	1,400	Following collection of 1,000 responses, ERG noted that the sample was biased towards women and asked for 400 male-only responses to better balance the sample.
Winter storms, cold regions (3 scenarios)	1,000	1,300	Following collection of 1,000 responses, ERG noted that the sample was biased towards women and asked for 300 male-only responses to better balance the sample.
Thunderstorms (3 scenarios)	2,000	1,500	Based on data collected in the winter surveys, ERG revised the necessary sample size down and re-allocated those sample unit to the winter surveys to allow for collection of additional male responses.
Tornadoes (1 scenario)	700	700	No changes were made to the sample size.
Coastal Flooding (2 scenarios)	900	700	The original prototype testing called for three upgrade/downgrade scenarios; in the final design only two upgrade/downgrade scenarios were retained. Thus, fewer respondents were needed for coastal flooding and 200 units were re-allocated to winter to allow for collecting more male responses.
Flash Flooding (2 scenarios)	900	800	The original allocation plan called for 900 respondents for both areal and flash flooding. ERG re-allocated 100 from flash to areal flooding to accommodate a change in prototype test design for flash flooding. In the original design flash flooding had four upgrade/downgrade scenarios; in the final design only two upgrade/downgrade scenarios were retained. Thus, fewer respondents were needed for flash flooding.
Areal Flooding (3 scenarios)	900	1,000	
<b>TOTALS</b>	<b>7,400</b>	<b>7,400</b>	-

[a] This is the number of respondents that see each prototype within each scenario. This is calculated by dividing the final allocated sample by 5 times the number of scenarios and then multiplying by two since each respondent sees two scenarios.

### 3.3 Inclusion Criteria

In implementing the survey, it was necessary to identify who to include in the respondent pool. NWS and ERG made the following decisions:

- All surveys limited respondents to only adults 20 years or older.
- Each survey limited the number of respondents that could be drawn from one state to ensure no one state dominated the results for a specific survey. These limits varied by survey (between 60 and 200 respondents per state) and appear in Table 4.

- Following the completion of the winter weather surveys, ERG limited the sample to be comprised of no more than 65 percent women. This was done since the first set of data collected for the winter weather surveys were skewed toward women.
- The coastal flooding survey required that respondents live within 10 miles of the coast.

### **3.4 Mode**

The survey was implemented as a web-based survey drawing from publicly available samples. ERG provided our survey provider, Qualtrics, Inc., with the surveys specifications for each survey (sample size, states, etc.) and Qualtrics drew random samples from each in-scope state.

### **3.5 Time Frames and Final Sample Sizes**

Table 4 above summarizes the time frames and final sample sizes. ERG implemented the surveys in February and March of 2018. For the most part, the surveys spent less than one week in the field. Overall, 7,492 total responses were collected over the seven surveys. The targeted final sample size was met in all but two of the surveys. For winter weather cold region survey, the sample was two units short; this occurred because we had requested an additional 300 male-only responses and Qualtrics was only able to collect an additional 298 male-only responses. For the coastal flooding the sample was 10 units short; this occurred due to the restriction that respondents must live within 10 miles of the coast combined with the restriction on gender.

## 4.0 Statistical Analysis Approach

This section describes the statistical analysis we performed to analyze the data collected to assess the prototypes. We begin by discussing the outcome variables and the treatments that we use in the analysis (Section 4.1), then discuss the statistical analysis procedure we used to analyze the outcome variables and treatments (Section 4.2) and conclude by discussing the factors we use to explain variation in the outcome variables not explained by the treatments (Section 4.3).

### 4.1 Outcome Variables and Treatments

The survey we developed was designed to assess how respondents' protective responses (outcomes) differed between groups that saw different prototypes (treatments). As discussed in Section 2.3, we developed four variables to gauge the protective response of the respondents:

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included<sup>13</sup> (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a description of what each type of action meant.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecasts given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

These four variables form the basis of our analyses that compare the effectiveness of the prototypes and the current system. The treatments in our analysis were whether or not the respondent saw a specific prototype. We measure these as simple yes/no variable in our analysis (yes = 1, no = 0).

### 4.2 Ordered Logistic Regression

Each protective action variable has five discrete categories that are ordered from least to most protective action. Thus, we use a statistical method called ordered logistic regression analysis to analyze these data. An ordered logistic analysis correlates a set of ordered response categories with a set of explanatory variables (e.g., demographics, responses to other questions) to determine factors that lead to respondents selecting higher or lower categories. As with any logistic regression, the ordered logistic model is a probability model; ultimately, we are assessing the probability of respondents being in certain

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<sup>13</sup> Given the nature of the hazard, flash flooding excluded the “prepare” option.

categories and identifying the factors that make it more (or less) likely for respondents to be in higher categories.

The key explanatory factor in our analysis is the prototype that the respondent saw. Thus, ordered logistic regression will tell us which prototypes are associated with respondents being more likely to select more protective actions. Given that all respondents see at least one prototype, the analyses are done relative to the current system.<sup>14</sup> For example, we can determine whether those who saw “Prototype 1” took more protective actions relative to the “current system.”

An additional consideration in our analysis is that respondents are included twice in the data since they see two scenarios. Thus, we have two sets of protective action responses and two sets of treatments for each respondent in the data. Although this effectively doubles the sample size we can use for the statistical analysis, it is necessary to adjust the estimated variances for the fact that our  $n$  analytical data points are derived from only  $n/2$  survey respondents. This is a relatively straightforward process. Standard variance calculations in linear and non-linear regression models assume each observation in the data is independent of one another (i.e., no inter-correlation of data points). In our case, we need to adjust the variance calculations to allow for correlations between the observations stemming from the same respondents. There are well-documented procedures for doing this and we follow the one in the statistical software we used (STATA).<sup>15</sup>

The results we present are phrased in terms of odds ratios for the included variables. Odds ratios reflect the increased probability of being in a “higher” response category for increased values of the variable. For example, we will be presenting the odds ratios associated with seeing prototypes 1 – 4 relative to seeing the current system; thus, we will be generating results that say things such as “those who saw prototype 1 were 1.5 times more likely to select a more protective action than those who saw the current system wording.” In that example, the odds ratio is the value 1.5. The key value in an odds ratio is 1.0; estimates below 1.0 reflect decreased probabilities of being in higher categories and values above 1.0 reflect increased probabilities of being in higher categories.<sup>16</sup> The statistical significance of an odds ratio is judged by comparing the value to 1.0; values that are significantly different than one are considered statistically significant.

Finally, the statistical analysis involved estimating 204 separate ordered logistic regression models. For each survey we implemented, we estimated statistical models for *each scenario* reflecting *the second*

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<sup>14</sup> This is necessary since the variables used to measure which prototype are yes/no variables that are translated to one (yes) or zero (no) values. Each respondent has five variables, one for each prototype and the current system, with one being set to one (the prototype they saw) and the other four set to zero. All five cannot be included in a statistical model at the same time since a perfect linear relationship exists between the five (one minus the sum of the five always equals zero) and perfect linear relationships result in models that cannot be estimated. Thus, standard statistical practice is to exclude one variable; when this occurs, the results are interpreted as being relative to the excluded variable.

<sup>15</sup> <https://www.stata.com/manuals13/u20.pdf#u20.21Obtainingrobustvarianceestimates>.

<sup>16</sup> By design, odds ratios are never less than zero.

through fourth prompts<sup>17</sup> for each of the four protective action variables. Furthermore, since the logistic regression included yes/no treatment variables for prototypes 1 – 4 (the current system acts as the comparison state in most models), there are 804 odds ratios that need to be presented and interpreted in this report.<sup>18</sup>

### 4.3 Other Explanatory Factors

The modeling approach also allows us to include other explanatory factors that may influence the protective actions selected by the respondents. For example, the survey includes a number of demographics and responses to other questions (e.g., risk perceptions) that may influence the protective levels chosen by the respondents. The explanatory factors we included in our modeling efforts include:<sup>19</sup>

- *The baseline protective response.* As noted above, each respondent was prompted with a baseline statement prior to seeing the prototype language. All respondents saw the same baseline statement. We used the respondent's baseline protective response for the scenario as the first control variable.
- *Respondents' perceived susceptibility to hazard-specific risk.* The survey asked respondents to rate their *perceived harm* and their *perceived threat* from the hazard to (1) themselves personally, (2) their home, and (2) their local community to the hazard, each on a scale of 1 (no likely risk) to 10 (extremely likely risk) (six total questions). ERG calculated an index value for this by adding together the response to each of six questions for each respondent. Higher values for this scale indicate respondents perceive they are at higher risk.
- *Affective response, part 1.* The survey asked respondents to rate their feelings (negative to positive) about varying degrees of the weather hazards (e.g., a 3-inch snow storm, a 12-inch snow storm). ERG translated the responses to numeric values and calculated an index by adding the values together for each respondent. Higher values of this index indicate the respondent is less worried about severe weather.
- *Affective response, part 2.* The survey asked respondents to describe their feelings about the weather hazards (e.g., a winter storm). Respondents selected from four five-point scales (calm/stressed, pleased/displeased, happy/sad, and elated/depressed). ERG translated the responses to numeric values and calculated an index by adding the values together for each respondent. Higher values of this index indicate the respondent is less worried about severe weather.
- *Adaptive behavior.* The survey asked respondents to rate their preparedness and ability to adapt to the hazard in a series of questions that varied by hazard. ERG formulated an index value for

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<sup>17</sup> The first prompt was the baseline prompt and was used as a control variable in the models for the subsequent prompts.

<sup>18</sup> Thunderstorms does not include an emergency in the current system; thus Prototype 4 acted as the comparison for the emergency with a downgrade scenario estimations.

<sup>19</sup> This set of factors included was based on a detailed statistical specification analysis.

each respondent by adding the responses together. Higher values of this variable indicate that respondents perceive that they are more prepared or have thought about precautionary measures.

- *Past experience.* The survey asked respondents whether they had experienced property damage or personal injury in the past from the specific hazard. We measured this as a yes/no variable in the analysis.
- *Attentiveness.* The survey asked respondents whether it was (1) wise, (2) useful, (3) valuable, and (4) beneficial to understand the risk posed by the weather hazard using a 10-point scale for each aspect (e.g., wise). ERG converted the response to an index by adding over the four for each respondent. Higher values of this index indicate the respondent sees value in staying informed on the specific hazard.
- *Information gathering capacity.* The survey asked respondents to agree or disagree with a series of four statements that asked whether they understood weather information. This was meant to measure the ability of respondents to gather and understand weather information. ERG formulated an index based on the responses to the four questions. The questions were phrased in the negative, so higher values reflect respondents who have lower capacities to gather/understand weather information.
- *Subjective norms.* The survey asked respondents about whether they felt friends and family looked to them to understand wildfire-related information. There were three questions and ERG formulated an index by summing over the three questions. Higher values reflect respondents who feel that others look to them to understand weather situations.
- *The respondent's age.* We measured age using the age category selected by the respondent. The values ranged from 1 (aged 20-24) to 6 (65 and older) using 10-year intervals in between.
- *Presence of children in the home.* This variable measured the presence (yes or no; one or zero, respectively) of children in the respondent's home. ERG assumed that those with children would be more likely to take a protective action.
- *Gender.* This was set equal to one if the respondent was female and zero otherwise.
- *College education.* This was set equal to one if the respondent indicated he/she had completed a college degree.
- *Race.* This was set equal to one if the respondent was white.
- *Information on prototype.* This was set equal to one if the respondent was provided with information on how to interpret the current system or the prototype prior to the scenario. One half of respondents were provided with this information.
- *Scenario sequence.* This was set equal to one if the observation reflected the first scenario seen by a respondent and two if it was the respondent's second scenario. This was meant to control for the possibility that respondents would be more (or less) protective in the second compared to the first scenario.

## 5.0 Winter Weather: Mild Regions

This section discusses the results from the winter weather mild regions survey. NWS and ERG determined that the winter weather survey would need to be implemented in two formats: one for colder regions and one for more mild regions. The milder regions survey was implemented in states that have a lower snow threshold for issuing warnings.

**States:** VA, NC, KY, TN, SC, GA, AL, MS, AR, MO, NE, OK

**Respondents:** 1,410

**Collection time frame:** 2/5/18 – 2/7/18; 2/15/18 – 2/16/18

### 5.1 Basic Demographics

Figure 2 provides a summary of the number of respondents selected from the states included in winter weather mild region survey. The largest numbers of respondents came from North Carolina (185) and the least from Nebraska (46).

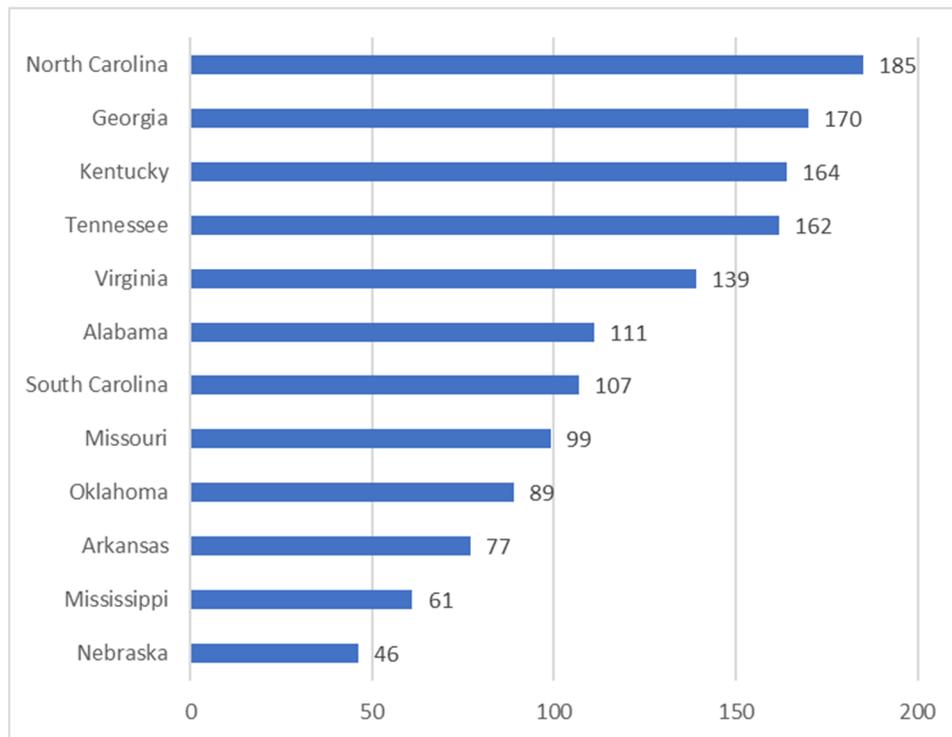


Figure 2. Numbers of Respondents from States Included in the Winter Weather Mild Survey

Table 6 provides a summary of the basic demographics for the survey. The sample appears to be well-distributed across ages and is slightly skewed toward women. Notably, almost two-thirds of the sample has less than a college degree and 85 percent were Caucasian.

**Table 6. Basic Demographics for Winter Weather Mild Regions Survey**

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
<b>Age</b>		<b>Race</b>	
20-24	9.6%	White	82.7%
25-34	22.0%	Black/African-American	11.4%
35-44	20.9%	Asian	1.8%
45-54	16.2%	Other	4.0%
55-64	16.7%	<b>Income</b>	
65+	14.8%	Less than \$24,999	30.5%
<b>Gender</b>		\$25,000 - \$49,999	30.8%
Female	58.2%	\$50,000 - \$99,999	28.0%
Male	41.8%	\$100,000 - \$199,999	9.2%
<b>Education</b>		More than \$200,000	1.5%
Less than college degree	64.5%	<b>Home Location</b>	
College degree	21.8%	Urban	16.7%
Post-undergraduate work/degree	13.8%	Suburban	45.7%
<b>Hispanic origin</b>		Rural	37.5%
Yes	4.5%		
No	95.5%	<b>Average number of adults in home</b>	<b>2.23</b>
		<b>Average number of children in home</b>	<b>0.80</b>

## 5.2 Current Knowledge

Table 7 provides a summary of the responses to the current knowledge questions. This survey used the first version of the current knowledge question described in Section 2.4; we provided respondents with a term and asked them to select from definitions. The current knowledge questions acted as a “test” of respondents understanding of the current system and each had a “correct” response. The correct responses for each row appear in orange shading in the table. The results for the three terms were:

- Winter Storm Warning – Only 43 percent correctly selected the right definition; 44 percent, however, selected the definition corresponding to "Winter Storm Watch"
- Winter Weather Advisory - Only 14.5 percent correctly selected the definition for Advisory; 60.6 percent selected the definition for Watch and almost 25 percent selected the definition for Warning.
- Winter Storm Watch – 70.6 percent selected the correct definition.

Thus, it appears that respondents most often selected the definition for Winter Storm Watch for any of the terms that were presented.

**Table 7. Winter Weather Mild Regions Current Knowledge**

Term Used in Question	Number Who Answered Question	Response Options		
		A storm is possible, and may pose a threat to life and/or property	A storm is certain, and may pose a threat to life and/or property	A storm is certain, but does not pose a direct threat to life and/or property
Winter Storm Warning	485	43.9%	43.1%	13.0%
Winter Weather Advisory	442	60.6%	24.9%	14.5%
Winter Storm Watch	483	70.6%	18.6%	10.8%

### 5.3 Prototypes Analyses

This section presents the results of the ordered logistic regression analyses we performed on the prototype testing. The methods are discussed in Section 4.0. We analyzed the data from four questions in the survey:

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included<sup>20</sup> (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a description of what each type of action meant.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecasts given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

The goal of the analyses was to determine whether those who saw specific prototypes were more or less likely to take more protective actions compared to the current system using those four questions to measure protective responses. As noted in Section 4.0, the analyses result in the estimation of odds ratios that indicate the degree to which the four new prototypes outperformed the current system. An odds ratio of 1.0 indicates that a prototype is just as protective as the current system, odds ratios below 1.0 indicate the prototype is less protective, and odds ratios above 1.0 indicate the prototype is more protective. By design, odds ratios cannot be below zero.

We present the results for each of the three scenarios for this survey:

- Warning with a downgrade

<sup>20</sup> Given the nature of the hazard, flash flooding excluded the “prepare” option.

- Warning with an upgrade
- Advisory with an upgrade

We present odds ratios for each prompt within each scenario (see Section 2.2). For each scenario, we organize the results by the protective response variables listed above. The specific prototypes tested for the winter weather mild regions survey appear in Table 8.

**Table 8. Specific Prototype Language Tested for Winter Weather Mild Regions Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	Winter Storm Watch	Winter Weather Outlook	Winter Weather Notice	Possible Winter Weather Event	Possible Winter Weather Conditions
Advisory level	Winter Weather Advisory	Winter Weather Warning	Winter Weather Alert	Moderate Winter Weather Warning	Level Orange Winter Weather Warning
Warning level	Winter Storm Warning	Winter Weather Warning	Winter Weather Warning	Severe Winter Weather Warning	Level Red Winter Weather Warning
Emergency level	Blizzard Warning	Winter Weather Warning	Winter Weather Emergency	Extreme Winter Weather Warning	Level Purple Winter Weather Warning

### 5.3.1 Warning with a Downgrade Scenario

After the baseline prompt, the warning with a downgrade scenario started with a watch-level prompt, and then moved to warning followed by a downgrade to an advisory. Table 9 presents the estimated odds ratios for the warning downgrade scenario; in the figure, the “\*” symbol is used to depict levels of statistical significance. Figure 3 provides a graphical depiction of the estimates in Table 9 and using red text and the “\*” again to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** Overall, the prototypes appear to be less protective than the current system in terms of the action selected by respondents. This was particularly true for the warning-level prompt where Prototypes 1 – 3 were found to be significantly less protective.
- **Likelihood of Monitoring.** Prototypes 2 – 4 appear to be more protective at the warning prompt, especially Prototype 4 where those who saw that prototype for more than twice as likely to say they would monitor compared to the current messages. Results are mixed otherwise although Prototype 2 is close to being significantly more protective at the Advisory level.
- **Likelihood of Preparing.** The results show little consistent results for preparing. However, at the watch prompt, all prototypes had odds ratios above 1.0, but none were significant.
- **Likelihood of Acting.** At the watch level, it appears the prototypes provided the same level of protective response or possibly a smaller level. At the warning prompt, Prototypes 3 and 4 were

found to be more protective at the advisory prompt, Prototypes 1 and 2 were found to be more protective.

Overall, it appears that the prototypes were associated with more protective responses at the warning prompt, especially Prototypes 4 and to a lesser extent Prototype 3.

**Table 9. Estimated Odds Ratios for Warning Downgrade Scenario: Winter Weather Mild Regions**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.901 (-0.46)	1.036 (0.16)	1.036 (0.16)	0.994 (-0.03)
Prototype 2	0.791 (-0.99)	0.998 (-0.01)	1.191 (0.78)	0.864 (-0.63)
Prototype 3	0.792 (-1.02)	1.119 (0.48)	1.246 (0.94)	1.027 (0.12)
Prototype 4	0.874 (-0.61)	0.864 (-0.62)	1.085 (0.36)	0.719 (-1.48)
<b>Prompt 3: Warning</b>				
Prototype 1	0.613** (-2.11)	0.858 (-0.61)	0.847 (-0.68)	1.322 (1.18)
Prototype 2	0.586** (-2.24)	1.345 (1.16)	0.723 (-1.41)	1.315 (1.26)
Prototype 3	0.639* (-1.84)	1.349 (1.08)	0.951 (-0.21)	1.571* (1.90)
Prototype 4	0.844 (-0.69)	2.176*** (2.71)	1.260 (0.99)	1.752** (2.45)
<b>Prompt 4: Advisory</b>				
Prototype 1	1.073 (0.27)	0.882 (-0.51)	1.154 (0.61)	1.533* (1.80)
Prototype 2	0.725 (-1.32)	1.485 (1.55)	1.321 (1.20)	1.763** (2.42)
Prototype 3	0.645* (-1.74)	0.740 (-1.12)	0.809 (-0.90)	0.840 (-0.76)
Prototype 4	0.995 (-0.02)	1.228 (0.80)	1.184 (0.75)	1.059 (0.26)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

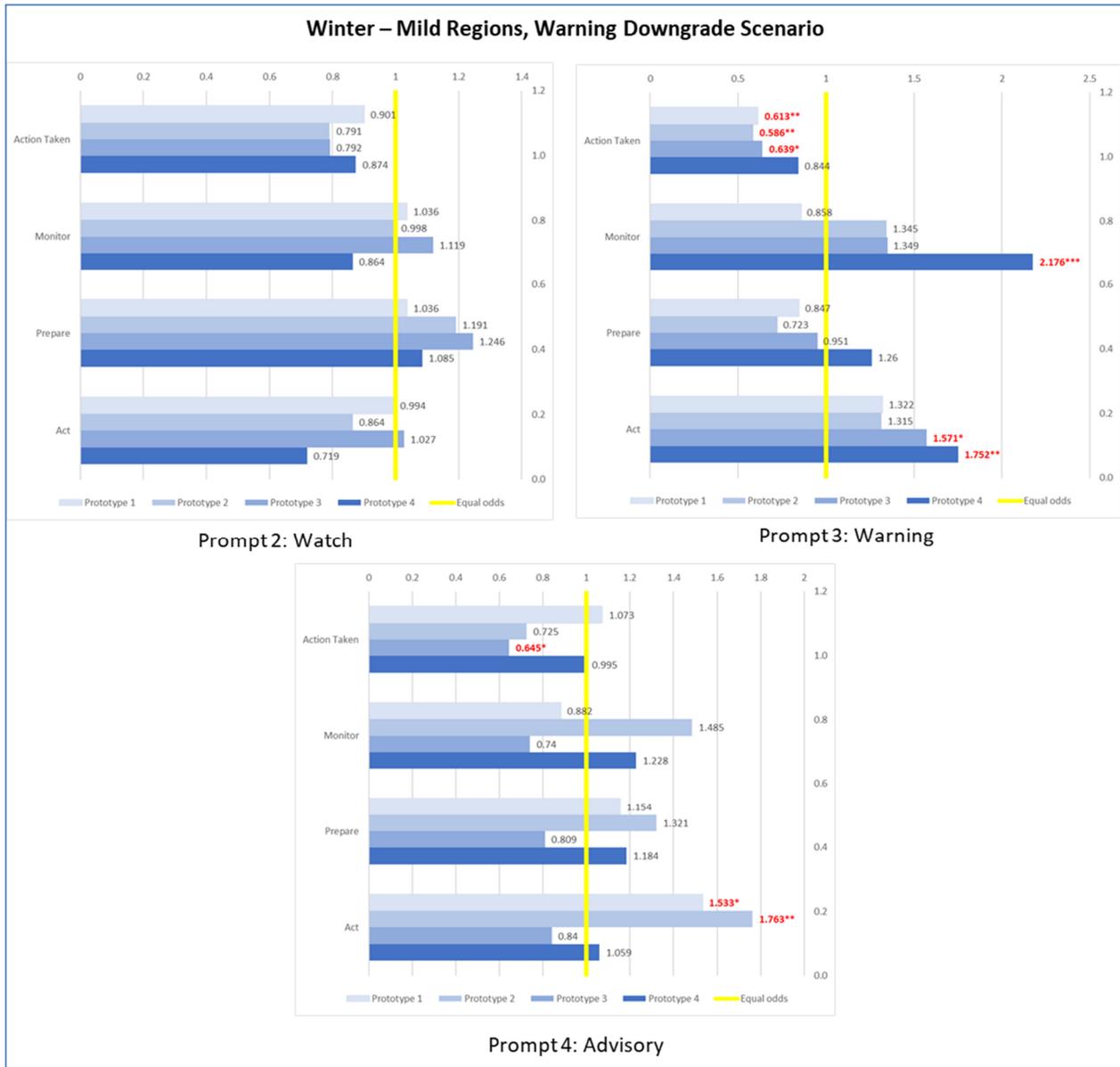


Figure 3. Graphical Depiction of Estimated Odds Ratios for Warning Downgrade Scenario: Winter Weather Mild Regions Survey

### 5.3.2 Warning with an Upgrade Scenario

After the baseline prompt, the warning with an upgrade scenario started with a watch-level prompt, and then moved to warning followed by an emergency. Table 10 presents the estimated odds ratios for the warning upgrade scenario; in the figure, the “\*” symbol is used to depict levels of statistical significance. Figure 4 provides a graphical depiction of the estimates in Table 10 and using red text and the “\*” again to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** There were no statistically significant results for this response variable. It does appear that the prototypes were almost equally protective at the warning prompt and possible less protective at the emergency prompt (except Prototype 2).
- **Likelihood of Monitoring.** The significant results for monitoring occurred at the warning level where all prototypes were found to be more protective than the current system with the results for Prototypes 1, 3 and 4 being statistically significant.
- **Likelihood of Preparing.** All estimated odds ratios for preparing were greater than one, indicating a stronger protective response for all prototypes compared to the current system. There were only three significant results, however: Prototype 2 at the watch level and Prototypes 2 and 3 at the emergency level.
- **Likelihood of Acting.** Except for one estimate, all estimated odds ratios for preparing were greater than one, indicating a stronger protective response for all prototypes compared to the current system. The only significant results, however, were for Prototype 2 at the Warning and Emergency level.

Overall, it appears that Prototype 2 was the most effective at generating preparation and action responses.

**Table 10. Estimated Odds Ratios for Warning Upgrade Scenario: Winter Weather Mild Regions**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	1.178 (0.66)	0.864 (-0.62)	1.333 (1.29)	1.402 (1.45)
Prototype 2	1.402 (1.43)	0.910 (-0.37)	1.759** (2.43)	1.440 (1.49)
Prototype 3	1.020 (0.09)	0.745 (-1.29)	1.036 (0.15)	1.107 (0.46)
Prototype 4	1.028 (0.12)	1.040 (0.18)	1.322 (1.25)	1.052 (0.23)
<b>Prompt 3: Warning</b>				
Prototype 1	0.904 (-0.44)	1.953*** (2.71)	1.318 (1.17)	1.265 (1.07)
Prototype 2	1.201 (0.77)	1.523 (1.52)	1.125 (0.47)	1.550* (1.81)
Prototype 3	1.072 (0.31)	1.609* (1.89)	1.349 (1.22)	1.203 (0.83)
Prototype 4	1.074 (0.29)	1.527* (1.66)	1.299 (1.03)	1.408 (1.44)
<b>Prompt 4: Emergency</b>				
Prototype 1	0.687 (-1.59)	1.187 (0.65)	1.498 (1.59)	1.271 (1.04)
Prototype 2	1.127 (0.46)	1.695 (1.58)	1.773** (2.13)	1.668** (2.00)
Prototype 3	0.717 (-1.38)	1.138 (0.45)	1.559* (1.67)	1.255 (0.91)
Prototype 4	0.742 (-1.22)	0.883 (-0.47)	1.203 (0.72)	0.882 (-0.50)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

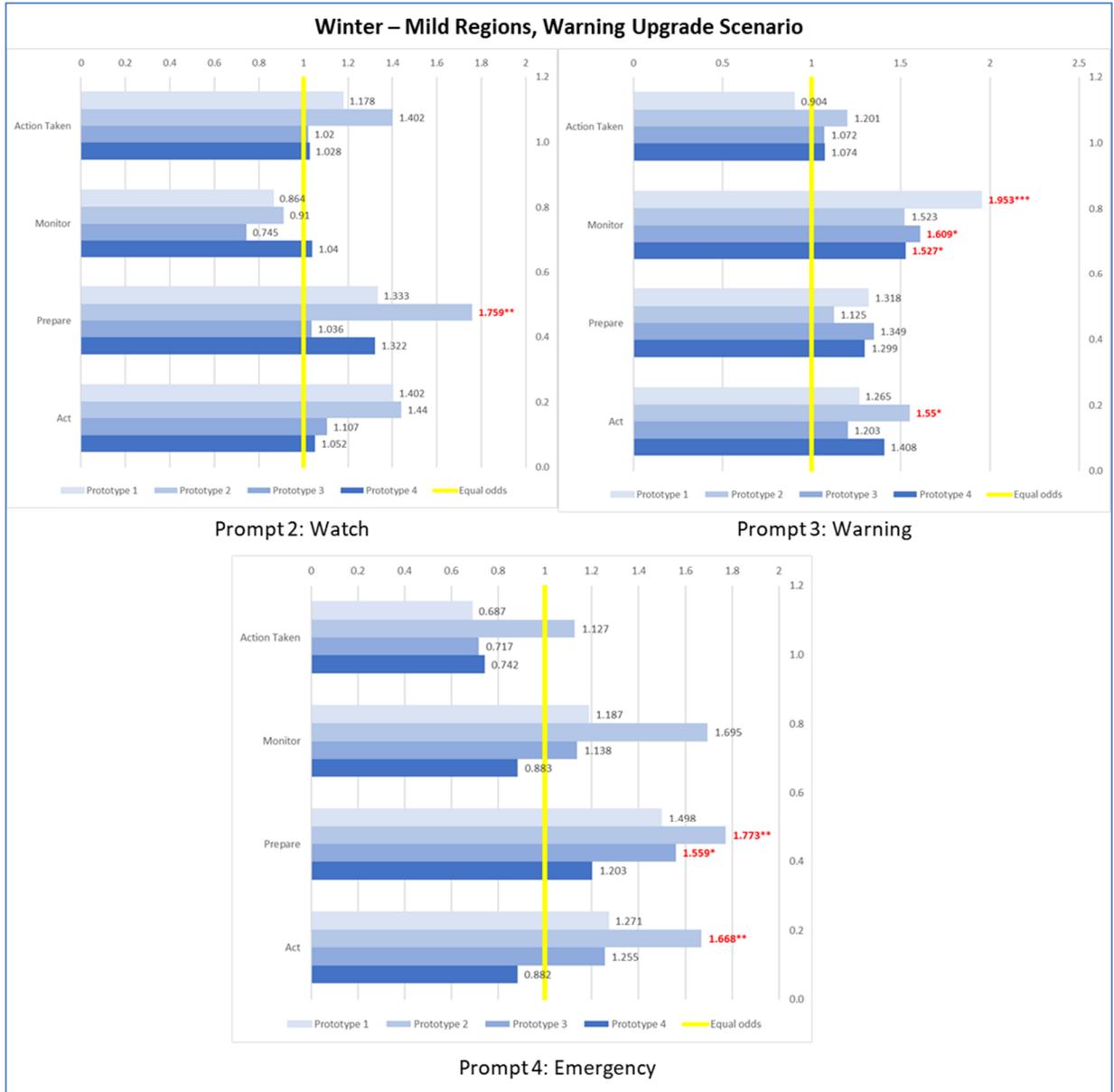


Figure 4. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Winter Weather Mild Regions Survey

### 5.3.3 *Advisory with an Upgrade Scenario*

After the baseline prompt, the advisory with an upgrade scenario started with a watch-level prompt, and then moved to an advisory followed by a warning. Table 11 presents the estimated odds ratios for the advisory upgrade scenario; in the figure, the “\*” symbol is used to depict levels of statistical significance. Figure 5 provides a graphical depiction of the estimates in Table 11 and using red text and the “\*” again to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** At the advisory and warning level prompts, the prototypes are associated with more protective responses, however, the only significant odds ratio was for Prototype 4 at the warning level.
- **Likelihood of Monitoring.** The results for monitoring were mixed with only one odds ratio; the significant ratio was for Prototype 1 at the watch level and it indicated a less protective response.
- **Likelihood of Preparing.** The results for preparing seemed to indicate the prototypes being associated with less protective response for the most part; however, only one was significant (Prototype 1 in the watch level).
- **Likelihood of Acting.** Prototypes 2 – 4 show a consistently higher protective response across all three prompts analyzed with Prototype 2’s impact being significant at the watch and advisory prompt and Prototype 4’s impact significant at the warning level.

Prototype 1 appears to be less protective at the watch level and Prototypes 2 – 4 appear to be more protective in terms of compelling action.

**Table 11. Estimated Odds Ratios for Advisory Upgrade Scenario: Winter Weather Mild Regions**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.876 (-0.60)	0.599** (-2.22)	0.478*** (-3.34)	0.924 (-0.34)
Prototype 2	1.418 (1.58)	1.157 (0.61)	0.879 (-0.56)	1.522** (2.05)
Prototype 3	0.843 (-0.79)	0.726 (-1.36)	0.718 (-1.55)	1.015 (0.07)
Prototype 4	0.813 (-0.97)	0.805 (-0.93)	0.902 (-0.47)	1.241 (0.99)
<b>Prompt 3: Advisory</b>				
Prototype 1	1.071 (0.32)	0.982 (-0.08)	0.917 (-0.40)	1.162 (0.74)
Prototype 2	1.343 (1.36)	1.373 (1.34)	0.967 (-0.16)	1.410* (1.69)
Prototype 3	1.153 (0.62)	0.976 (-0.10)	0.748 (-1.36)	1.113 (0.47)
Prototype 4	1.200 (0.81)	1.228 (0.82)	0.913 (-0.41)	1.291 (1.14)
<b>Prompt 4: Warning</b>				
Prototype 1	1.232 (0.93)	0.795 (-0.89)	0.972 (-0.12)	0.955 (-0.22)
Prototype 2	1.223 (0.88)	0.921 (-0.32)	0.916 (-0.37)	1.128 (0.57)
Prototype 3	1.167 (0.65)	1.081 (0.31)	1.118 (0.50)	1.227 (0.87)
Prototype 4	1.527* (1.80)	1.118 (0.40)	1.136 (0.55)	1.489* (1.70)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

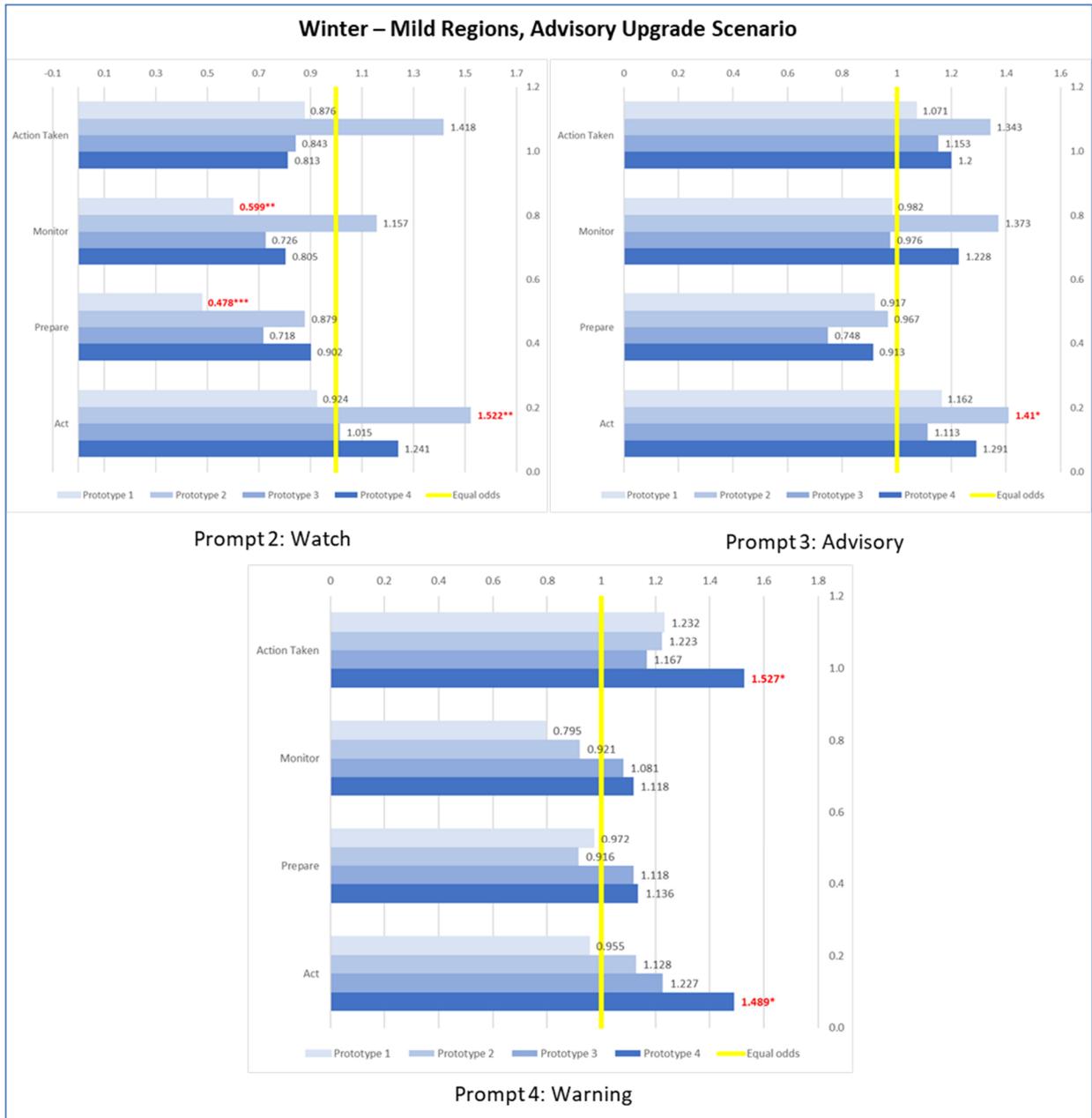


Figure 5. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: Winter Weather Mild Regions Survey

## 5.4 Summary and Conclusions

Table 12 presents the percentage of estimates for each prototype that were significantly greater or significantly less than 1.0. As can be seen, Prototype 2 had the largest percentage of estimates greater than 1.0 followed by Prototype 4; Prototype 4, however, never was significantly less than 1.0.

**Table 12. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Winter Mild Survey**

Prototype	All Estimates	
	> 1.0	< 1.0
Prototype 1	6%	8%
Prototype 2	19%	3%
Prototype 3	8%	6%
Prototype 4	14%	0%
Total Number of Estimates [a]	36	

[a] This is the total for each prototype.

Table 13 expands the summary in Table 12 breaking the percentage out by prompt level. Here we see that most of Prototype 2's estimates that were significantly greater than 1.0 were at the watch, advisory, and emergency prompts while all of Prototype 4's significant estimates were at the warning level.

**Table 13. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Winter Mild Survey**

Prototype	Watch		Advisory		Warning		Emergency	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	17%	13%	0%	8%	8%	0%	0%
Prototype 2	17%	0%	25%	0%	8%	8%	50%	0%
Prototype 3	0%	0%	0%	13%	17%	8%	25%	0%
Prototype 4	0%	0%	0%	0%	42%	0%	0%	0%
Total Number of Estimates [a]	12		8		12		4	

[a] This is the total for each prototype.

Table 14 breaks out the percentages by the protective response variable used. These data indicate that Prototype 2's estimates that were greater than 1.0 were concentrated on increasing preparation and the likelihood of taking action. Prototype 4's estimates that were greater than 1.0 were concentrated on increasing the likelihood of monitoring and the likelihood of taking action.

**Table 14. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Winter Mild Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	11%	11%	11%	0%	11%	11%	0%
Prototype 2	0%	11%	0%	0%	22%	0%	56%	0%
Prototype 3	0%	22%	11%	0%	11%	0%	11%	0%
Prototype 4	11%	0%	22%	0%	0%	0%	22%	0%
Total Number of Estimates [a]	9		9		9		9	

[a] This is the total for each prototype.

Appendix B provides a cross-tabulation of the information in Table 13 and Table 14.

Based on these summaries and the analyses in this section, some overall conclusions can be drawn.

- At the warning level, it appears that all the prototypes are more protective in terms of increasing the likelihood of monitoring, preparing, and acting than the current system.
- At the emergency level, the prototypes also appear to be more protective.
- Prototype 1 may be the least effective since it frequently had odds ratios below 1.0 and had a number that were significantly less than 1.0.
- Prototype 2 may be the most effective since it frequently had odds ratios above 1.0 and had a number that were significantly greater than 1.0.
- Prototype 4 was also effective but had fewer odds ratios that were significantly greater than 1.0.

## 6.0 Winter Weather: Cold Regions

This section discusses the results from the winter weather cold regions survey. As discussed in relation to the winter weather mild regions, NWS and ERG determined that the winter weather survey would need to be implemented in two formats: one for colder regions and one for more mild regions. The colder regions survey was implemented in states that have a higher snow threshold for issuing warnings.

**States:** ME, NH, VT, MA, RI, CT, NY, PA, MI, WI, MN, CO, WY, MT, ID

**Respondents:** 1,298

**Collection time frame:** 2/5/18 – 2/7/18; 2/15/18 – 2/16/18

### 6.1 Basic Demographics

Figure 6 provides a summary of the number of respondents selected from the states included in winter weather mild region survey. Pennsylvania, New York, and Michigan each had 187 respondents; as discussed in Section 3.1, the number of responses from states were limited to ensure no one state dominated a survey.

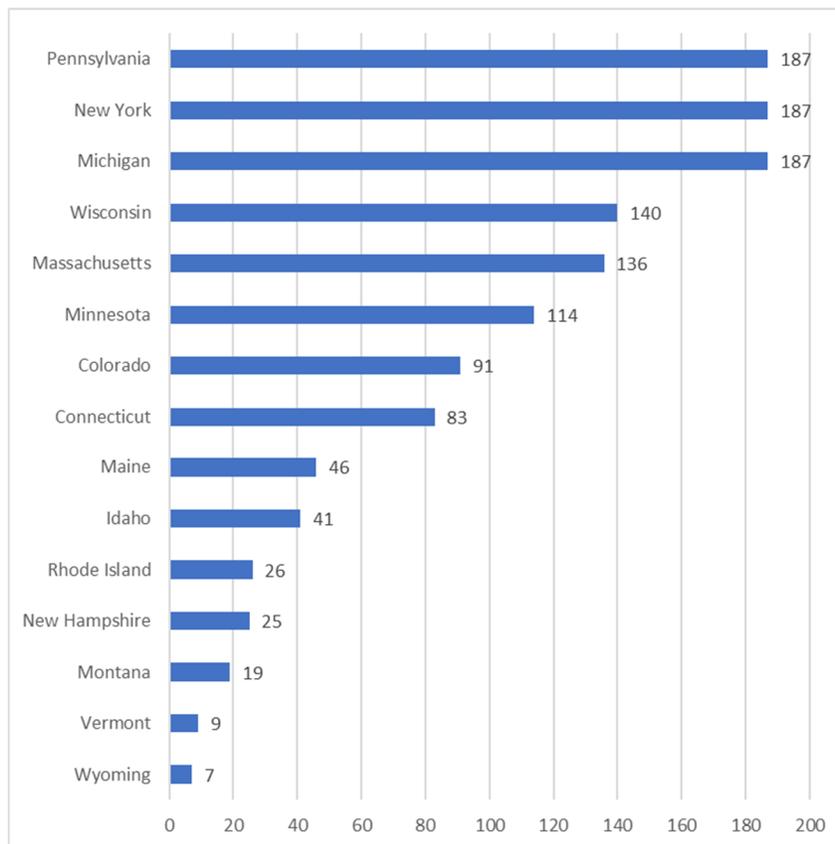


Figure 6. Numbers of Respondents from States Included in the Winter Weather Cold Survey

Table 15 summarizes the basic demographics for the sample.

**Table 15. Basic Demographics for Winter Weather Cold Regions Survey**

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
<b>Age</b>		<b>Race</b>	
20-24	3.5%	White	88.1%
25-34	16.2%	Black/African-American	4.9%
35-44	16.6%	Asian	3.1%
45-54	19.7%	Other	3.9%
55-64	23.7%	<b>Income</b>	
65+	20.4%	Less than \$24,999	23%
<b>Gender</b>		\$25,000 - \$49,999	31%
Female	55.4%	\$50,000 - \$99,999	32%
Male	44.6%	\$100,000 - \$199,999	11%
<b>Education</b>		More than \$200,000	3%
Less than college degree	54.5%	<b>Home Location</b>	
College degree	27.3%	Urban	23.9%
Post-undergraduate work/degree	18.2%	Suburban	47.1%
<b>Hispanic origin</b>		Rural	29.0%
Yes	6.4%		
No	93.6%	<b>Average number of adults in home</b>	<b>2.08</b>
		<b>Average number of children in home</b>	<b>0.51</b>

## 6.2 Current Knowledge

Table 16 provides a summary of the responses to the current knowledge questions. This survey used the first version of the current knowledge question described in Section 2.4; we provided respondents with a term and asked them to select from definitions. The current knowledge questions acted as a “test” of respondents understanding of the current system and each had a “correct” response. The correct responses for each row appear in orange shading in the table. The results for the three terms were:

- Winter Storm Warning – Only 43.8 percent correctly selected the right definition with 42.2 percent selecting the definition corresponding to "Winter Storm Watch"
- Winter Weather Advisory - Only 17.4 percent correctly selected the definition for Advisory; 60.4 percent selected the definition for Watch and almost 22 percent selected the definition for Warning.
- Winter Storm Watch – 68.9 percent selected the correct definition.

Thus, it appears that respondents tended to select the definition for Winter Storm Watch for any of the terms that were presented.

**Table 16. Winter Weather Cold Regions Current Knowledge**

Term Used in Question	Number Who Answered Question	Response Options		
		A storm is possible, and may pose a threat to life and/or property	A storm is certain, and may pose a threat to life and/or property	A storm is certain, but does not pose a direct threat to life and/or property
Winter Storm Warning	422	42.2%	43.8%	14.0%
Winter Weather Advisory	432	60.4%	22.2%	17.4%
Winter Storm Watch	444	68.9%	19.8%	11.3%

### 6.3 Prototypes Analyses

This section presents the results of the ordered logistic regression analyses we performed on the prototype testing. The methods are discussed in Section 4.0. We analyzed the data from four questions in the survey:

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included<sup>21</sup> (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a description of what each type of action meant.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecasts given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

The goal of the analyses was to determine whether those who saw specific prototypes were more or less likely to take more protective actions compared to the current system using those four questions to measure protective responses. As noted in Section 4.0, the analyses result in the estimation of odds ratios that indicate the degree to which the four new prototypes outperformed the current system. An odds ratio of 1.0 indicates that a prototype is just as protective as the current system, odds ratios below 1.0 indicate the prototype is less protective, and odds ratios above 1.0 indicate the prototype is more protective. By design, odds ratios cannot be below zero.

We present the results for each of the three scenarios for this survey:

- Warning with a downgrade

<sup>21</sup> Given the nature of the hazard, flash flooding excluded the “prepare” option.

- Warning with an upgrade
- Advisory with an upgrade

We present odds ratios for each prompt within each scenario (see Section 2.2). For each scenario, we organize the results by the protective response variables listed above. The specific prototypes tested for the winter weather mild regions survey appear in Table 17.<sup>22</sup>

**Table 17. Specific Prototype Language Tested for Winter Weather Cold Regions Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	Winter Storm Watch	Winter Weather Outlook	Winter Weather Notice	Possible Winter Weather Event	Possible Winter Weather Conditions
Advisory level	Winter Weather Advisory	Winter Weather Warning	Winter Weather Alert	Moderate Winter Weather Warning	Level Orange Winter Weather Warning
Warning level	Winter Storm Warning	Winter Weather Warning	Winter Weather Warning	Severe Winter Weather Warning	Level Red Winter Weather Warning
Emergency level	Blizzard Warning	Winter Weather Warning	Winter Weather Emergency	Extreme Winter Weather Warning	Level Purple Winter Weather Warning

### 6.3.1 Warning with a Downgrade Scenario

After the baseline prompt, the warning with a downgrade scenario started with a watch-level prompt, and then moved to warning followed by a downgrade to an advisory. Table 18 presents the estimated odds ratios for the warning downgrade scenario; in the table, the “\*” symbol is used to depict levels of statistical significance. Figure 7 provides a graphical depiction of the estimates in Table 18 and using red text to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** The prototypes appear to be significantly less effective at the watch level compared to the current system, and more effective at the advisory level (but not significantly so).
- **Likelihood of Monitoring.** Prototype 3 was found to be significantly less effective at the advisory level than the current system but was more effective (but not significant) at the watch and warning levels.
- **Likelihood of Preparing.** Those who saw Prototype 4 were more likely to prepare at the warning level compared to the current system and those who saw Prototype 1 were more likely to prepare at the advisory level.

<sup>22</sup> These are the same ones tested for the winter weather mild regions survey. The snow amounts for each term differed between the two surveys.

- **Likelihood of Acting.** The prototypes appear to be less effective than the current system at increasing the likelihood of action at the watch level (not significant), a result that was also significant for Prototype 3 at the advisory level.

The one general trend we can identify is that the prototype appears to be less effective at the watch level.

**Table 18. Estimated Odds Ratios for Warning Downgrade Scenario: Winter Weather Cold Regions**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.469*** (-3.47)	0.766 (-1.12)	0.699 (-1.49)	0.895 (-0.47)
Prototype 2	0.663* (-1.86)	0.763 (-1.24)	0.917 (-0.41)	0.810 (-0.97)
Prototype 3	0.643** (-1.96)	1.129 (0.48)	0.849 (-0.68)	0.816 (-0.86)
Prototype 4	0.546*** (-2.72)	0.832 (-0.85)	0.814 (-0.86)	0.840 (-0.71)
<b>Prompt 3: Warning</b>				
Prototype 1	0.882 (-0.57)	1.130 (0.44)	0.833 (-0.76)	0.804 (-0.89)
Prototype 2	1.009 (0.04)	0.826 (-0.68)	0.684 (-1.64)	0.838 (-0.74)
Prototype 3	1.412 (1.48)	1.393 (1.07)	1.275 (0.88)	1.161 (0.61)
Prototype 4	1.265 (1.08)	1.451 (1.27)	1.515* (1.78)	1.222 (0.84)
<b>Prompt 4: Advisory</b>				
Prototype 1	1.381 (1.52)	0.869 (-0.56)	1.557* (1.91)	0.962 (-0.17)
Prototype 2	1.182 (0.74)	0.699 (-1.48)	1.073 (0.30)	1.184 (0.73)
Prototype 3	1.207 (0.82)	0.608* (-1.87)	1.092 (0.38)	0.644* (-1.90)
Prototype 4	1.242 (1.00)	1.021 (0.08)	1.349 (1.31)	1.079 (0.35)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

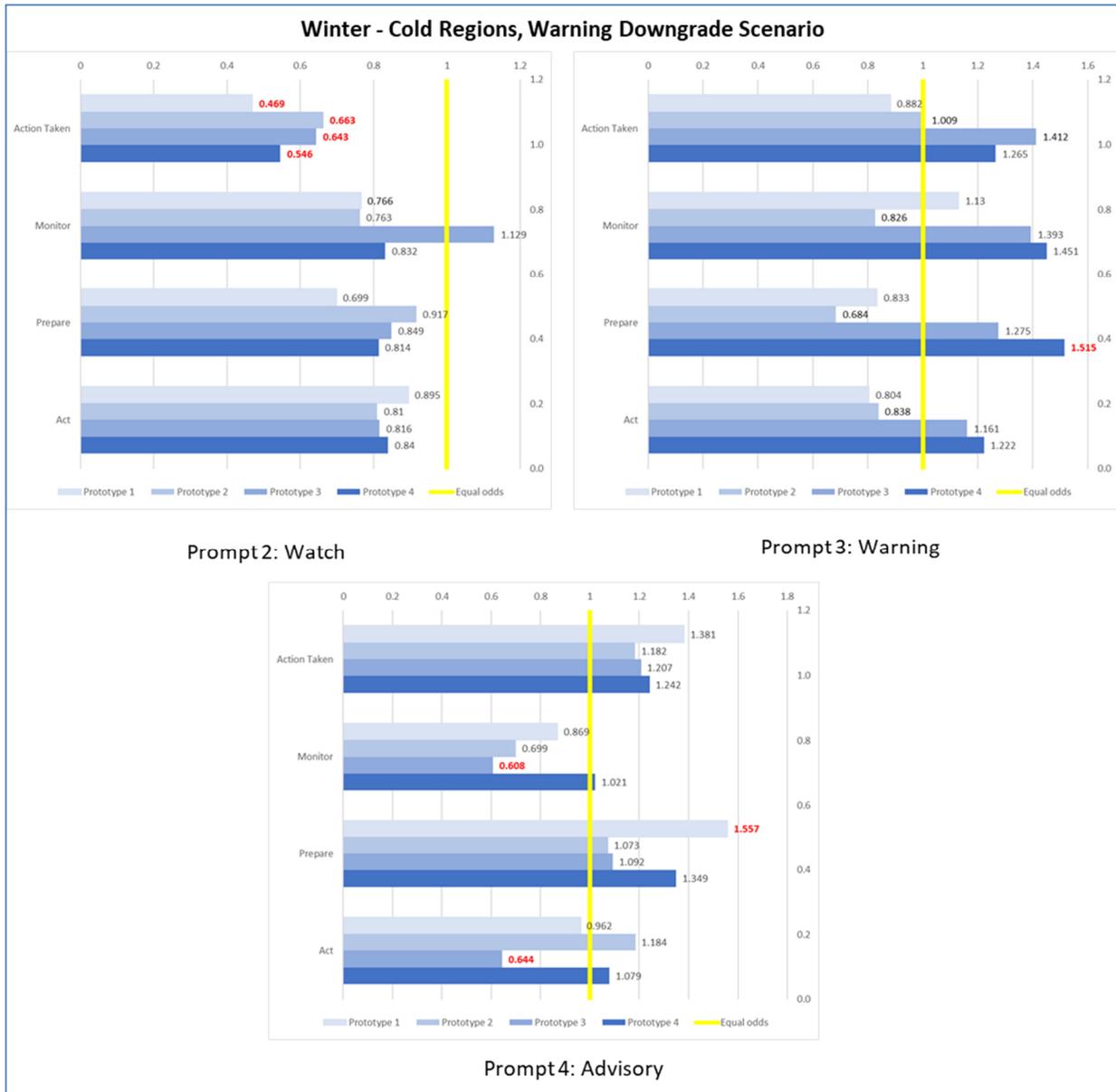


Figure 7. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Winter Weather Cold Regions Survey

### 6.3.2 Warning with an Upgrade Scenario

After the baseline prompt, the warning with an upgrade scenario started with a watch-level prompt, and then moved to warning followed by an emergency. Table 19 presents the estimated odds ratios for the warning upgrade scenario; in the table, the “\*” symbol is used to depict levels of statistical significance. Figure 4 provides a graphical depiction of the estimates in Table 19 using red text to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** The prototypes appear to be more protective than the current system, especially at the warning level where Prototypes 1 – 3 are all significant. Prototype 2 was also significant at the watch level.
- **Likelihood of Monitoring.** The prototypes were all significantly less effective than the current system at increasing monitoring at the watch level. At the warning and emergency level, however, Prototype 3 appears to be more effective than the current system (significant at the warning level).
- **Likelihood of Preparing.** The prototypes tend to be less effective than the current system at increasing preparation at the watch level with the effect for Prototypes 1 being significant. At the warning and emergency levels, Prototype 3 was clearly more effective than the current system with the effect at the warning level being significant. Also, the other prototypes were less effective than the current system at the emergency level (Prototypes 1 was significantly less).
- **Likelihood of Acting.** Once again, the prototypes are less effective than the current system at increasing the likelihood of action at the watch with the effects for Prototypes 1 and 4 being significant. At the warning and emergency levels, Prototype 3 was clearly more effective than the current system with the effect at the warning level being significant. Also, the other prototypes were less effective than the current system at the emergency level (Prototypes 1 and 4 were significantly less).

Overall, it appears that the prototypes were less effective at the watch level and Prototype 3 was clearly the most effective at increasing the likelihood people monitored, prepared, and acted at the warning and emergency levels.

**Table 19. Estimated Odds Ratios for Warning Upgrade Scenario: Winter Weather Cold Regions**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	1.065 (0.24)	0.374*** (-4.02)	0.678* (-1.70)	0.568** (-2.27)
Prototype 2	1.583* (1.88)	0.665* (-1.71)	0.763 (-1.13)	0.715 (-1.35)
Prototype 3	1.207 (0.76)	0.528** (-2.45)	1.135 (0.53)	0.794 (-0.88)
Prototype 4	1.049 (0.19)	0.531** (-2.52)	0.788 (-1.06)	0.579** (-2.18)
<b>Prompt 3: Warning</b>				
Prototype 1	1.789** (2.49)	0.935 (-0.26)	1.126 (0.54)	0.861 (-0.65)
Prototype 2	1.818** (2.52)	0.713 (-1.18)	0.754 (-1.19)	1.066 (0.27)
Prototype 3	2.168*** (3.15)	1.838** (2.13)	2.312*** (3.36)	1.890** (2.57)
Prototype 4	1.343 (1.26)	0.952 (-0.16)	1.497 (1.62)	1.348 (1.17)
<b>Prompt 4: Emergency</b>				
Prototype 1	1.026 (0.11)	0.620 (-1.60)	0.577** (-2.20)	0.453*** (-3.24)
Prototype 2	1.177 (0.68)	1.013 (0.04)	0.837 (-0.63)	0.833 (-0.68)
Prototype 3	1.198 (0.73)	1.522 (1.30)	1.499 (1.47)	1.343 (1.14)
Prototype 4	0.778 (-0.95)	0.684 (-1.14)	0.715 (-1.21)	0.617* (-1.93)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

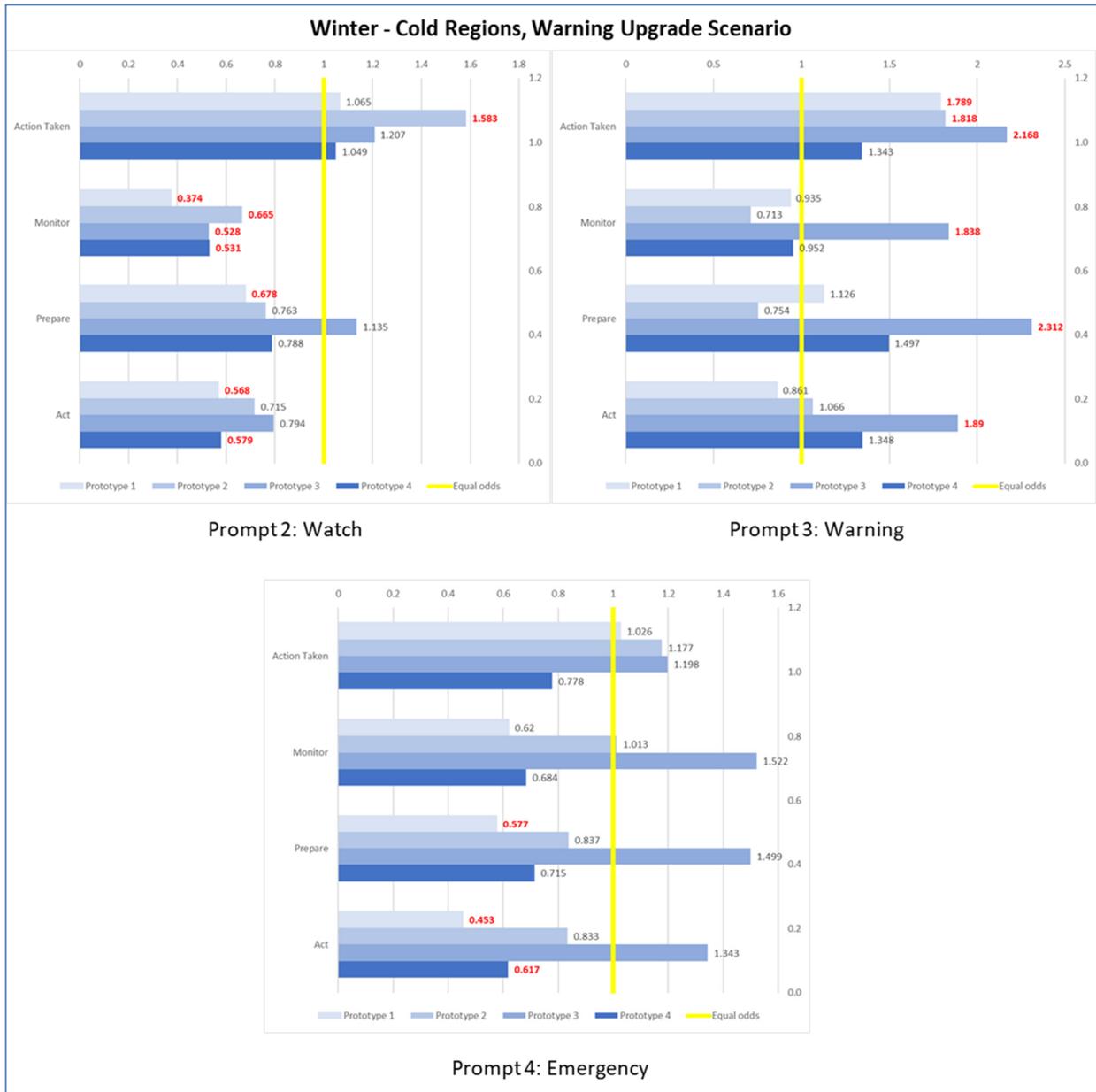


Figure 8. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Winter Weather Cold Regions Survey

### 6.3.3 Advisory with an Upgrade Scenario

After the baseline prompt, the advisory with an upgrade scenario started with a watch-level prompt, and then moved to an advisory followed by a warning. Table 20 presents the estimated odds ratios for the advisory upgrade scenario; in the figure, the “\*” symbol is used to depict levels of statistical significance. Figure 9 provides a graphical depiction of the estimates in Table 20 and using red text and the “\*” again to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** For the most part, the prototypes appear to be less effective than the current system at increasing the protective response at the watch level. Prototype 4 is more effective at the advisory level.
- **Likelihood of Monitoring.** The prototypes appear to be less effective at the watch level (not significant) and also less effective at the warning level (not significant and except for Prototype 3). At the advisory level, all the prototypes were more effective, but the differences were not significant.
- **Likelihood of Preparing.** The prototypes appear to be less effective at the watch level, but at the advisory and then at the warning level Prototypes 3 and 4 appear to be more effective. At the advisory level, Prototype 4 more than doubles the likelihood of preparation.
- **Likelihood of Acting.** The prototypes appear to be less effective at the watch level and less or just as effective at the advisory level, but Prototypes 3 and 4 appear to be more effective at the warning level (only Prototype 3 is significant).

Overall, the prototypes appear to be less effective at the watch level compared to the current system. Prototypes 3 and 4 appear to be more effective at increasing the likelihood of preparation and at the advisory and warning level and more effective at increasing the likelihood acting at the warning level.

**Table 20. Estimated Odds Ratios for Advisory Upgrade Scenario: Winter Weather Cold Regions**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.464*** (-3.37)	0.874 (-0.65)	0.546*** (-2.83)	0.656* (-1.95)
Prototype 2	0.514*** (-2.92)	0.788 (-1.03)	0.616** (-2.30)	0.806 (-1.02)
Prototype 3	0.638** (-2.03)	0.846 (-0.77)	0.646** (-2.08)	0.858 (-0.72)
Prototype 4	0.535*** (-2.88)	0.874 (-0.59)	0.776 (-1.20)	0.804 (-1.00)
<b>Prompt 3: Advisory</b>				
Prototype 1	1.415 (1.57)	1.351 (1.35)	1.516** (2.03)	0.929 (-0.37)
Prototype 2	1.075 (0.34)	1.216 (0.82)	1.177 (0.77)	0.825 (-0.91)
Prototype 3	1.230 (1.00)	1.270 (1.07)	1.596** (2.18)	1.052 (0.23)
Prototype 4	1.630** (2.23)	1.294 (1.06)	2.146*** (3.34)	1.093 (0.41)
<b>Prompt 4: Warning</b>				
Prototype 1	0.890 (-0.55)	0.640* (-1.85)	0.925 (-0.35)	0.907 (-0.49)
Prototype 2	0.705 (-1.59)	0.694 (-1.23)	0.937 (-0.28)	1.069 (0.30)
Prototype 3	1.006 (0.03)	1.125 (0.45)	1.573* (1.92)	1.506** (2.06)
Prototype 4	1.178 (0.71)	0.765 (-1.01)	1.396 (1.42)	1.319 (1.27)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

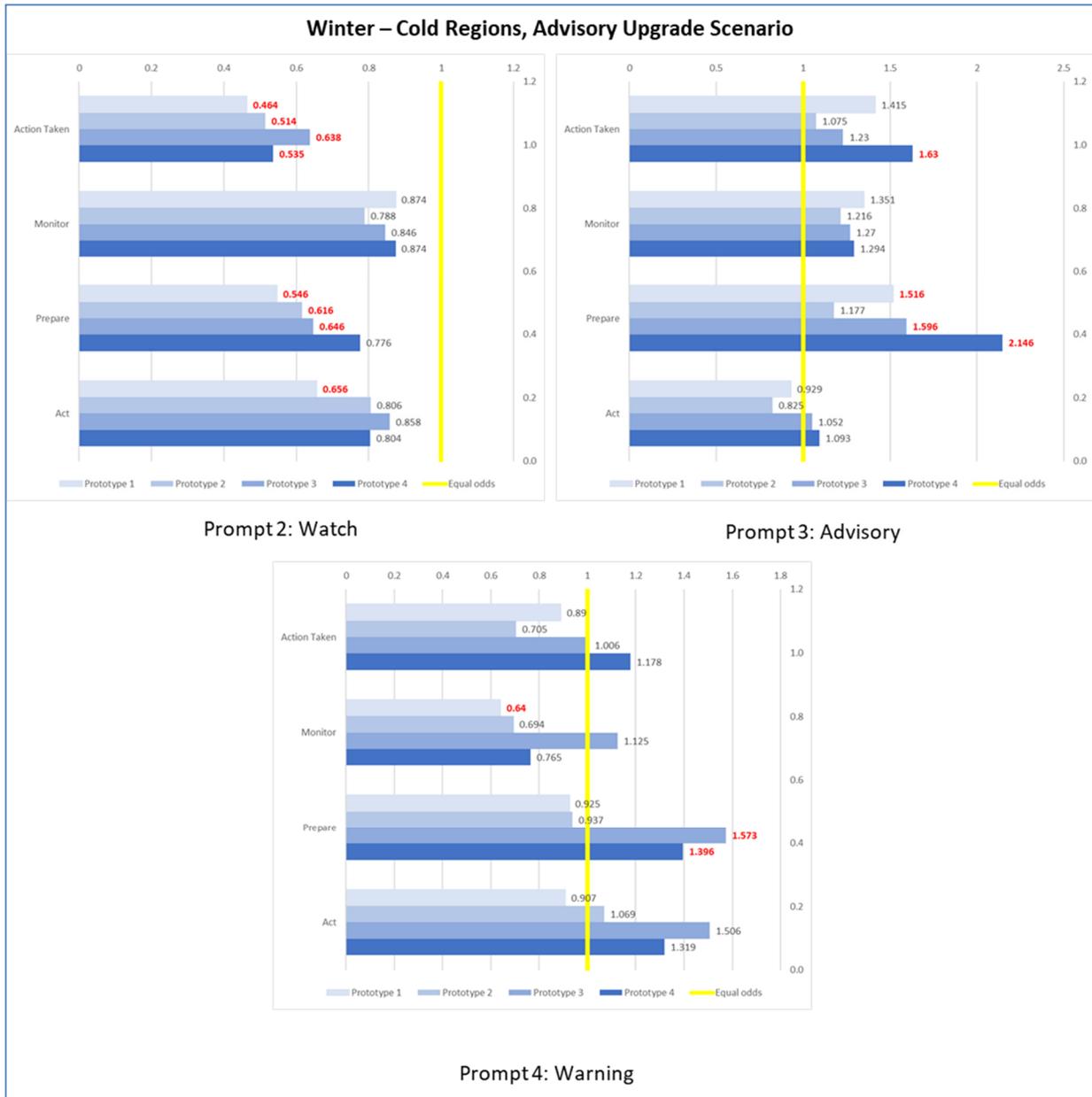


Figure 9. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: Winter Weather Cold Regions Survey

## 6.4 Summary and Conclusions

Table 21 presents the percentage of estimates for each prototype that were significantly greater or significantly less than 1.0. Prototype 3 had the largest percentage of estimates significantly greater than 1.0 but had almost an equal amount that were significantly less than 1.0. The other three prototypes had more estimates significantly less than 1.0 than greater than 1.0.

**Table 21. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Winter Cold Survey**

Prototype	All Estimates	
	> 1.0	< 1.0
Prototype 1	8%	28%
Prototype 2	6%	11%
Prototype 3	19%	17%
Prototype 4	8%	14%
Total Number of Estimates [a]	36	

[a] This is the total for each prototype.

Table 22 expands the summary in Table 21 breaking the percentage out by prompt level. This tabulation shows that most of the underperformance by the prototypes relative to the current system occurred at the watch level. Prototypes 1 and 4 performed well at the advisory level and Prototype 3 performed well at the warning level. None of the prototypes performed well at the emergency level.

**Table 22. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Winter Cold Survey**

Prototype	Watch		Advisory		Warning		Emergency	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	58%	25%	0%	8%	8%	0%	50%
Prototype 2	8%	33%	0%	0%	8%	0%	0%	0%
Prototype 3	0%	33%	13%	25%	50%	0%	0%	0%
Prototype 4	0%	33%	25%	0%	8%	0%	0%	25%
Total Number of Estimates [a]	12		8		12		4	

[a] This is the total for each prototype.

Table 23 breaks out the percentages by the protective response variable used. The results are mixed across the protective response variables. Prototype 3 does appear to be effective at increasing the likelihood of preparing compared to the current system.

**Table 23. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Winter Cold Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	11%	22%	0%	22%	22%	33%	0%	33%
Prototype 2	22%	22%	0%	11%	0%	11%	0%	0%
Prototype 3	11%	22%	11%	22%	33%	11%	22%	11%
Prototype 4	11%	22%	0%	11%	22%	0%	0%	22%
Total Number of Estimates [a]	9		9		9		9	

[a] This is the total for each prototype.

Appendix B provides a cross-tabulation of the information in Table 22 and Table 23.

Based on these summaries and the analyses in this section, some overall conclusions can be drawn.

- At the watch level, it appears that all the prototypes are less protective than the current system.
- Prototype 3 appears to be more effective at the increasing preparation at the warning level.
- Prototype 4 appears to be more effective at the increasing the likelihood of action at the advisory level.
- None of the prototypes outperformed the current system at the emergency level.

## 7.0 Thunderstorms

This section discusses the results from the thunderstorms survey. NWS and ERG determined that the entire United States was in-scope for this survey.

**States:** All U.S. States and Washington DC

**Respondents:** 1,501

**Collection time frame:** 2/20/18 – 2/22/18

### 7.1 Basic Demographics

Figure 10 provides a summary of the number of respondents selected from each state. New York, Florida, and California each had 98 respondents; as discussed in Section 3.1, the number of responses from states were limited to ensure no one state dominated a survey. Table 24 summarizes the basic demographics for the sample.

**Table 24. Basic Demographics for Thunderstorms Survey**

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
<b>Age</b>		<b>Race</b>	
20-24	5.5%	White	82.9%
25-34	21.7%	Black/African-American	8.7%
35-44	21.2%	Asian	4.8%
45-54	15.7%	Other	3.6%
55-64	18.9%	<b>Income</b>	
65+	17.2%	Less than \$24,999	23.4%
<b>Gender</b>		\$25,000 - \$49,999	29.2%
Female	46.2%	\$50,000 - \$99,999	30.9%
Male	53.8%	\$100,000 - \$199,999	14.3%
<b>Education</b>		More than \$200,000	2.3%
Less than college degree	52.3%	<b>Home Location</b>	
College degree	30.8%	Urban	24.2%
Post-undergraduate work/degree	16.9%	Suburban	49.0%
<b>Hispanic origin</b>		Rural	26.8%
Yes	9.7%	<b>Average number of adults in home</b>	<b>2.15</b>
No	90.3%	<b>Average number of children in home</b>	<b>0.62</b>

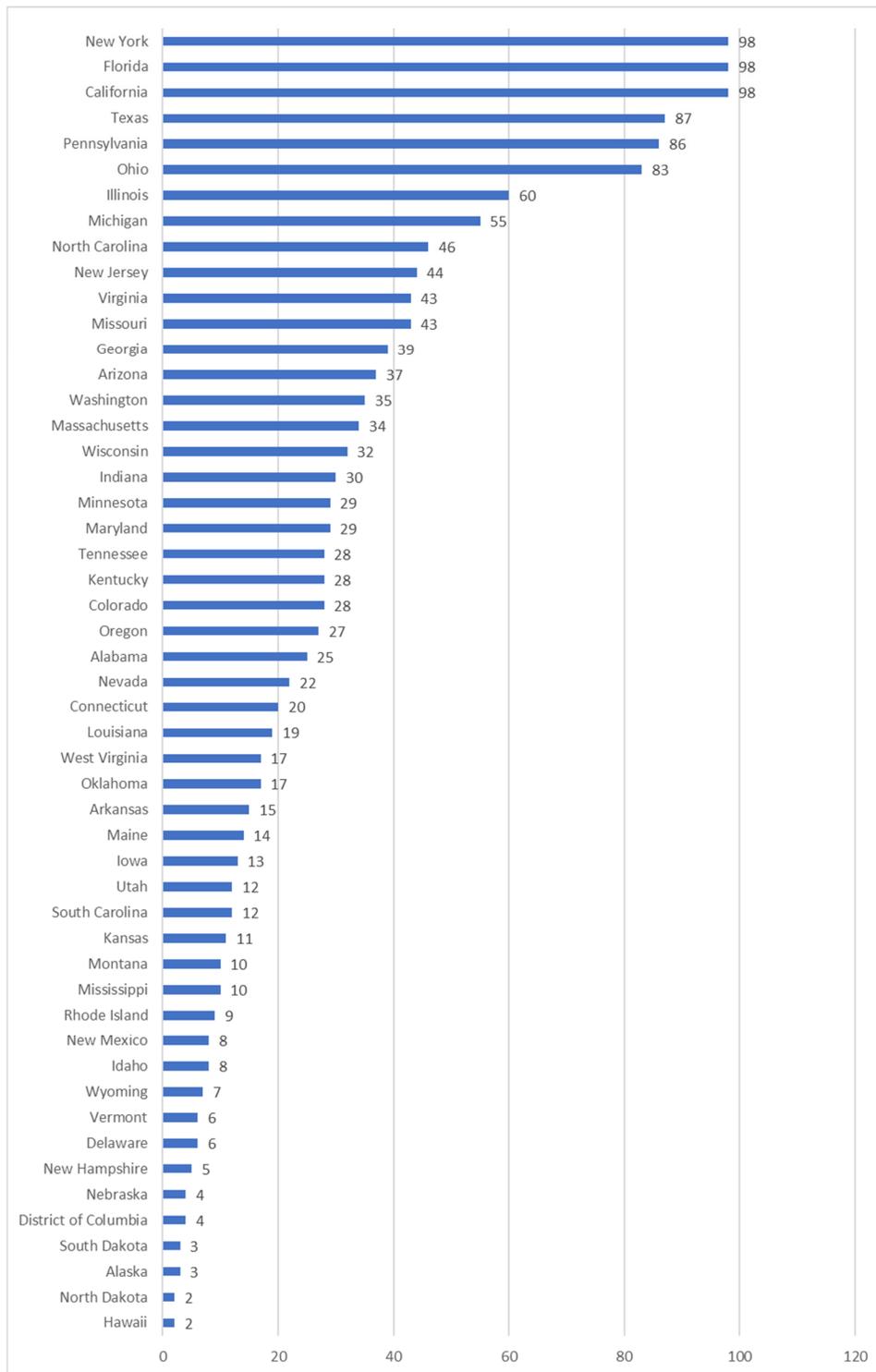


Figure 10. Numbers of Respondents from States Included in the Thunderstorms Survey

## 7.2 Current Knowledge

Table 25 provides a summary of the responses to the current knowledge questions. This survey used the second version of the current knowledge question described in Section 2.4; we provided respondents with a definition and asked them to select from terms that fit the definition. The current knowledge questions acted as a “test” of respondents understanding of the current system and each had a “correct” response. The correct responses for each row appear in orange shading in the table. The results for the three terms were:

- Severe Thunderstorm Watch – Only 43.5 percent correctly selected the right term for the definition provided which represented a plurality among the respondents.
- Significant Weather Advisory - Only 24.3 percent correctly selected Advisory for the definition provided; 50.5 percent selected Severe Thunderstorm Warning for the definition and 25.2 percent selected Severe Thunderstorm Watch.
- Severe Thunderstorm Warning – 56.8 percent selected the correct term for the definition.

**Table 25. Thunderstorms Current Knowledge**

Definition Used in Question	Number Who Answered Question	Response Options		
		Severe Thunderstorm Watch	Significant Weather Advisory	Severe Thunderstorm Warning
When there is the possibility for thunderstorms to produce damaging winds and/or hail	526	43.5%	23.2%	33.3%
When a thunderstorm is producing winds greater than 40 miles per hour and/or pea-sized (1/4-inch) hail	489	25.2%	24.3%	50.5%
When a thunderstorm is producing winds greater than 58 miles per hour and/or quarter-sized (1-inch) hail or larger	486	21.2%	22.0%	56.8%

### 7.3 Prototypes Analyses

This section presents the results of the ordered logistic regression analyses we performed on the prototype testing. The methods are discussed in Section 4.0. We analyzed the data from four questions in the survey:

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included<sup>23</sup> (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a description of what each type of action meant.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecasts given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

The goal of the analyses was to determine whether those who saw specific prototypes were more or less likely to take more protective actions compared to the current system using those four questions to measure protective responses. As noted in Section 4.0, the analyses result in the estimation of odds ratios that indicate the degree to which the four new prototypes outperformed the current system. An odds ratio of 1.0 indicates that a prototype is just as protective as the current system, odds ratios below 1.0 indicate the prototype is less protective, and odds ratios above 1.0 indicate the prototype is more protective. By design, odds ratios cannot be below zero.

We present the results for each of the three scenarios for this survey:

- Warning with a downgrade
- Warning with an upgrade
- Advisory with an upgrade

We present odds ratios for each prompt within each scenario (see Section 2.2). For each scenario, we organize the results by the protective response variables listed above. The specific prototypes tested for the winter weather mild regions survey appear in Table 26. One difference between the analysis for thunderstorm and the other hazards is the lack of an emergency-level prompt for the current system. Thus, in analyzing the warning upgrade scenario, we needed to exclude the current system from the analyses and comparisons are made to Prototype 4 instead.

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<sup>23</sup> Given the nature of the hazard, flash flooding excluded the “prepare” option.

**Table 26. Specific Prototype Language Tested for Thunderstorms Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	Severe Thunderstorm Watch	Thunderstorm Outlook	Thunderstorm Notice	Possible Thunderstorms	Possible Thunderstorm Conditions
Advisory level	Significant Weather Advisory	Thunderstorm Warning	Thunderstorm Alert	Thunderstorm Warning	Level Orange Thunderstorm Warning
Warning level	Severe Thunderstorm Warning	Thunderstorm Warning	Thunderstorm Warning	Severe Thunderstorm Warning	Level Red Thunderstorm Warning
Emergency level	-	Thunderstorm Warning	Thunderstorm Emergency	Extreme Thunderstorm Warning	Level Purple Thunderstorm Warning

### 7.3.1 Warning with a Downgrade Scenario

After the baseline prompt, the warning with a downgrade scenario started with a watch-level prompt, and then moved to warning followed by a downgrade to an advisory. Table 27 presents the estimated odds ratios for the warning downgrade scenario; in the figure, the “\*” symbol is used to depict levels of statistical significance. Figure 7 provides a graphical depiction of the estimates in Table 27 and using red text and the “\*” again to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** At the watch level, the prototypes are all significantly less protective than the current system. At the warning level, Prototypes 1 and 2 are significantly less effective than the current system. Finally, at the advisory level, Prototype 1 is significantly more effective.
- **Likelihood of Monitoring.** The prototypes result in significantly less monitoring than the current system at the watch level. There were no other significant effects at the warning and advisory level, but Prototype 4 appears to be more effective at both levels (but not significant).
- **Likelihood of Preparing.** Again, the prototypes result in significantly less monitoring than the current system at the watch level. Prototype 2 is significantly less effective at the warning level.
- **Likelihood of Acting.** Again, the prototypes result in significantly less monitoring than the current system at the watch level. Prototypes 1 and 2 were significantly less effective at the warning level.

Overall, there were few general conclusions to be drawn from these results. It does appear, however, that the prototypes were less effective at the watch level.

**Table 27. Estimated Odds Ratios for Warning Downgrade Scenario: Thunderstorms**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.489*** (-4.09)	0.561*** (-3.15)	0.509*** (-3.82)	0.475*** (-4.38)
Prototype 2	0.623*** (-2.60)	0.521*** (-3.42)	0.598*** (-2.98)	0.569*** (-3.43)
Prototype 3	0.476*** (-4.33)	0.503*** (-3.37)	0.429*** (-4.70)	0.429*** (-4.85)
Prototype 4	0.462*** (-4.49)	0.686** (-2.12)	0.392*** (-5.54)	0.402*** (-5.23)
<b>Prompt 3: Warning</b>				
Prototype 1	0.607*** (-3.01)	0.813 (-1.07)	0.740* (-1.66)	0.661** (-2.25)
Prototype 2	0.595*** (-2.99)	0.800 (-1.09)	0.635*** (-2.64)	0.470*** (-4.39)
Prototype 3	1.042 (0.24)	1.220 (0.87)	0.922 (-0.41)	1.248 (1.08)
Prototype 4	1.109 (0.60)	1.387 (1.56)	1.075 (0.39)	1.152 (0.76)
<b>Prompt 4: Advisory</b>				
Prototype 1	1.463** (2.35)	0.957 (-0.24)	1.261 (1.37)	1.230 (1.23)
Prototype 2	0.867 (-0.87)	0.786 (-1.36)	0.829 (-1.14)	0.856 (-0.93)
Prototype 3	1.101 (0.57)	0.977 (-0.12)	1.017 (0.10)	1.188 (0.97)
Prototype 4	1.126 (0.77)	1.211 (1.03)	0.979 (-0.13)	0.978 (-0.14)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

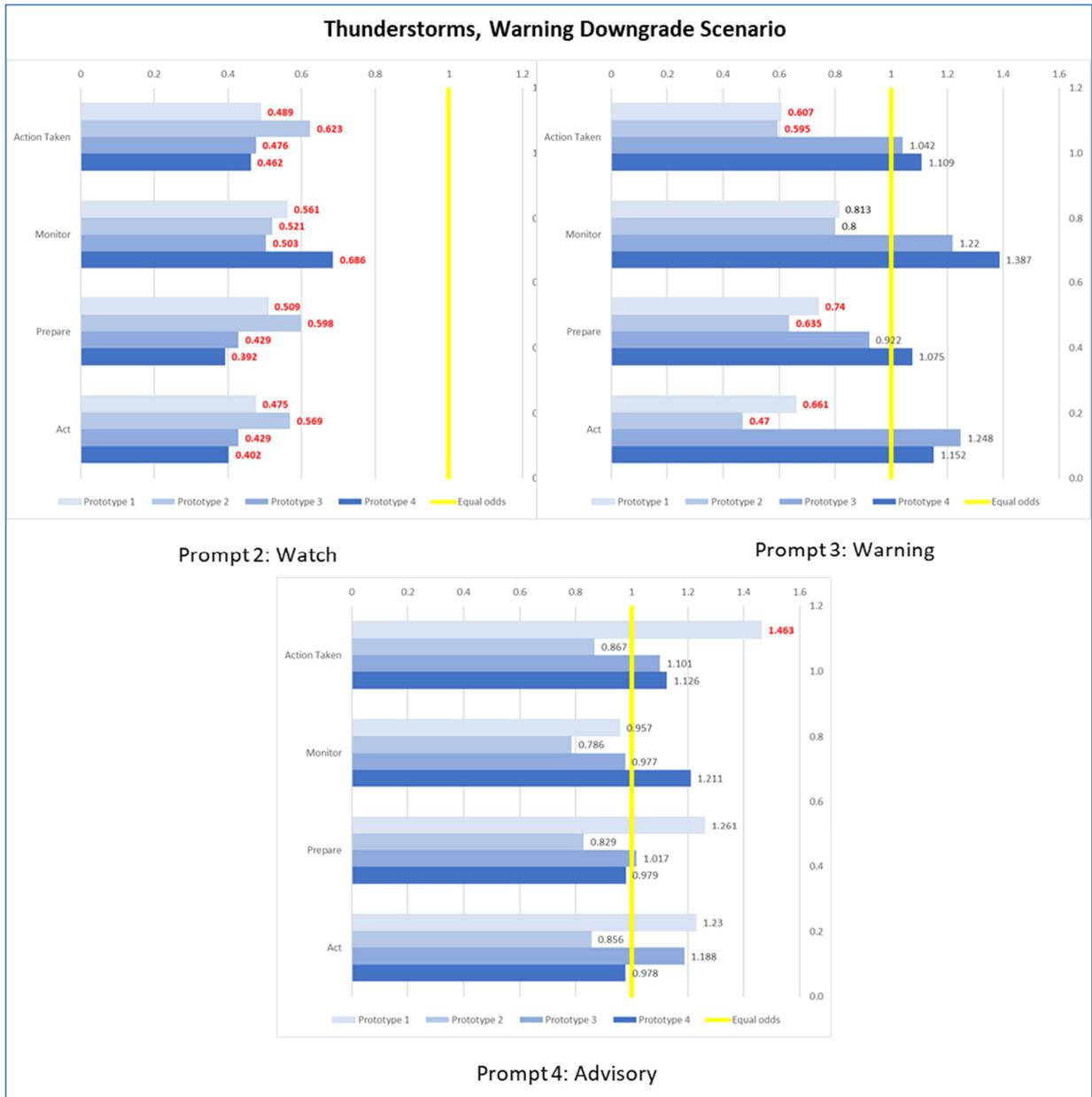


Figure 11. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Thunderstorms Survey

### 7.3.2 Warning with an Upgrade Scenario

After the baseline prompt, the warning with an upgrade scenario started with a watch-level prompt, and then moved to warning followed by an emergency. Table 28 presents the estimated odds ratios for the warning upgrade scenario; in the table, the “\*” symbol is used to depict levels of statistical significance. Figure 12 provides a graphical depiction of the estimates in Table 28 using red text to depict statistical significance. As a reminder, the current system does not contain an emergency-level prompt; thus, in our analyses for this survey, we compared the protective response of Prototypes 1 – 3 to that of Prototype 4.<sup>24</sup> The results for each protective response variable can be described as follows:

- **Action Taken.** At the watch level, Prototype 2 is more effective than Prototype 4 at increasing the protective response action. At the warning level, Prototypes 1 and 2 are less effective than Prototype 4 and Prototype 1 is again less effective at the emergency level.
- **Likelihood of Monitoring.** Prototype 1 is less effective at the warning and emergency level compared to Prototype 4.
- **Likelihood of Preparing.** The results for preparing are similar to those for the action taken. At the watch level, Prototype 2 is more effective than Prototype 4. At the warning level, Prototypes 1 and 2 are less effective than Prototype 4 and Prototype 1 is again less effective at the emergency level.
- **Likelihood of Acting.** Once again, the results for preparing are similar to those for the action taken and preparing.

With the exception of Prototype 2 at the watch level, it appears Prototypes 1 – 3 are less effective than Prototype 4 at increase protective response.

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<sup>24</sup> This is necessary to allow the regression model to calculate. We could have selected any of the Prototypes as the base, we selected Prototype 4.

**Table 28. Estimated Odds Ratios for Warning Upgrade Scenario: Thunderstorms**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	1.033 (0.18)	0.775 (-1.20)	1.053 (0.28)	1.173 (0.88)
Prototype 2	1.656*** (2.73)	1.158 (0.73)	1.922*** (3.35)	1.641*** (2.60)
Prototype 3	0.969 (-0.18)	1.126 (0.58)	0.984 (-0.09)	1.140 (0.73)
<b>Prompt 3: Warning</b>				
Prototype 1	0.490*** (-3.63)	0.498*** (-2.75)	0.481*** (-3.40)	0.491*** (-3.47)
Prototype 2	0.450*** (-4.08)	0.624* (-1.83)	0.588** (-2.40)	0.539*** (-2.85)
Prototype 3	0.683* (-1.92)	0.755 (-1.05)	0.715 (-1.47)	0.801 (-0.98)
<b>Prompt 4: Emergency</b>				
Prototype 1	0.569*** (-2.76)	0.550** (-1.99)	0.496*** (-2.85)	0.508*** (-2.82)
Prototype 2	0.791 (-1.15)	0.799 (-0.76)	0.851 (-0.65)	0.877 (-0.53)
Prototype 3	1.039 (0.18)	1.207 (0.61)	0.937 (-0.26)	1.000 (-0.00)

Exponentiated coefficients;  $z$  statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

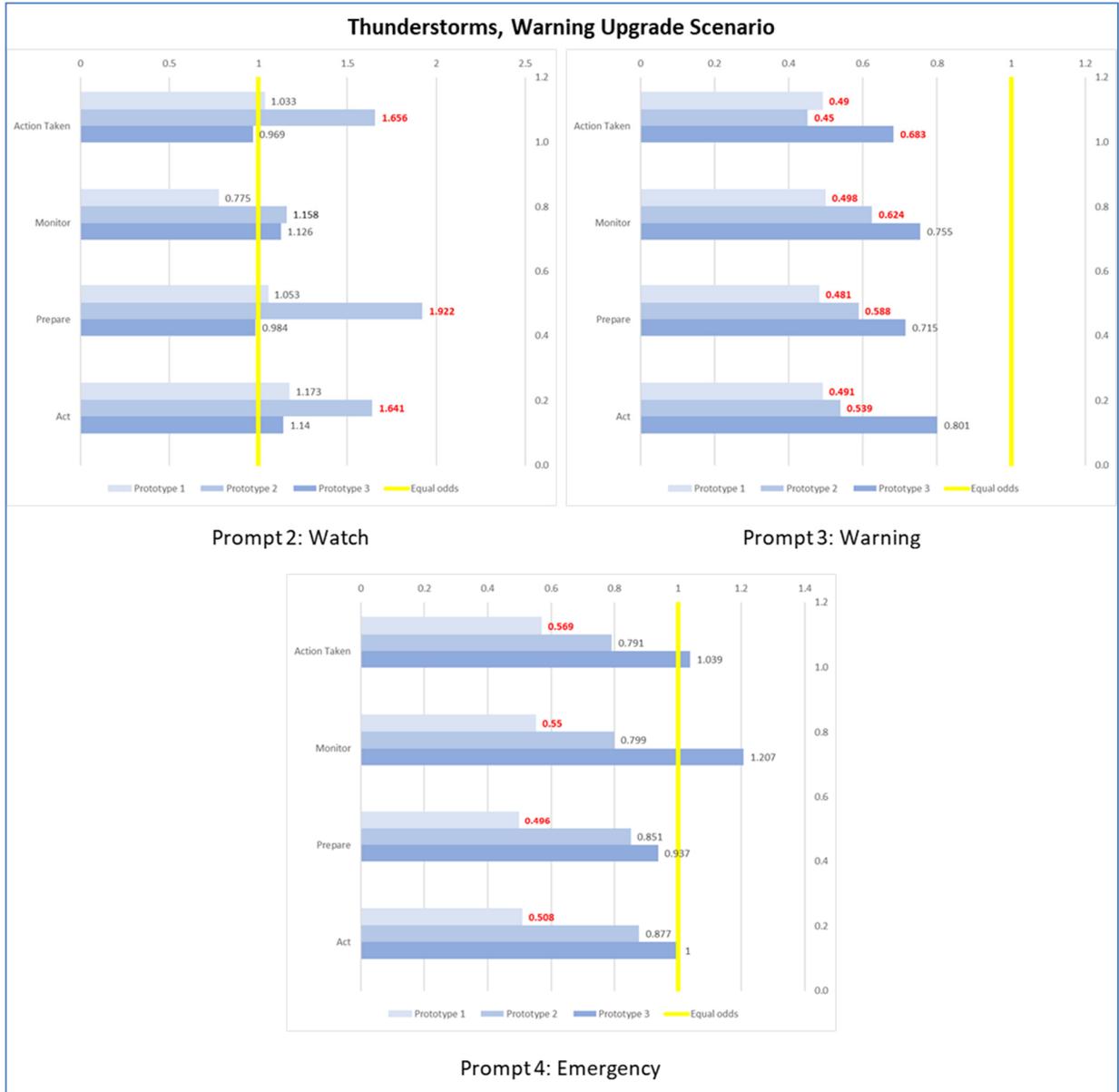


Figure 12. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Thunderstorms Survey

### 7.3.3 *Advisory with an Upgrade Scenario*

After the baseline prompt, the advisory with an upgrade scenario started with a watch-level prompt, and then moved to an advisory followed by a warning. Table 29 presents the estimated odds ratios for the advisory upgrade scenario; in the figure, the “\*” symbol is used to depict levels of statistical significance. Figure 13 provides a graphical depiction of the estimates in Table 29 using red text to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** All of the prototypes are significantly less effective than the current system at increasing the protective response at the watch level. Prototypes 1, 3, and 4 are more effective at the advisory level.
- **Likelihood of Monitoring.** All of the prototypes are significantly less effective than the current system at increasing monitoring at the watch level. Prototype 2 is more effective at the advisory level and Prototype 4 is more effective at the warning level.
- **Likelihood of Preparing.** All of the prototypes are significantly less effective than the current system at increasing preparation at the watch level. Prototype 1 is more effective at the advisory level.
- **Likelihood of Acting.** All of the prototypes are significantly less effective than the current system at increasing action at the watch level. Prototypes 1 – 3 are more effective at the advisory level.

Overall, the prototypes are less effective at the watch level compared to the current system. Prototype 1 is more effective at the advisory level and to a lesser degree the other three prototypes.

**Table 29. Estimated Odds Ratios for Advisory Upgrade Scenario: Thunderstorms**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.563*** (-3.22)	0.592*** (-2.83)	0.578*** (-3.17)	0.623*** (-2.86)
Prototype 2	0.632*** (-2.66)	0.710* (-1.84)	0.554*** (-3.31)	0.737* (-1.81)
Prototype 3	0.462*** (-4.51)	0.495*** (-3.92)	0.428*** (-4.81)	0.484*** (-4.25)
Prototype 4	0.498*** (-4.10)	0.566*** (-3.21)	0.441*** (-4.64)	0.418*** (-5.39)
<b>Prompt 3: Advisory</b>				
Prototype 1	1.562*** (2.82)	1.347 (1.64)	1.853*** (3.70)	1.991*** (4.15)
Prototype 2	1.241 (1.24)	1.436* (1.89)	1.244 (1.23)	1.348* (1.69)
Prototype 3	1.459** (2.26)	1.142 (0.76)	1.189 (1.03)	1.552*** (2.68)
Prototype 4	1.415** (1.97)	1.026 (0.15)	1.123 (0.70)	1.196 (1.03)
<b>Prompt 4: Warning</b>				
Prototype 1	0.873 (-0.79)	0.908 (-0.49)	0.799 (-1.26)	0.828 (-1.04)
Prototype 2	0.864 (-0.86)	1.113 (0.53)	0.866 (-0.78)	0.939 (-0.34)
Prototype 3	0.956 (-0.28)	1.169 (0.78)	0.993 (-0.04)	1.018 (0.10)
Prototype 4	1.184 (0.95)	1.745*** (2.59)	1.094 (0.47)	0.934 (-0.36)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

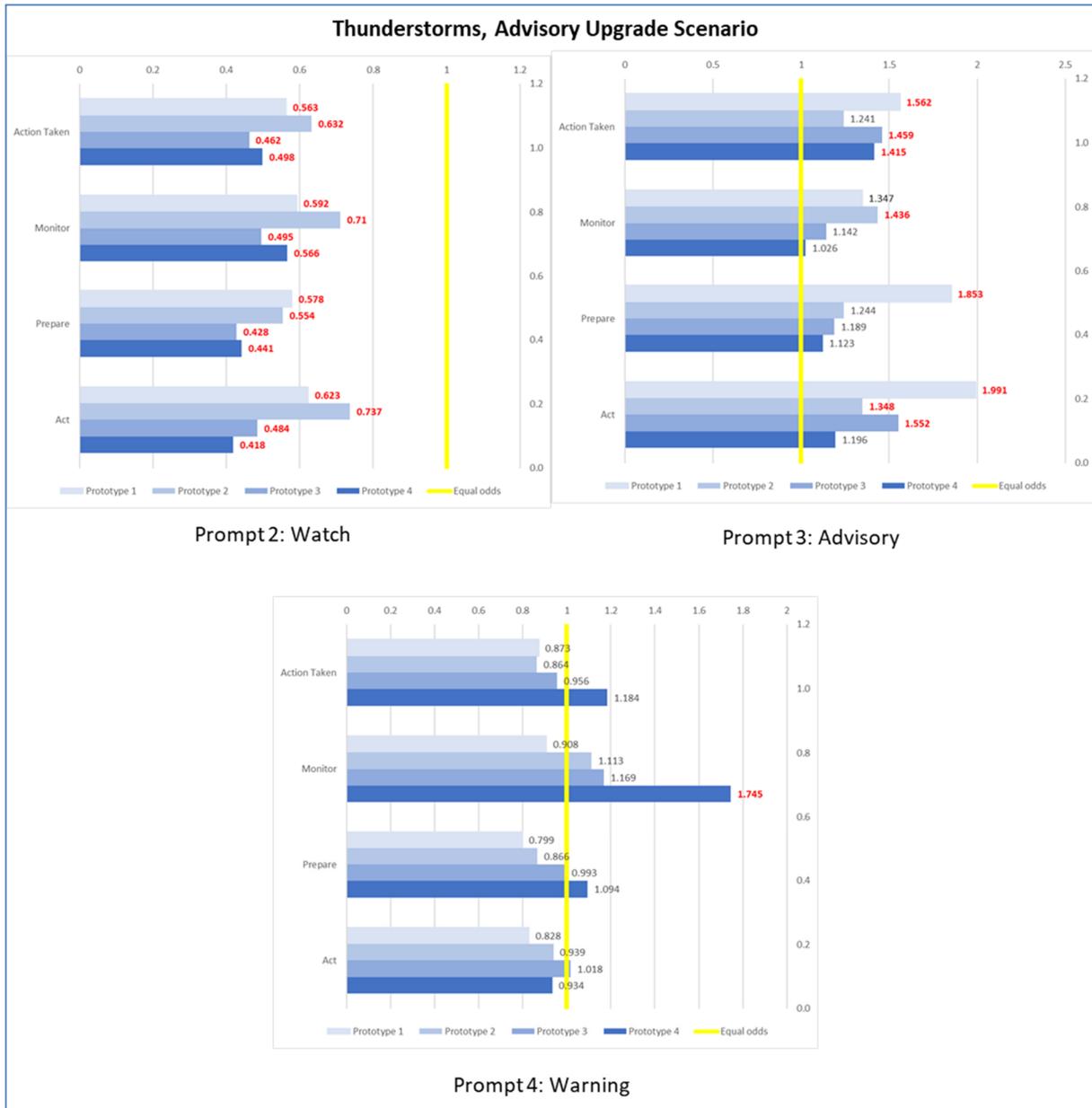


Figure 13. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: Thunderstorms Survey

## 7.4 Summary and Conclusions

Table 30 presents the percentage of estimates for each Prototype that were significantly greater or significantly less than 1.0. The table excludes the odds ratios from the warning with an upgrade scenario since those estimations did not compare to the current system. These tabulations indicate that, overall, the current system tended to outperform the prototypes.

**Table 30. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Thunderstorms Survey**

Prototype	All Estimates	
	> 1.0	< 1.0
Prototype 1	17%	46%
Prototype 2	8%	46%
Prototype 3	8%	33%
Prototype 4	8%	33%
Total Number of Estimates [a]	24	

Note: The odds ratio included in these calculations exclude those from the warning with an upgrade scenario since those estimates did not use the current system as a comparison point.

[a] This is the total for each prototype.

Table 31 expands the summary in Table 30 breaking the percentage out by prompt level. Here we see that most of the underperformance by the prototypes occurred at the watch level where two-thirds of all estimates for each prototype were significantly less than 1.0. Prototypes 1 and 2 were also less protective than the warning level and Prototype 1 was less protective at the emergency level. At the advisory level, however, all of the prototypes, and Prototype 1 in particular, outperformed the current system.

**Table 31. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Thunderstorms Survey**

Prototype	Watch		Advisory		Warning	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	100%	50%	0%	0%	38%
Prototype 2	0%	100%	25%	0%	0%	38%
Prototype 3	0%	100%	25%	0%	0%	0%
Prototype 4	0%	100%	13%	0%	13%	0%
Total Number of Estimates [a]	8		8		8	

Note: The odds ratio included in these calculations exclude those from the warning with an upgrade scenario since those estimates did not use the current system as a comparison point.

[a] This is the total for each prototype.

Table 32 breaks out the percentages by the protective response variable used. These results indicate that the current system tended to outperform the prototypes across all the protective response variables.

**Table 32. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Thunderstorms Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	33%	50%	0%	33%	17%	50%	17%	50%
Prototype 2	0%	50%	17%	33%	0%	50%	17%	50%
Prototype 3	17%	33%	0%	33%	0%	33%	17%	33%
Prototype 4	17%	33%	17%	33%	0%	33%	0%	33%
Total Number of Estimates [a]	6		6		6		6	

Note: The odds ratio included in these calculations exclude those from the warning with an upgrade scenario since those estimates did not use the current system as a comparison point.

[a] This is the total for each prototype.

Appendix B provides a cross-tabulation of the information in Table 31 and Table 32.

Based on these summaries and the analyses in this section, some overall conclusions can be drawn.

- Overall, the current system seemed to outperform the prototypes this was especially true at the watch level.
- At the advisory level, the prototypes appear to be more protective.

## 8.0 Tornadoes

This section discusses the results from the tornadoes survey. NWS and ERG identified a set of states that were more prone to tornado activity as a basis for this sample used (see text box).

**States:** AL, AR, GA, IA, IL, IN, KS, KY, LA, MO, MN, MS, NC, NE, OK, SC, TN, TX

**Respondents:** 700

**Collection time frame:** 2/20/18 – 2/22/18

### 8.1 Basic Demographics

Figure 14 provides a summary of the number of respondents selected from each state. Texas and Alabama each had 77 respondents and Oklahoma had 76; as discussed in Section 3.1, the number of responses from states were limited to ensure no one state dominated a survey. Table 33 summarizes the basic demographics for the sample. Notably, the sample skewed slightly towards women.

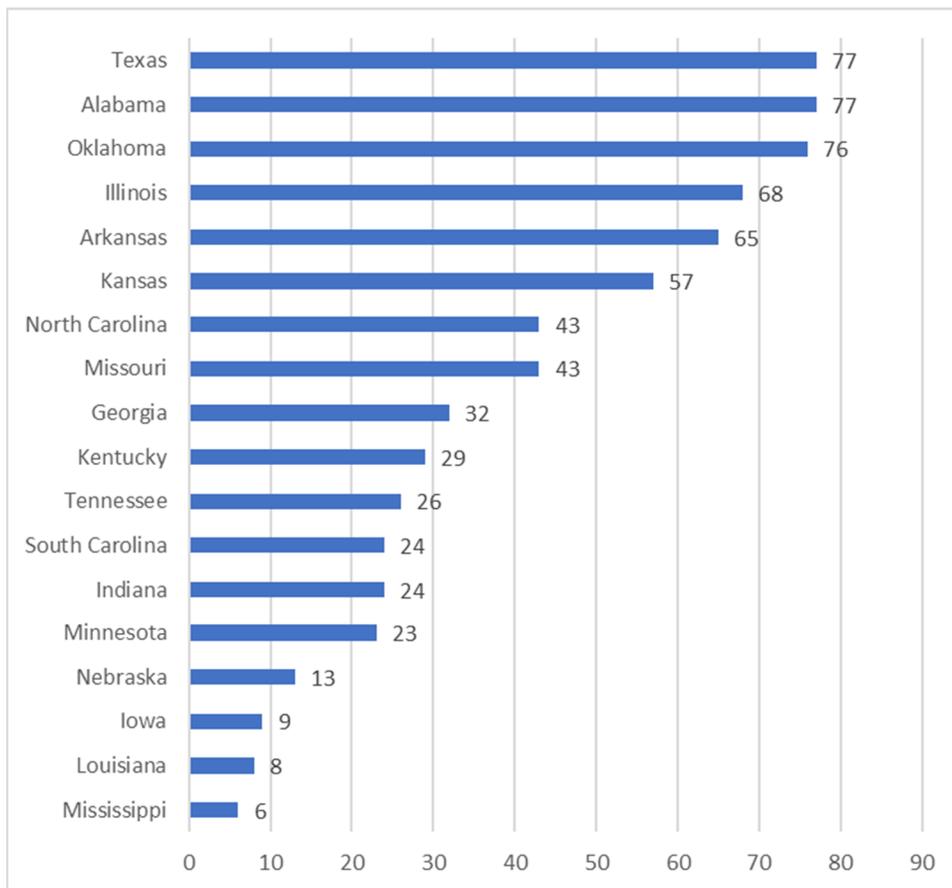


Figure 14. Numbers of Respondents from States Included in the Tornadoes Survey

**Table 33. Basic Demographics for Tornadoes Survey**

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
<b>Age</b>		<b>Race</b>	
20-24	7.3%	White	85.3%
25-34	23.9%	Black/African-American	7.9%
35-44	19.4%	Asian	3.0%
45-54	16.3%	Other	3.9%
55-64	19.6%	<b>Income</b>	
65+	13.6%	Less than \$24,999	23.0%
<b>Gender</b>		\$25,000 - \$49,999	31.3%
Female	59.3%	\$50,000 - \$99,999	31.9%
Male	40.7%	\$100,000 - \$199,999	12.3%
<b>Education</b>		More than \$200,000	1.6%
Less than college degree	56.6%	<b>Home Location</b>	
College degree	27.4%	Urban	20.0%
Post-undergraduate work/degree	16.0%	Suburban	48.6%
<b>Hispanic origin</b>		Rural	31.4%
Yes	8.3%		
No	91.7%	<b>Average number of adults in home</b>	<b>2.14</b>
		<b>Average number of children in home</b>	<b>0.70</b>

## 8.2 Current Knowledge

Table 34 provides a summary of the responses to the current knowledge questions. This survey used the second version of the current knowledge question described in Section 2.4; we provided respondents with a definition and asked them to select from terms that fit the definition. The current knowledge questions acted as a “test” of respondents understanding of the current system and each had a “correct” response. The correct responses for each row appear in orange shading in the table. The results for the three terms were:

- Tornado Watch – 67.3 percent correctly selected the right term for the definition provided.
- Tornado Warning - 70.6 percent correctly selected the right term
- Tornado Emergency – Only 28.9 percent selected the correct term for the definition; 61.3 percent interpreted the definition as a Tornado Warning.

Thus, there appears to be good understanding of the Watch and Warning terms, but the Emergency wording is interpreted as a Warning.

**Table 34. Tornadoes Current Knowledge**

Definition Used in Question	Number Who Answered Question	Response Options		
		Tornado Watch	Tornado Warning	Tornado Emergency
When there is the possibility of tornadoes	251	67.3%	27.5%	5.2%
When a tornado has been spotted or indicated on weather radar	214	23.8%	70.6%	5.6%
When a confirmed, life-threatening tornado capable of causing catastrophic damage has been spotted or observed on weather radar	235	9.8%	61.3%	28.9%

### 8.3 Prototypes Analyses

This section presents the results of the ordered logistic regression analyses we performed on the prototype testing. The methods are discussed in Section 4.0. We analyzed the data from four questions in the survey:

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included<sup>25</sup> (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a description of what each type of action meant.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecasts given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

The goal of the analyses was to determine whether those who saw specific prototypes were more or less likely to take more protective actions compared to the current system using those four questions to measure protective responses. As noted in Section 4.0, the analyses result in the estimation of odds ratios that indicate the degree to which the four new prototypes outperformed the current system. An odds ratio of 1.0 indicates that a prototype is just as protective as the current system, odds ratios below

<sup>25</sup> Given the nature of the hazard, flash flooding excluded the “prepare” option.

1.0 indicate the prototype is less protective, and odds ratios above 1.0 indicate the prototype is more protective. By design, odds ratios cannot be below zero.

The tornadoes survey included only one scenario: warning with an upgrade. Additionally, there was no advisory level prompt tested as part of the survey. We present odds ratios for each prompt within each scenario (see Section 2.2). We organize the results by the protective response variables listed above. The specific prototypes tested for the tornadoes survey appear in Table 35.<sup>26</sup>

**Table 35. Specific Prototype Language Tested for Tornadoes Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	Tornado Watch	Tornado Outlook	Tornado Notice	Possible Tornado Event	Possible Tornado Conditions
Warning level	Tornado Warning	Tornado Warning	Tornado Warning	Tornado Warning	Level Red Tornado Warning
Emergency level	Tornado Emergency	Tornado Warning	Tornado Emergency	Extreme Tornado Warning	Level Purple Tornado Warning

After the baseline prompt, the warning with an upgrade scenario started with a watch-level prompt, and then moved to warning followed by an emergency. Table 36 presents the estimated odds ratios for the warning upgrade scenario; in the table, the “\*” symbol is used to depict levels of statistical significance. Figure 15 provides a graphical depiction of the estimates in Table 36 using red text to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** Prototype 1 was significantly less protective than the current system at all levels. Prototypes 2 and 3 were more effective at the watch and warning levels and Prototype 4 was also more effective at the warning level. At the emergency level, the prototypes appear to be the same or less protective than the current system (with on Prototype 1 being significantly less).
- **Likelihood of Monitoring.** There were no notable differences in monitoring between the prototype and the current system.
- **Likelihood of Preparing.** Prototypes 1 and 4 are less effective at increasing preparation at the watch level and Prototype 1 is again less effective at the emergency level.
- **Likelihood of Acting.** Prototype 1 is less effective at increasing action at both the watch and emergency level.

Overall, it appears that the Prototype 1 was less effective than the current system and that were less effective at the watch level. There are some cases where the prototypes are more effective, but the results are not consistent. The current system seemed to outperform the prototypes at the emergency level.

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<sup>26</sup> These are the same ones tested for the winter weather mild regions survey. The snow amounts for each term differed between the two surveys.

**Table 36. Estimated Odds Ratios for Warning Upgrade Scenario: Tornadoes**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.673** (-2.37)	0.793 (-1.26)	0.564*** (-3.75)	0.610*** (-3.34)
Prototype 2	1.368* (1.86)	1.005 (0.03)	1.013 (0.08)	1.083 (0.51)
Prototype 3	1.555*** (2.77)	0.995 (-0.03)	1.187 (1.15)	1.222 (1.28)
Prototype 4	0.899 (-0.71)	0.828 (-1.08)	0.787* (-1.66)	0.882 (-0.87)
<b>Prompt 3: Warning</b>				
Prototype 1	0.689** (-2.31)	0.715 (-1.47)	0.879 (-0.77)	0.901 (-0.61)
Prototype 2	0.930 (-0.46)	0.769 (-1.14)	0.934 (-0.45)	1.048 (0.29)
Prototype 3	1.167 (0.98)	0.837 (-0.82)	1.020 (0.13)	1.188 (1.07)
Prototype 4	1.310* (1.67)	1.044 (0.18)	1.198 (1.06)	1.300 (1.54)
<b>Prompt 4: Emergency</b>				
Prototype 1	0.401*** (-4.84)	0.713 (-1.46)	0.718** (-2.01)	0.596*** (-2.68)
Prototype 2	0.809 (-1.04)	1.061 (0.25)	1.046 (0.27)	1.201 (0.93)
Prototype 3	1.008 (0.04)	1.060 (0.25)	1.046 (0.26)	1.157 (0.71)
Prototype 4	0.731 (-1.58)	0.881 (-0.54)	0.965 (-0.21)	0.841 (-0.91)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

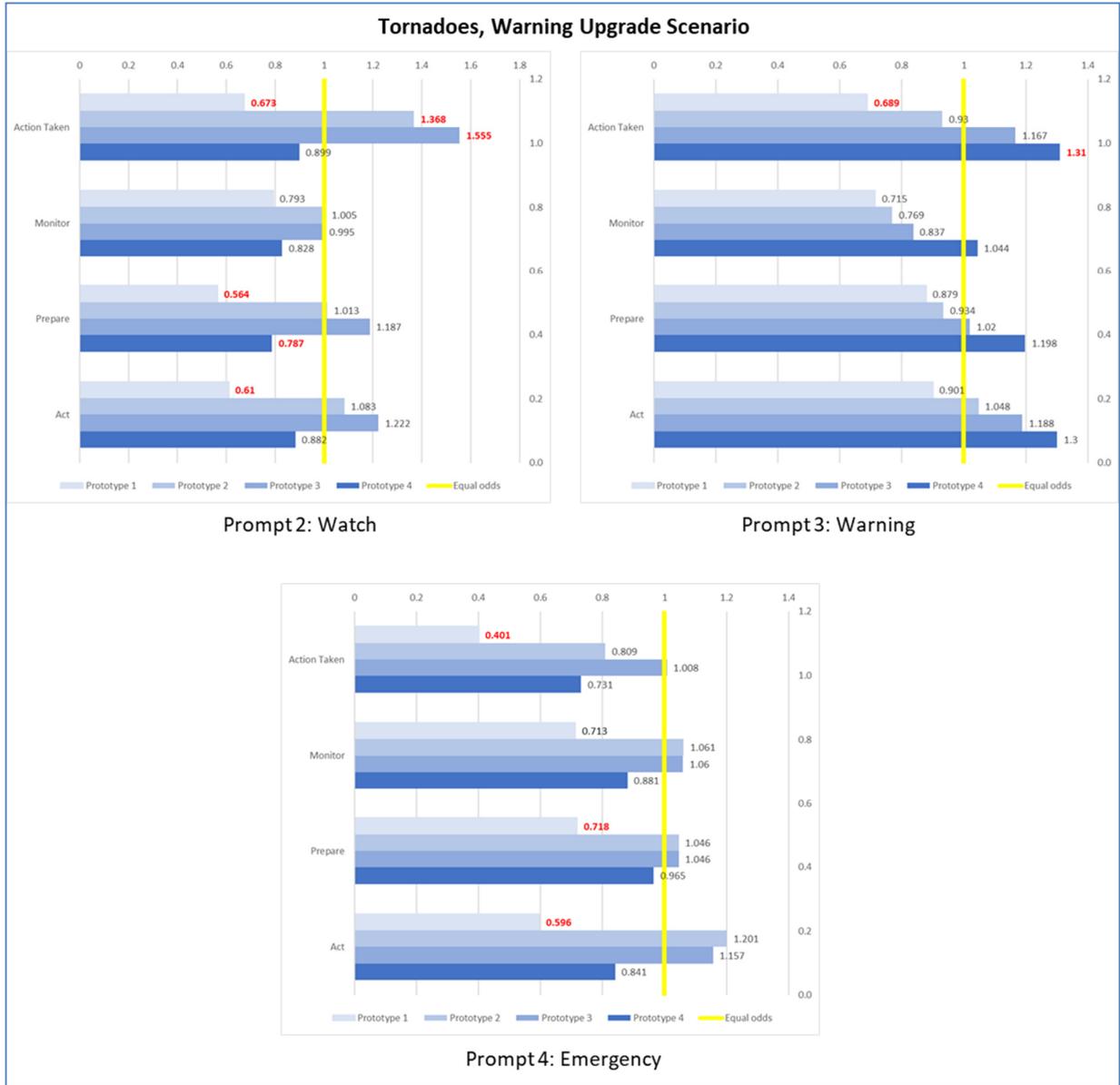


Figure 15. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Tornadoes Survey

## 8.4 Summary and Conclusions

Table 37 presents the percentage of estimates for each prototype that were significantly greater or significantly less than 1.0. These tabulations indicate that Prototype 1 was generally outperformed by the current system and the Prototype 2 and 3 were slightly better than the current system.

**Table 37. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Tornadoes Survey**

Prototype	All Estimates	
	> 1.0	< 1.0
Prototype 1	0%	58%
Prototype 2	8%	0%
Prototype 3	8%	0%
Prototype 4	8%	8%
Total Number of Estimates [a]	12	

[a] This is the total for each prototype.

Table 38 expands the summary in Table 37 breaking the percentage out by prompt level. These tabulations indicate that Prototype 1 was outperformed at all prompts levels, especially at the watch and emergency level. Additionally, when Prototypes 2 and 3 outperformed the current system it was at the watch level and when Prototype 4 outperformed the current system it was at the warning level.

**Table 38. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Tornadoes Survey**

Prototype	Watch		Warning		Emergency	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	75%	0%	25%	0%	75%
Prototype 2	25%	0%	0%	0%	0%	0%
Prototype 3	25%	0%	0%	0%	0%	0%
Prototype 4	0%	25%	25%	0%	0%	0%
Total Number of Estimates [a]	4		4		4	

[a] This is the total for each prototype.

Table 39 breaks out the percentages by the protective response variable used. These tabulations indicate that the prototypes and current system generated similar response in terms of monitoring. Prototype 1's underperformance occurred in terms of increasing the protection action selected (action taken), increasing preparation, and increasing the likelihood of action.

**Table 39. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Tornadoes Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	100%	0%	0%	0%	67%	0%	67%
Prototype 2	33%	0%	0%	0%	0%	0%	0%	0%
Prototype 3	33%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	33%	0%	0%	0%	0%	33%	0%	0%
Total Number of Estimates [a]	3		3		3		3	

[a] This is the total for each prototype.

Appendix B provides a cross-tabulation of the information in Table 38 and Table 39.

Based on these summaries and the analyses in this section, some overall conclusions can be drawn.

- Prototype 1 was outperformed by the current system.
- Prototypes 2 and 3 may be the more effective than the current system at the watch level, but the results are weak in that regards.
- The current system and the prototypes perform similarly in increasing monitoring.

## 9.0 Coastal Flooding

This section discusses the results from the coastal flooding survey. NWS and ERG determined that people living within 10 miles of the coast along the Atlantic Ocean and Gulf of Mexico would be in-scope for this survey.

### 9.1 Basic Demographics

Figure 16 provides a summary of the number of respondents selected from each state. Five states (New York, New Jersey, Massachusetts, Florida, and Connecticut) each had 59 respondents and two states (Texas and North Carolina) had 56 each. As discussed in Section 3.1, the number of responses from states were limited to ensure no one state dominated a survey.

**States:** ME, NH, MA, RI, CT, NY, NJ, MD, DE, VA, NC, SC, GA, FL, AL, MS, LA, TX  
(Note: only respondents within 10 miles of the coast were considered in-scope)

**Respondents:** 690

**Collection time frame:** 3/2/18 – 3/12/18

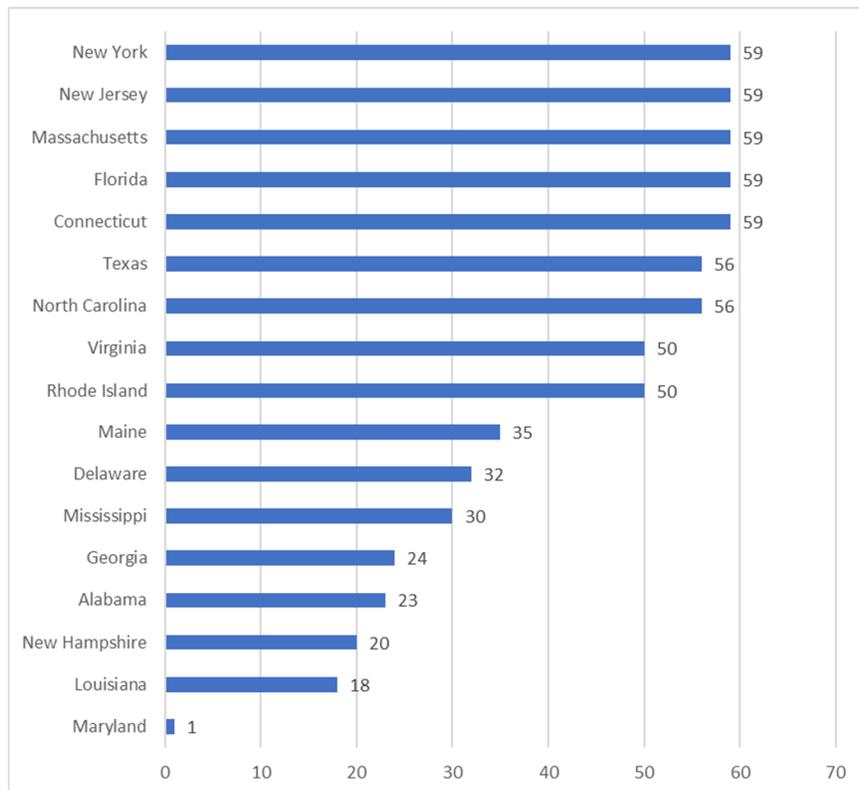


Figure 16. Numbers of Respondents from States Included in the Coastal Flooding Survey

Table 40 summarizes the basic demographics for the sample. Notably, the sample skewed slightly towards older residents with more than 50 percent of sample in 55 and older age groups. The sample was also slightly skewed toward women but was more evenly distributed across education ranges compared to the other surveys.

**Table 40. Basic Demographics for Coastal Flooding Survey**

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
<b>Age</b>		<b>Race</b>	
20-24	4.6%	White	86.4%
25-34	14.1%	Black/African-American	7.8%
35-44	14.1%	Asian	3.5%
45-54	14.1%	Other	2.3%
55-64	21.3%	<b>Income</b>	
65+	31.9%	Less than \$24,999	12.6%
<b>Gender</b>		\$25,000 - \$49,999	18.8%
Female	61.9%	\$50,000 - \$99,999	38.0%
Male	38.1%	\$100,000 - \$199,999	24.6%
<b>Education</b>		More than \$200,000	5.9%
Less than college degree	38.8%	<b>Home Location</b>	
College degree	31.2%	Urban	24.4%
Post-undergraduate work/degree	30.0%	Suburban	59.4%
<b>Hispanic origin</b>		Rural	16.2%
Yes	7.7%		
No	92.3%	<b>Average number of adults in home</b>	<b>2.23</b>
		<b>Average number of children in home</b>	<b>0.32</b>

## 9.2 Current Knowledge

Table 34 provides a summary of the responses to the current knowledge questions. This survey used the second version of the current knowledge question described in Section 2.4; we provided respondents with a definition and asked them to select from terms that fit the definition. The current knowledge questions acted as a “test” of respondents understanding of the current system and each had a “correct” response. The correct responses for each row appear in orange shading in the table. The results for the three terms were:

- Coastal Flood Watch – 41.6 percent correctly selected the right term which represented a plurality, but another 39.8 percent selected the term Coastal Flood Advisory.
- Coastal Flood Advisory – 44.4 percent correctly selected the right term which represented a plurality, but another 39 percent selected the term Coastal Flood Watch.
- Coastal Flood Warning – 55.6 percent selected the correct term.

Thus, there appears to be some confusion between the Advisory and the Watch terms.

**Table 41. Coastal Flooding Current Knowledge**

Definition Used in Question	Number Who Answered Question	Response Options		
		Coastal Flood Watch	Coastal Flood Advisory	Coastal Flood Warning
When there is the possibility for coastal flooding in the next 36 hours	226	41.6%	39.8%	18.6%
When coastal flooding with limited impacts occurring	241	39.0%	44.4%	16.6%
When coastal flooding is likely to impact buildings and/or roads	223	16.1%	28.3%	55.6%

### 9.3 Prototypes Analyses

This section presents the results of the ordered logistic regression analyses we performed on the prototype testing. The methods are discussed in Section 4.0. We analyzed the data from four questions in the survey:

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included<sup>27</sup> (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a description of what each type of action meant.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecasts given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

The goal of the analyses was to determine whether those who saw specific prototypes were more or less likely to take more protective actions compared to the current system using those four questions to measure protective responses. As noted in Section 4.0, the analyses result in the estimation of odds ratios that indicate the degree to which the four new prototypes outperformed the current system. An odds ratio of 1.0 indicates that a prototype is just as protective as the current system, odds ratios below

<sup>27</sup> Given the nature of the hazard, flash flooding excluded the “prepare” option.

1.0 indicate the prototype is less protective, and odds ratios above 1.0 indicate the prototype is more protective. By design, odds ratios cannot be below zero.

We present the results for two scenarios for this survey:

- Emergency with a downgrade
- Advisory with an upgrade

We present odds ratios for each prompt within each scenario (see Section 2.2). For each scenario, we organize the results by the protective response variables listed above. The specific prototypes tested for the coastal flooding survey appear in Table 42.<sup>28</sup>

**Table 42. Specific Prototype Language Tested for Coastal Flooding Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
<b>Watch level</b>	Coastal Flood Watch	Flood Outlook	Flood Notice	Possible Flood Event	Possible Flood Conditions
<b>Advisory level</b>	Coastal Flood Advisory	Flood Warning	Flood Alert	Minor Flood Warning	Level Orange Flood Warning
<b>Warning level</b>	Coastal Flood Warning	Flood Warning	Flood Warning	Moderate Flood Warning	Level Red Flood Warning
<b>Emergency level</b>	Coastal Flood Warning	Flood Warning	Flood Emergency	Extreme Flood Warning	Level Purple Flood Warning

### 9.3.1 Emergency with a Downgrade Scenario

After the baseline prompt, the emergency with a downgrade scenario started with a watch-level prompt, and then moved to an emergency warning followed by a downgrade to an advisory. Table 43 presents the estimated odds ratios for the warning downgrade scenario; in the table, the “\*” symbol is used to depict levels of statistical significance. Figure 17 provides a graphical depiction of the estimates in Table 43 and using red text to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** Prototype 1 was resulted in less protective response actions at the watch level compared to the current system. At the emergency level, Prototypes 2 – 4 resulted in more protective responses. Finally, at the advisory level, Prototype 3 was less effective and Prototype 4 was more effective.
- **Likelihood of Monitoring.** At the emergency level, Prototype 2-4 were more effective at increasing monitoring compared to the current system; At the advisory level, Prototypes 2 and 4 were more effective.

<sup>28</sup> These are the same ones tested for the winter weather mild regions survey. The snow amounts for each term differed between the two surveys.

- **Likelihood of Preparing.** Prototype 2 was more effective at the watch level and Prototype 3 was less effective at the advisory level compared to the current system. All four prototypes resulted in significantly more preparation at the emergency level.
- **Likelihood of Acting.** Prototype 2 was more effective at increasing action the watch level and Prototype 3 was less effective at increasing action at the advisory level compared to the current system. Prototypes 2-4 were significantly more effective at increase action at the emergency level.

Overall, Prototype 3 appears to be less effective at the advisory level while all of the prototypes appear to be more protective at the emergency level.

**Table 43. Estimated Odds Ratios for Emergency Downgrade Scenario: Coastal Flooding**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.632* (-1.85)	0.781 (-0.89)	0.866 (-0.60)	0.920 (-0.31)
Prototype 2	1.010 (0.04)	1.104 (0.39)	1.576** (1.98)	1.921*** (2.80)
Prototype 3	0.897 (-0.49)	0.982 (-0.07)	1.158 (0.68)	1.482 (1.57)
Prototype 4	0.825 (-0.81)	1.034 (0.14)	0.830 (-0.81)	1.039 (0.16)
<b>Prompt 3: Emergency</b>				
Prototype 1	1.205 (0.94)	1.327 (0.91)	1.536* (1.79)	1.018 (0.08)
Prototype 2	2.769*** (4.84)	2.344*** (2.87)	2.330*** (3.58)	2.692*** (4.36)
Prototype 3	1.808*** (2.88)	1.936** (2.06)	2.191*** (3.24)	1.473* (1.80)
Prototype 4	2.352*** (3.58)	1.819* (1.93)	1.497* (1.66)	2.143*** (3.16)
<b>Prompt 4: Advisory</b>				
Prototype 1	0.801 (-0.98)	1.321 (0.95)	1.257 (0.89)	1.091 (0.38)
Prototype 2	0.861 (-0.71)	1.682* (1.80)	1.117 (0.49)	0.958 (-0.20)
Prototype 3	0.401*** (-4.38)	0.878 (-0.49)	0.577** (-2.35)	0.414*** (-4.13)
Prototype 4	1.558* (1.87)	1.910** (2.24)	1.220 (0.79)	1.429 (1.52)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

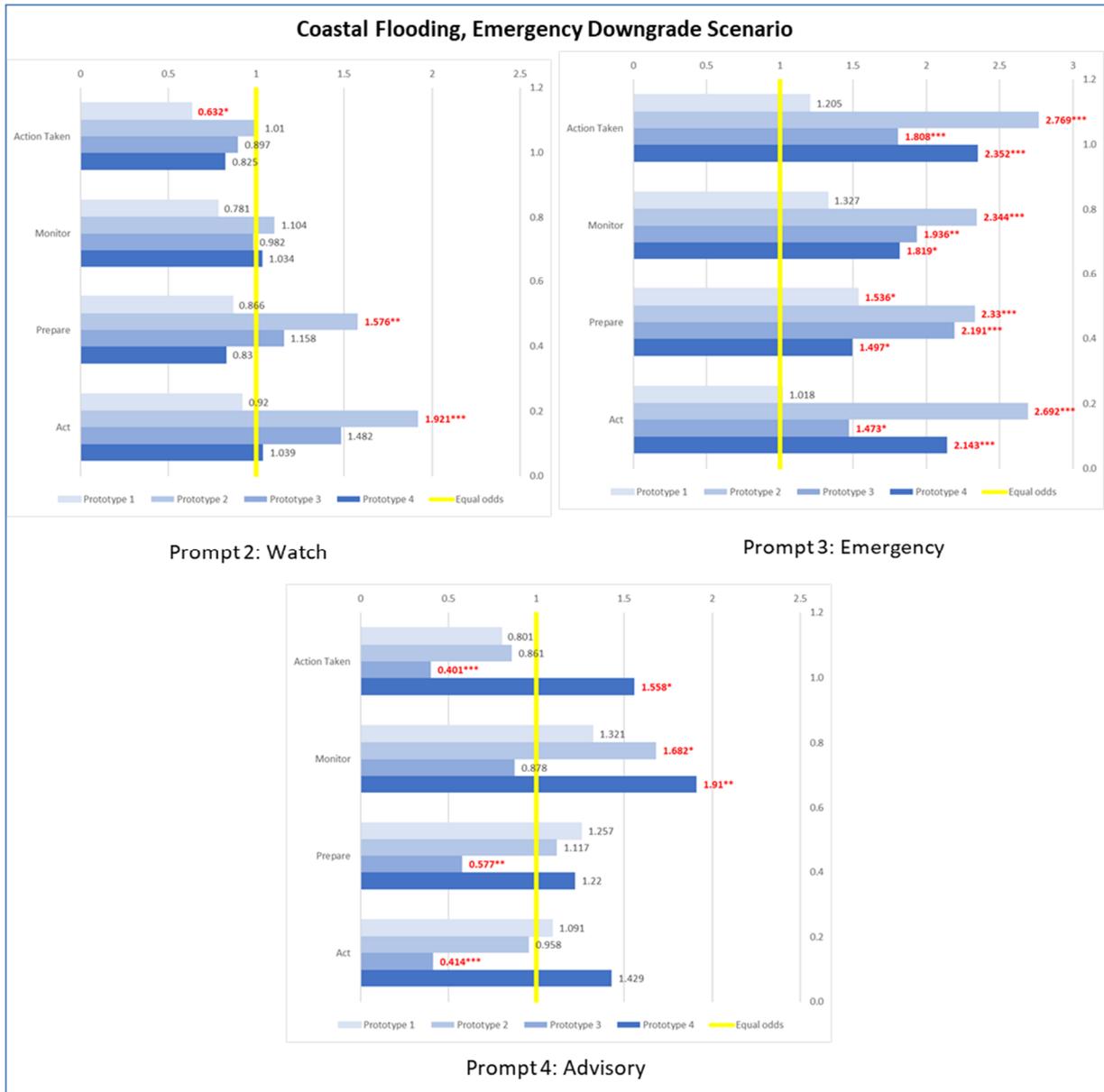


Figure 17. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Coastal Flooding Survey

### 9.3.2 Advisory with an Upgrade Scenario

After the baseline prompt, the advisory with an upgrade scenario started with a watch-level prompt, and then moved to an advisory followed by a warning. Table 44 presents the estimated odds ratios for the advisory upgrade scenario; in the figure, the “\*” symbol is used to depict levels of statistical significance. Figure 18 provides a graphical depiction of the estimates in Table 44 using red text to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** Prototypes 1 and 4 were significantly less protective than the current system at the watch level. At the advisory level, Prototypes 1, 2, and 4 were significantly more protective, but Prototype 3 was significantly less protective. At the warning level, Prototypes 2 – 4 were significantly more protective.
- **Likelihood of Monitoring.** Prototype 3 was found to be less effective than the current system at increasing monitoring at the advisory level but was much more effective (odds ration greater than 2.3) than the current system, at the warning level. Prototype 4 was found to be more effective than the current system at the advisory level.
- **Likelihood of Preparing.** At the watch level, Prototype 1 was less effective than the current system at increasing preparation, but Prototype 2 was more effective. At the advisory level, Prototypes 1, 2, and 4 were more effective than the current system, but Prototype 3 was less effective.
- **Likelihood of Acting.** Prototypes 2 and 4 were found to be more effective than the current system, at increasing the likelihood of acting at the advisory and warning levels. Prototype 2 was also more effective at the watch level. Prototype 3, however, was found to be more effective at the warning level, but less effective at the advisory level.

Overall, the prototypes are more effective at the advisory level compared to the current system, except for Prototype 3. Prototypes 2 and 4 are consistently more effective at the advisory and warning levels.

**Table 44. Estimated Odds Ratios for Advisory Upgrade Scenario: Coastal Flooding**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.646* (-1.69)	0.771 (-0.92)	0.631** (-2.08)	0.771 (-1.04)
Prototype 2	1.098 (0.40)	0.932 (-0.27)	1.637** (2.00)	1.623* (1.94)
Prototype 3	0.729 (-1.38)	1.148 (0.49)	0.943 (-0.27)	0.839 (-0.78)
Prototype 4	0.505*** (-2.87)	1.095 (0.32)	0.933 (-0.32)	0.837 (-0.81)
<b>Prompt 3: Advisory</b>				
Prototype 1	1.934*** (2.74)	1.109 (0.41)	1.607** (2.21)	1.323 (1.32)
Prototype 2	1.842** (2.55)	0.977 (-0.09)	1.535* (1.85)	2.001*** (3.10)
Prototype 3	0.680* (-1.69)	0.510*** (-2.63)	0.581** (-2.25)	0.507*** (-2.78)
Prototype 4	1.907*** (2.78)	1.614* (1.71)	1.676** (2.21)	1.681** (2.44)
<b>Prompt 4: Warning</b>				
Prototype 1	1.153 (0.65)	0.971 (-0.11)	0.764 (-1.14)	1.107 (0.46)
Prototype 2	1.971*** (2.85)	1.316 (0.93)	1.077 (0.27)	2.211*** (2.96)
Prototype 3	1.767*** (2.60)	2.348** (2.19)	1.503 (1.52)	1.821** (2.41)
Prototype 4	1.860*** (2.58)	1.436 (1.12)	1.140 (0.49)	1.628** (2.02)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

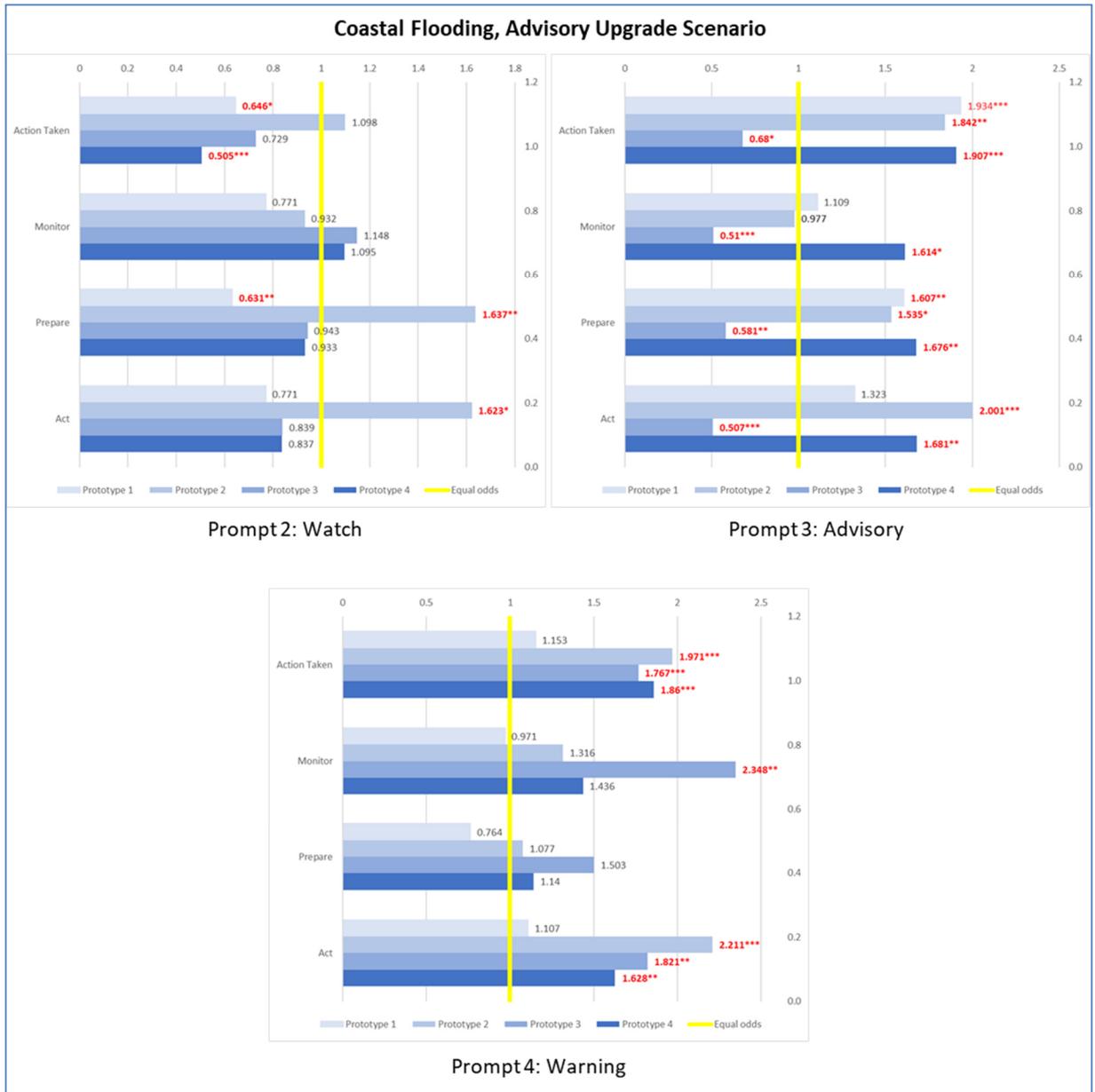


Figure 18. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: Coastal Flooding Survey

## 9.4 Summary and Conclusions

Table 45 presents the percentage of estimates for each prototype that were significantly greater or significantly less than 1.0. These tabulations indicate that Prototypes 2 and 4 strongly outperformed the current system overall.

**Table 45. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Coastal Flooding Survey**

Prototype	All Estimates	
	> 1.0	< 1.0
Prototype 1	13%	13%
Prototype 2	58%	0%
Prototype 3	29%	29%
Prototype 4	50%	4%
Total Number of Estimates [a]	24	

[a] This is the total for each prototype.

Table 46 expands the summary in Table 45 breaking the percentage out by prompt level. Here we see that Prototype 2's estimates that significantly exceeded 1.0 at all prompt levels, especially at the emergency level. Prototype 4's significant estimates were at the advisory, warning, and emergency levels and Prototype 4 was outperformed by the current system at the watch level.

**Table 46. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Coastal Flooding Survey**

Prototype	Watch		Advisory		Warning		Emergency	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	38%	50%	0%	0%	0%	25%	0%
Prototype 2	50%	0%	75%	0%	38%	0%	100%	0%
Prototype 3	0%	0%	0%	100%	38%	38%	100%	0%
Prototype 4	0%	13%	100%	0%	50%	0%	100%	0%
Total Number of Estimates [a]	8		4		8		4	

[a] This is the total for each prototype.

Table 47 breaks out the percentages by the protective response variable used. These data show that both Prototype 2's and Prototype 4's significant estimates were across the four protective response variables.

**Table 47. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Coastal Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	17%	33%	0%	0%	33%	17%	0%	0%
Prototype 2	50%	0%	33%	0%	67%	0%	83%	0%
Prototype 3	33%	33%	33%	17%	17%	33%	33%	33%
Prototype 4	67%	17%	50%	0%	33%	0%	50%	0%
Total Number of Estimates [a]	6		6		6		6	

[a] This is the total for each prototype.

Appendix B provides a cross-tabulation of the information in Table 46 and Table 47.

Based on these summaries and the analyses in this section, some overall conclusions can be drawn.

- Overall, the prototypes outperformed the current system at the emergency level.
- Prototypes 2 and 4 showed the most significant results compared to the current system with Prototype 2's results being seen across all prompt levels and response variables.

## 10.0 Flash Flooding

This section discusses the results from the flash flooding survey. NWS and ERG identified a set of states that were more prone to flash flood events as the basis for selecting a sample.

### 10.1 Basic Demographics

Figure 19 provides a summary of the number of respondents selected from each state. Seven states each had 59 respondents, one had 58, and one had 55. As discussed in Section 3.1, the number of responses from states were limited to ensure no one state dominated a survey.

**States:** TX, MS, AR, AL, TN, KY, MO, IA, IL, MI, IN, OH, PA, NY, NJ, CT, MA, NC, VA, MD, WV, WI

**Respondents:** 841

**Collection time frame:** 3/2/18 – 3/7/18

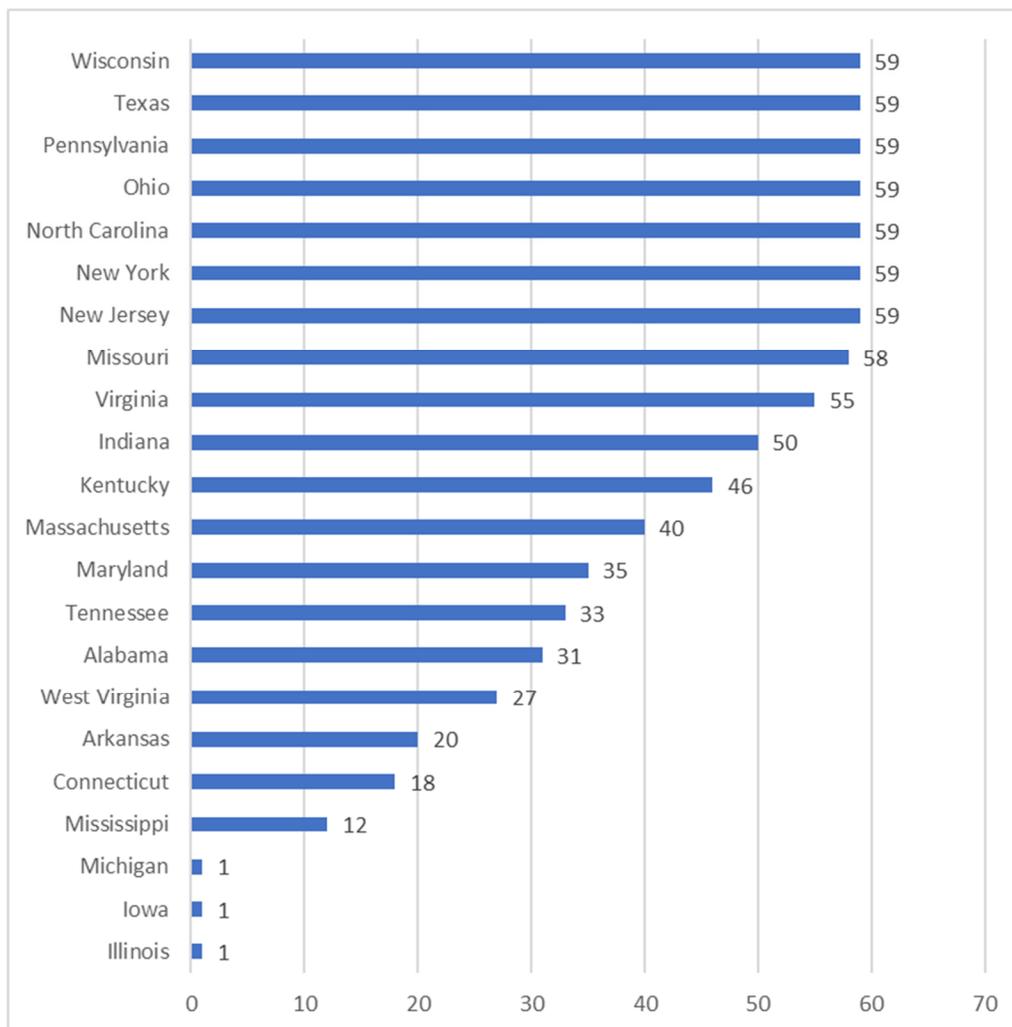


Figure 19. Numbers of Respondents from States Included in the Flash Flooding Survey

Table 48 summarizes the basic demographics for the sample. The sample was skewed toward women.

**Table 48. Basic Demographics for Flash Flooding Survey**

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
<b>Age</b>		<b>Race</b>	
20-24	3.1%	White	87.4%
25-34	18.0%	Black/African-American	7.3%
35-44	20.5%	Asian	3.8%
45-54	20.5%	Other	1.6%
55-64	20.6%	<b>Income</b>	
65+	17.5%	Less than \$24,999	16.9%
<b>Gender</b>		\$25,000 - \$49,999	27.1%
Female	64.9%	\$50,000 - \$99,999	38.3%
Male	35.1%	\$100,000 - \$199,999	15.3%
<b>Education</b>		More than \$200,000	2.4%
Less than college degree	50.3%	<b>Home Location</b>	
College degree	34.2%	Urban	15.9%
Post-undergraduate work/degree	15.5%	Suburban	52.4%
<b>Hispanic origin</b>		Rural	31.6%
Yes	3.9%		
No	96.1%	<b>Average number of adults in home</b>	<b>2.03</b>
		<b>Average number of children in home</b>	<b>0.59</b>

## 10.2 Current Knowledge

Table 49 provides a summary of the responses to the current knowledge questions. This survey used the second version of the current knowledge question described in Section 2.4; we provided respondents with a definition and asked them to select from terms that fit the definition. The current knowledge questions acted as a “test” of respondents understanding of the current system and each had a “correct” response. The correct responses for each row appear in orange shading in the table. The results for the three terms were:

- Flood Watch – 50 percent correctly selected the right term which represented a plurality, but another 45.7 percent selected the term Flash Flood Warning.
- Flash Flood Warning – 64.5 percent correctly selected the right term.
- Flash Flood Emergency – 62.2 percent selected the correct term.

**Table 49. Flash Flooding Current Knowledge**

Definition Used in Question	Number Who Answered Question	Response Options		
		Flood Watch	Flash Flood Warning	Flash Flood Emergency
When there is the possibility for flash flooding in the next 12 hours	276	50.0%	45.7%	4.4%
When flash flooding that could impact buildings and/or roads is occurring or expected shortly	279	19.7%	64.5%	15.8%
When life-threatening, catastrophic flash flooding is observed and causing significant impacts to buildings and/or roads	286	8.7%	29.0%	62.2%

### 10.3 Prototypes Analyses

This section presents the results of the ordered logistic regression analyses we performed on the prototype testing. The methods are discussed in Section 4.0. We analyzed the data from four questions in the survey:<sup>29</sup>

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included<sup>30</sup> (1) do nothing, (2) monitor, (3) take some action, or (4) take protective action. Each survey provided a description of what each type of action meant.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecasts given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of acting** – Respondents were asked how likely they were to take action and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of protective action** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

The goal of the analyses was to determine whether those who saw specific prototypes were more or less likely to take more protective actions compared to the current system using those four questions to measure protective responses. As noted in Section 4.0, the analyses result in the estimation of odds ratios that indicate the degree to which the four new prototypes outperformed the current system. An odds ratio of 1.0 indicates that a prototype is just as protective as the current system, odds ratios below 1.0 indicate the prototype is less protective, and odds ratios above 1.0 indicate the prototype is more protective. By design, odds ratios cannot be below zero.

<sup>29</sup> The flash flood survey did not use the “likelihood of preparing” question and instead used two action questions.

<sup>30</sup> Given the nature of the hazard, flash flooding excluded the “prepare” option.

We present the results for two scenarios for this survey:

- Emergency with a downgrade
- Warning with an upgrade

We present odds ratios for each prompt within each scenario (see Section 2.2). For each scenario, we organize the results by the protective response variables listed above. The specific prototypes tested for the coastal flooding survey appear in Table 50. Given the scenarios tested, there was not advisory level prompt for this survey.

**Table 50. Specific Prototype Language Tested for Flash Flooding Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
<b>Watch level</b>	Flood Watch	Flood Outlook	Flood Notice	Possible Flood Event	Possible Flood Conditions
<b>Warning level</b>	Flash Flood Warning	Flood Warning	Flood Warning	Moderate Flood Warning	Level Red Flood Warning
<b>Emergency level</b>	Flash Flood Emergency	Flood Warning	Flood Emergency	Extreme Flood Warning	Level Purple Flood Warning

### *10.3.1 Emergency with a Downgrade Scenario*

After the baseline prompt, the emergency with a downgrade scenario started with a watch-level prompt, and then moved to an emergency warning followed by a downgrade to an advisory. Table 43 presents the estimated odds ratios for the warning downgrade scenario; in the table, the “\*” symbol is used to depict levels of statistical significance. Figure 17 provides a graphical depiction of the estimates in Table 43 and using red text to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** Prototype 1 was significantly less effective at increasing the protective action selected at the emergency level compared to the current system, but more effective at the warning level. Prototype 3 was less effective at the warning level and Prototypes 1 and 4 were more effective at the warning level.
- **Likelihood of Monitoring.** Prototype 1 was less effective at increasing monitoring at the watch level and Prototype 3 was less effective at the warning level.
- **Likelihood of Acting.** Prototype 1 was less effective at increasing action at the emergency level and Prototype 3 was less effective at the warning level.
- **Likelihood of Taking Protective Action.** Prototype 1 was less effective at increasing the likelihood of taking protective action at the emergency level and Prototype 3 was less effective at the warning level. Prototype 2 was more effective at the watch level compared to the current system.

Overall, Prototype 1 appears to be less effective at the watch and emergency levels and Prototype 3 was less effective at the warning level.

**Table 51. Estimated Odds Ratios for Emergency Downgrade Scenario: Flash Flooding**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Acting	(4) Likelihood of Taking Protective Action
<b>Prompt 2: Watch</b>				
Prototype 1	0.715 (-1.57)	0.563** (-2.42)	0.716 (-1.60)	0.861 (-0.71)
Prototype 2	1.183 (0.77)	1.010 (0.04)	1.229 (0.95)	1.486* (1.81)
Prototype 3	1.080 (0.35)	1.112 (0.44)	0.978 (-0.11)	1.171 (0.71)
Prototype 4	1.069 (0.30)	1.000 (-0.00)	1.025 (0.10)	1.066 (0.28)
<b>Prompt 3: Emergency</b>				
Prototype 1	0.508*** (-3.03)	0.697 (-1.19)	0.684* (-1.70)	0.512*** (-2.84)
Prototype 2	1.163 (0.66)	1.049 (0.15)	1.005 (0.02)	1.246 (0.87)
Prototype 3	0.941 (-0.26)	1.130 (0.37)	0.970 (-0.13)	0.939 (-0.27)
Prototype 4	1.038 (0.15)	0.832 (-0.58)	0.968 (-0.13)	0.937 (-0.27)
<b>Prompt 4: Warning</b>				
Prototype 1	1.423* (1.72)	0.939 (-0.23)	0.991 (-0.04)	1.098 (0.45)
Prototype 2	1.305 (1.24)	0.947 (-0.20)	0.919 (-0.40)	0.884 (-0.56)
Prototype 3	0.462*** (-3.95)	0.588** (-2.05)	0.512*** (-3.25)	0.401*** (-4.57)
Prototype 4	1.785** (2.53)	1.412 (1.10)	1.229 (0.84)	1.659** (2.23)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

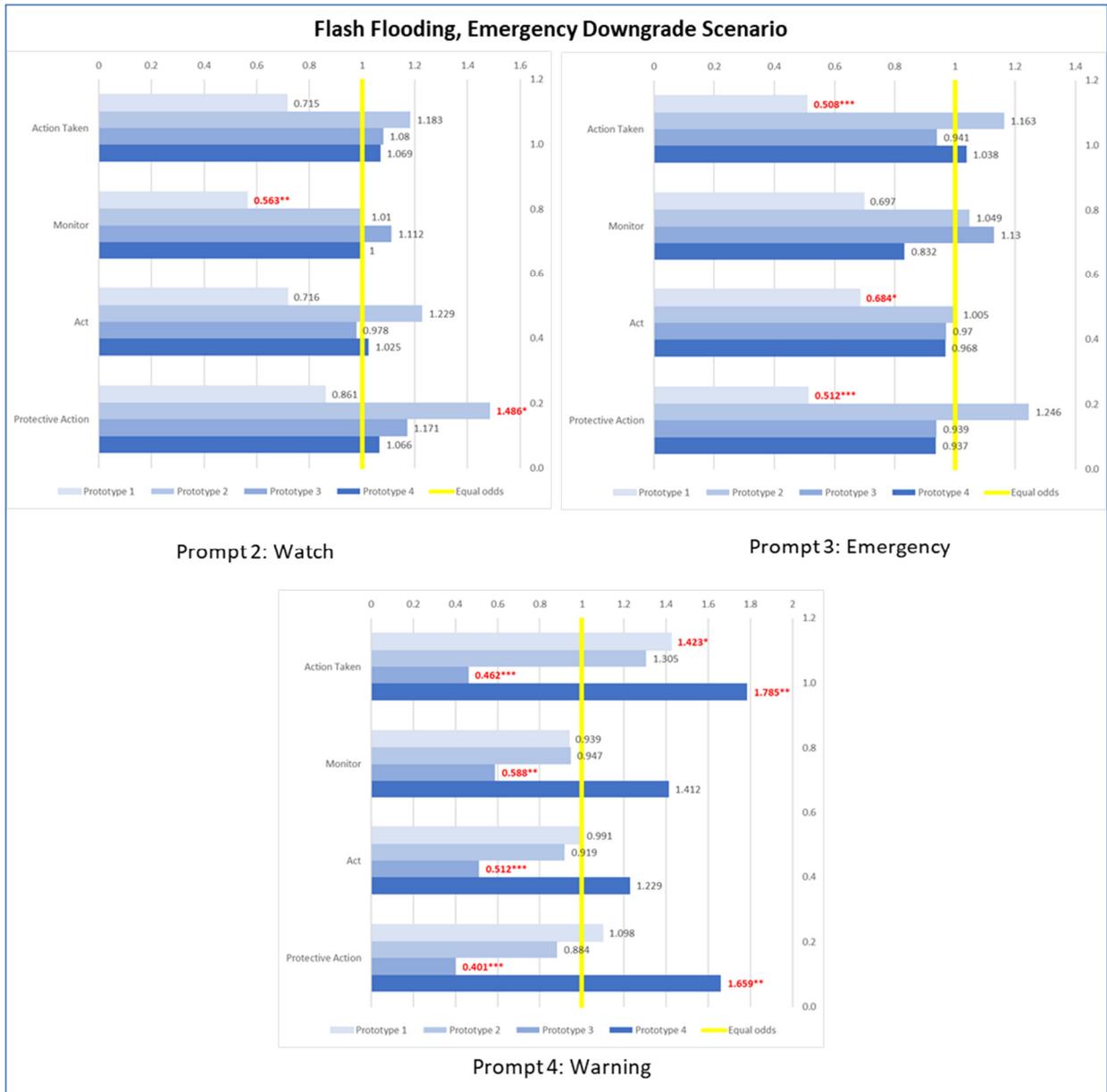


Figure 20. Graphical Depiction of Estimated Odds Ratios for Emergency Downgrade Scenario: Flash Flooding Survey

### *10.3.2 Warning with an Upgrade Scenario*

After the baseline prompt, the warning with an upgrade scenario started with a watch-level prompt, and then moved to warning followed by an emergency. Table 52 presents the estimated odds ratios for the warning upgrade scenario; in the table, the “\*” symbol is used to depict levels of statistical significance. Figure 21 provides a graphical depiction of the estimates in Table 52 using red text to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** Prototype 2 is more effective than the current system at increasing the protective action selected at the watch level. Prototype 4 is much more effective (odds ratio greater than 2.7) than the current system at the warning level. Prototype 3 is less effective at the warning level and Prototype 1 is less effective at the emergency level.
- **Likelihood of Monitoring.** At the warning level, Prototype 3 is less effective at increasing monitoring compared to the current system and Prototype 4 is more effective.
- **Likelihood of Acting.** Prototype 3 is less effective at increasing action compared to the current system at the warning level.
- **Likelihood of Taking Protective Action.** Prototype 4 is much more effective (odds ratio greater than 2.4) than the current system at increasing the likelihood of taking protective action at the warning level. Prototype 3 is less effective at the warning level and Prototype 1 is less effective at the emergency level.

Overall, it appears that, at the warning level, the Prototype 3 was less effective than the current system and Prototype 4 was more effective.

**Table 52. Estimated Odds Ratios for Warning Upgrade Scenario: Flash Flooding**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Acting	(4) Likelihood of Taking Protective Action
<b>Prompt 2: Watch</b>				
Prototype 1	0.760 (-1.23)	0.823 (-0.82)	0.790 (-1.22)	0.995 (-0.03)
Prototype 2	1.533** (2.00)	0.968 (-0.14)	0.966 (-0.19)	0.990 (-0.05)
Prototype 3	1.225 (0.95)	0.855 (-0.73)	1.229 (1.07)	1.231 (1.12)
Prototype 4	1.402 (1.61)	1.027 (0.11)	1.360 (1.59)	1.281 (1.31)
<b>Prompt 3: Warning</b>				
Prototype 1	1.400 (1.60)	1.320 (1.06)	0.953 (-0.22)	1.177 (0.88)
Prototype 2	1.197 (0.91)	0.695 (-1.52)	1.036 (0.19)	1.116 (0.60)
Prototype 3	0.589*** (-2.62)	0.577** (-2.20)	0.625** (-2.20)	0.731* (-1.66)
Prototype 4	2.798*** (4.48)	1.735* (1.85)	1.371 (1.32)	2.405*** (4.20)
<b>Prompt 4: Emergency</b>				
Prototype 1	0.520*** (-3.10)	0.979 (-0.08)	1.140 (0.60)	0.675* (-1.92)
Prototype 2	1.189 (0.82)	1.082 (0.27)	1.222 (0.94)	0.904 (-0.48)
Prototype 3	0.868 (-0.66)	1.465 (1.43)	0.992 (-0.04)	0.905 (-0.46)
Prototype 4	1.133 (0.55)	1.583 (1.62)	0.930 (-0.33)	1.048 (0.22)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

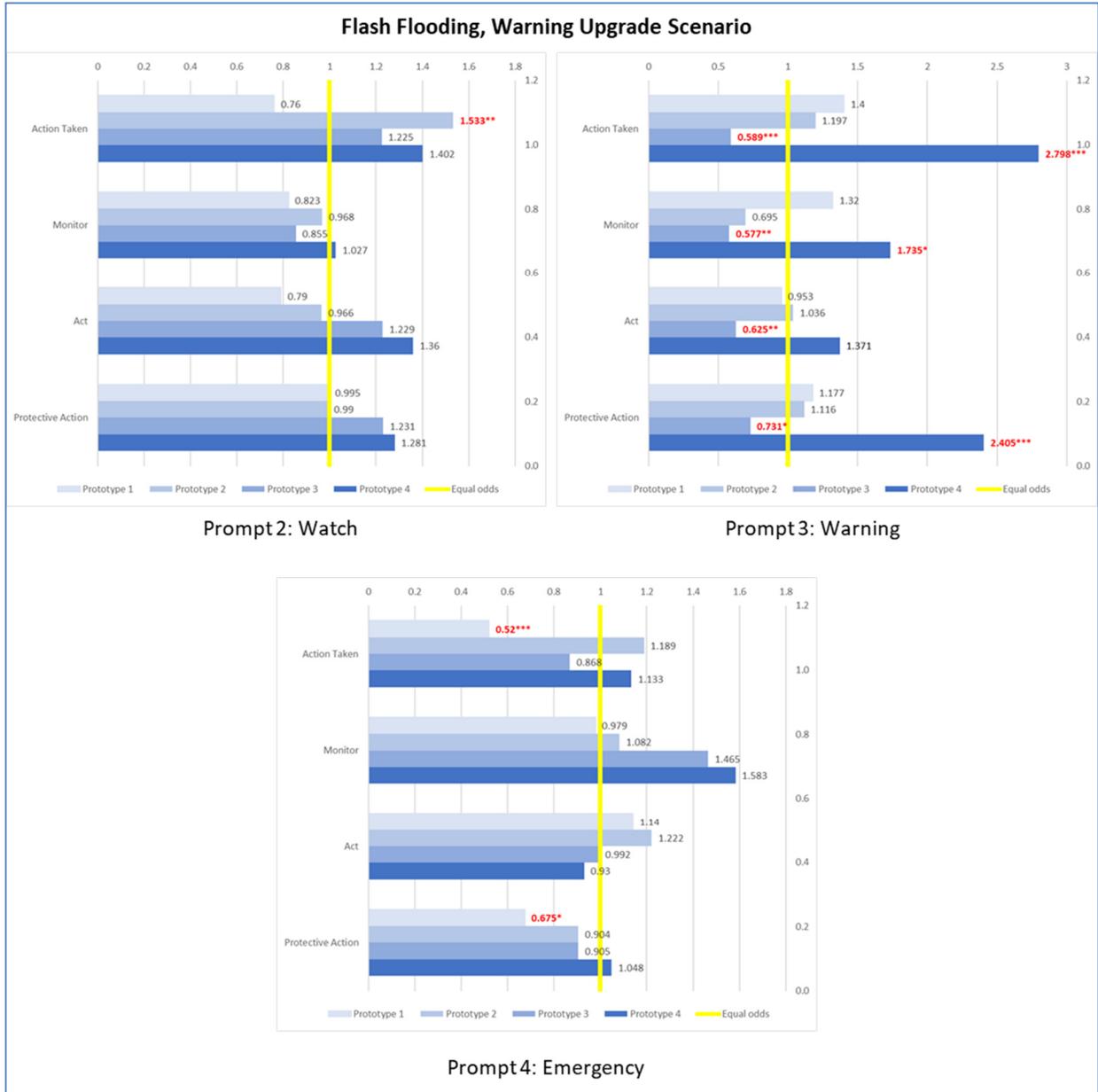


Figure 21. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Flash Flood Survey

## 10.4 Summary and Conclusions

Table 53 presents the percentage of estimates for each prototype that were significantly greater or significantly less than 1.0. These data indicate that Prototype 4 outperformed the current system overall, but the current system outperformed Prototypes 1 and 3.

**Table 53. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Flash Flood Survey**

Prototype	All Estimates	
	> 1.0	< 1.0
Prototype 1	4%	25%
Prototype 2	8%	0%
Prototype 3	0%	33%
Prototype 4	21%	0%
Total Number of Estimates [a]	24	

[a] This is the total for each prototype.

Table 54 expands the summary in Table 53 breaking the percentage out by prompt level. Here we see that Prototype 4's strong results came at the warning level only. We also see that Prototype 3 only underperformed at the warning level and that Prototype 1 mostly underperformed at the emergency level.

**Table 54. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Flash Flood Survey**

Prototype	Watch		Warning		Emergency	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	13%	13%	0%	0%	63%
Prototype 2	25%	0%	0%	0%	0%	0%
Prototype 3	0%	0%	0%	100%	0%	0%
Prototype 4	0%	0%	63%	0%	0%	0%
Total Number of Estimates [a]	8		8		8	

[a] This is the total for each prototype.

Table 55 breaks out the percentages by the protective response variable used. These data indicate that the weaker results for Prototypes 1 and 3 were across all three response variables.

**Table 55. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Flash Flood Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Acting [b]	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	17%	33%	0%	17%	0%	25%
Prototype 2	17%	0%	0%	0%	8%	0%
Prototype 3	0%	33%	0%	33%	0%	33%
Prototype 4	33%	0%	17%	0%	17%	0%
Total Number of Estimates [a]	6		6		12	

[a] This is the total for each prototype.

[b] Includes results for both likelihood of acting and likelihood of taking protective action.

Appendix B provides a cross-tabulation of the information in Table 54 and Table 55.

Based on these summaries and the analyses in this section, some overall conclusions can be drawn.

- Overall, the current system seemed to outperform the prototypes this was especially true at the watch level.
- At the advisory level, the prototypes appear to be more protective.

## 11.0 Areal Flooding

This section discusses the results from the areal flooding survey. NWS and ERG identified a set of states that were more prone to flood events as the basis for selecting a sample.

### 11.1 Basic Demographics

Figure 22 provides a summary of the number of respondents selected from each state. California had 87 respondents and another five states had 80 respondents each. As discussed in Section 3.1, the number of responses from states were limited to ensure no one state dominated a survey. Table 56 summarizes the basic demographics for the sample. The sample was skewed toward women.

**States:** TX, MS, AR, AL, TN, KY, MO, IA, IL, IN, OH, PA, NY, NJ, CT, MA, NC, VA, MD, WV, CA (south of San Francisco), AZ, OK, KS

**Respondents:** 1,052

**Collection time frame:** 3/2/18 – 3/12/18

**Table 56. Basic Demographics for Areal Flooding Survey**

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
<b>Age</b>		<b>Race</b>	
20-24	4.6%	White	85.1%
25-34	19.0%	Black/African-American	6.8%
35-44	21.4%	Asian	4.5%
45-54	18.8%	Other	3.7%
55-64	18.0%	<b>Income</b>	
65+	18.3%	Less than \$24,999	20.0%
<b>Gender</b>		\$25,000 - \$49,999	29.9%
Female	64.9%	\$50,000 - \$99,999	33.4%
Male	35.1%	\$100,000 - \$199,999	14.5%
<b>Education</b>		More than \$200,000	2.3%
Less than college degree	54.6%	<b>Home Location</b>	
College degree	28.0%	Urban	24.9%
Post-undergraduate work/degree	17.4%	Suburban	49.7%
<b>Hispanic origin</b>		Rural	25.4%
Yes	6.4%	<b>Average number of adults in home</b>	<b>2.06</b>
No	93.6%	<b>Average number of children in home</b>	<b>0.63</b>

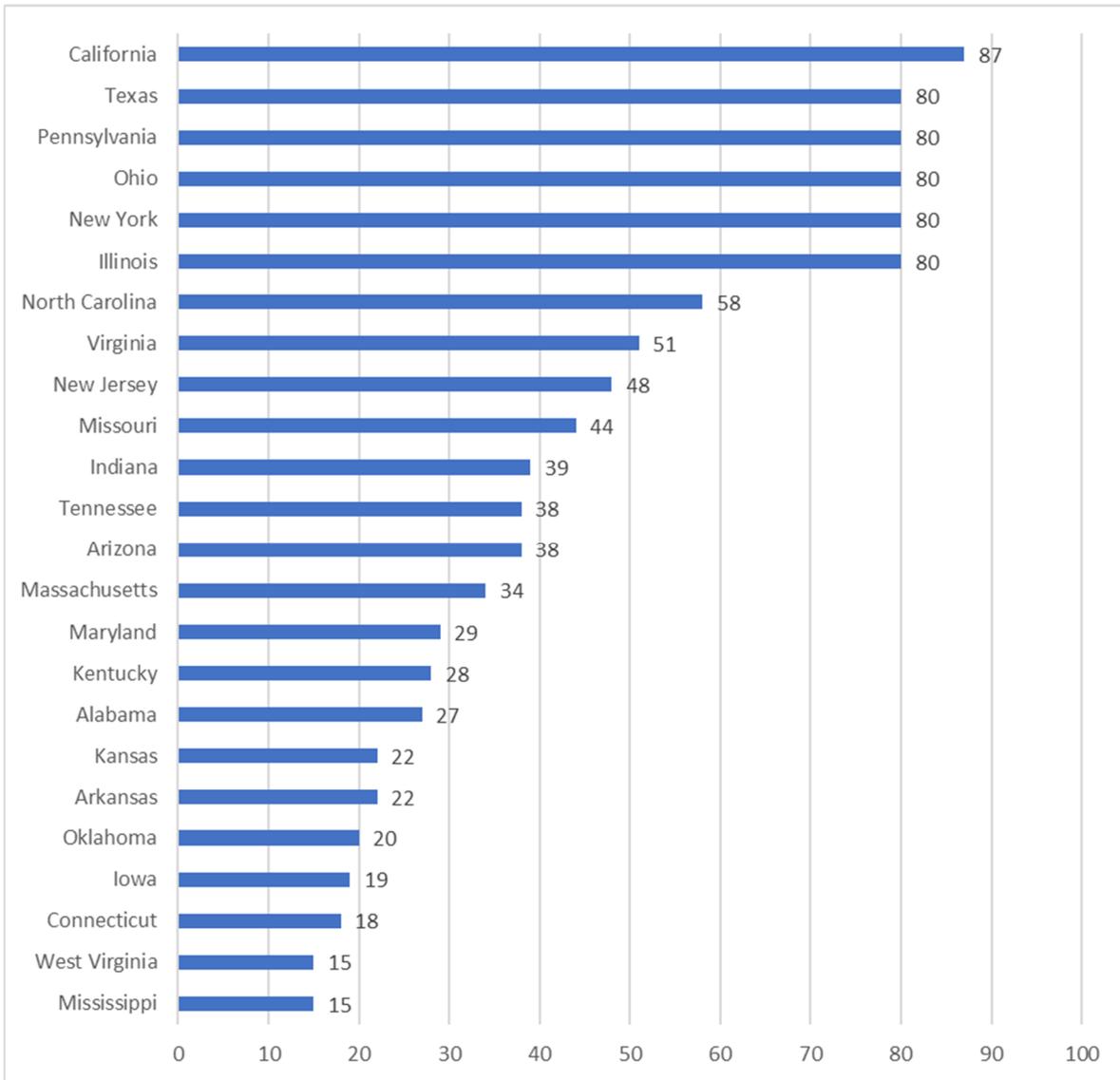


Figure 22. Numbers of Respondents from States Included in the Areal Flooding Survey

## 11.2 Current Knowledge

Table 57 provides a summary of the responses to the current knowledge questions. This survey used the second version of the current knowledge question described in Section 2.4; we provided respondents with a definition and asked them to select from terms that fit the definition. The current knowledge questions acted as a “test” of respondents understanding of the current system and each had a “correct” response. The correct responses for each row appear in orange shading in the table. The results for the three terms were:

- Flood Watch – 44.4 percent correctly selected the right term which represented a plurality, but another 38.9 percent selected the term Flood Advisory.
- Flood Advisory – 42.6 percent correctly selected the right term which represented a plurality, but another 30.3 percent selected the term Flood Watch and another 27.2 selected Flood Warning.
- Flood Warning – 43.6 percent correctly selected the right term which represented a plurality, but 28.2 percent selected each of the other two terms.

Although pluralities were able to select the correct terms, there does appear to be some confusion on correct interpretation of the definitions.

**Table 57. Areal Flooding Current Knowledge**

Definition Used in Question	Number Who Answered Question	Response Options		
		Flood Watch	Flood Advisory	Flood Warning
When there is the possibility for flooding in the next 36 hours	383	44.4%	38.9%	16.7%
When river levels are elevated or flooding with limited impacts occur	357	30.3%	42.6%	27.2%
When flooding is likely to impact buildings and/or roads	312	28.2%	28.2%	43.6%

### 11.3 Prototypes Analyses

This section presents the results of the ordered logistic regression analyses we performed on the prototype testing. The methods are discussed in Section 4.0. We analyzed the data from four questions in the survey:

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included<sup>31</sup> (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a description of what each type of action meant.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecasts given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

The goal of the analyses was to determine whether those who saw specific prototypes were more or less likely to take more protective actions compared to the current system using those four questions to measure protective responses. As noted in Section 4.0, the analyses result in the estimation of odds ratios that indicate the degree to which the four new prototypes outperformed the current system. An odds ratio of 1.0 indicates that a prototype is just as protective as the current system, odds ratios below 1.0 indicate the prototype is less protective, and odds ratios above 1.0 indicate the prototype is more protective. By design, odds ratios cannot be below zero.

We present the results for each of the three scenarios for this survey:

- Warning with a downgrade
- Warning with an upgrade
- Advisory with an upgrade

We present odds ratios for each prompt within each scenario (see Section 2.2). For each scenario, we organize the results by the protective response variables listed above. The specific prototypes tested for the winter weather mild regions survey appear in Table 58.

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<sup>31</sup> Given the nature of the hazard, flash flooding excluded the “prepare” option.

**Table 58. Specific Prototype Language Tested for Areal Flooding Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	Flood Watch	Flood Outlook	Flood Notice	Possible Flood Event	Possible Flood Conditions
Advisory level	Flood Advisory	Flood Warning	Flood Alert	Minor Flood Warning	Level Orange Flood Warning
Warning level	Flood Warning	Flood Warning	Flood Warning	Moderate Flood Warning	Level Red Flood Warning
Emergency level	Flood Warning	Flood Warning	Flood Emergency	Extreme Flood Warning	Level Purple Flood Warning

### 11.3.1 Warning with a Downgrade Scenario

After the baseline prompt, the warning with a downgrade scenario started with a watch-level prompt, and then moved to warning followed by a downgrade to an advisory. Table 59 presents the estimated odds ratios for the warning downgrade scenario; in the figure, the “\*” symbol is used to depict levels of statistical significance. Figure 23 provides a graphical depiction of the estimates in Table 59 using red text to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** Prototype 2 is more effective at increasing the protective response selected compared to the current system at the watch and advisory levels. Prototype 3 is less effective at the warning and advisory levels and Prototype 4 is more effective at the warning level.
- **Likelihood of Monitoring.** Prototypes 1, 2, and 4 are all significantly more effective at increasing monitoring at the advisory level and Prototype 4 is also more effective at the warning level.
- **Likelihood of Preparing.** Prototypes 1 and 2 are both more effective at increasing preparation at the advisory level and Prototype 4 is again more effective at the warning level.
- **Likelihood of Acting.** Prototype 2 is more effective at increasing the likelihood of acting at the advisory level and Prototype 3 is less effective at the advisory level. Prototype 4 is once again more effective at the warning level.

Overall, Prototype 4 is clearly more effective at the warning level in this scenario and Prototypes 1 and 2 are more effective at the advisory level. Prototype 3 appears to be less effective at the advisory level.

**Table 59. Estimated Odds Ratios for Warning Downgrade Scenario: Areal Flooding**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.933 (-0.29)	0.859 (-0.54)	0.764 (-1.07)	0.862 (-0.62)
Prototype 2	1.555* (1.75)	1.513 (1.49)	1.073 (0.30)	1.420 (1.49)
Prototype 3	0.931 (-0.28)	1.306 (0.99)	0.860 (-0.66)	1.019 (0.08)
Prototype 4	0.856 (-0.63)	1.236 (0.77)	0.693 (-1.56)	0.813 (-0.81)
<b>Prompt 3: Warning</b>				
Prototype 1	1.005 (0.02)	1.248 (0.75)	0.916 (-0.37)	0.948 (-0.23)
Prototype 2	1.235 (0.93)	1.438 (1.18)	0.977 (-0.10)	1.264 (0.99)
Prototype 3	0.497*** (-3.15)	1.052 (0.17)	0.923 (-0.34)	0.720 (-1.48)
Prototype 4	1.697** (2.36)	2.071** (2.21)	1.766** (2.11)	1.543* (1.78)
<b>Prompt 4: Advisory</b>				
Prototype 1	1.114 (0.45)	1.644* (1.87)	1.478* (1.65)	1.389 (1.37)
Prototype 2	1.609** (2.05)	1.947** (2.40)	1.569* (1.85)	1.532* (1.80)
Prototype 3	0.509*** (-2.93)	0.889 (-0.43)	0.781 (-1.03)	0.603** (-2.08)
Prototype 4	1.266 (0.99)	1.649* (1.72)	1.274 (0.98)	1.081 (0.32)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

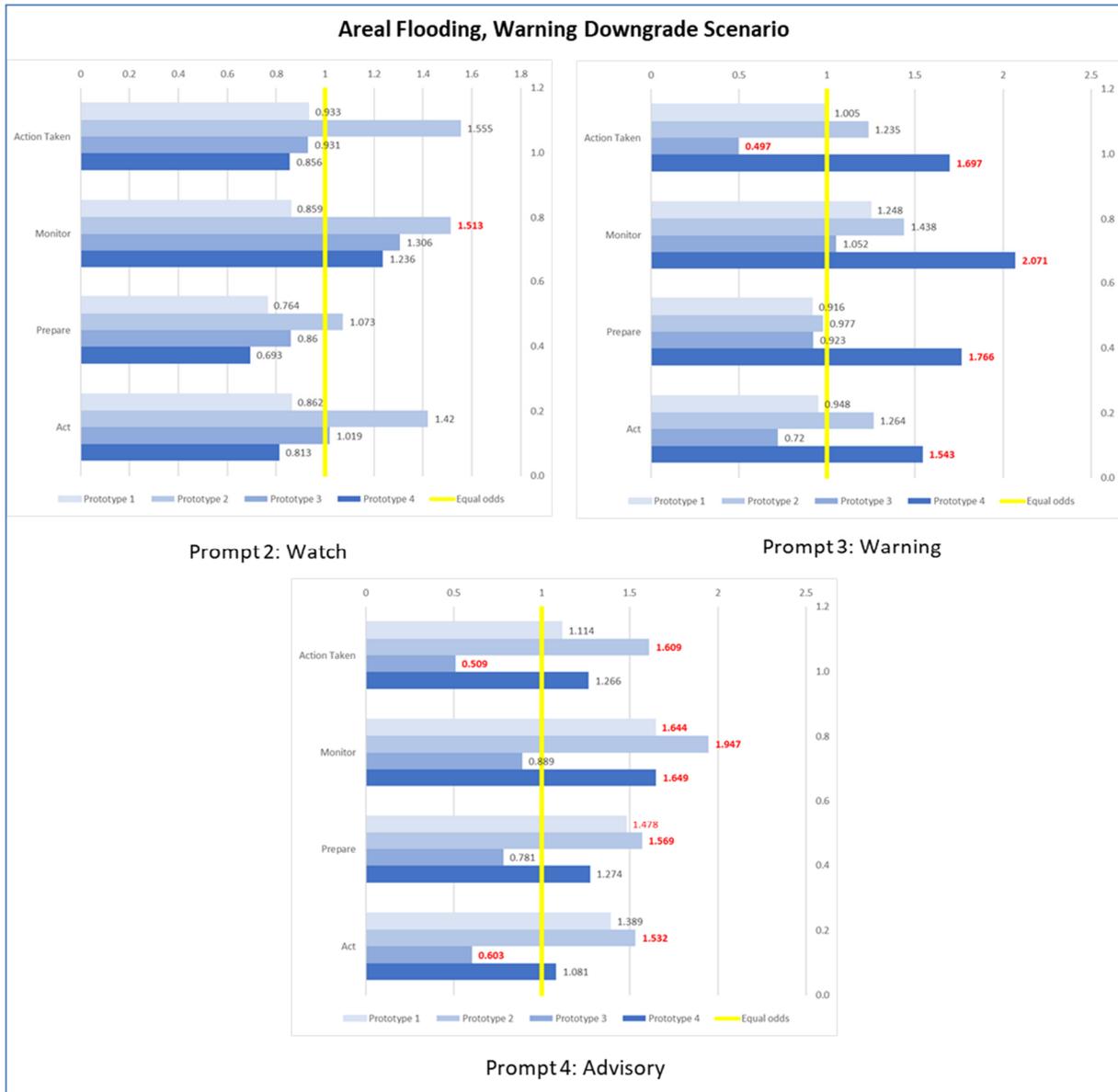


Figure 23. Graphical Depiction of Estimated Odds Ratios for Warning Downgrade Scenario: Areal Flooding Survey

### *11.3.2 Warning with an Upgrade Scenario*

After the baseline prompt, the warning with an upgrade scenario started with a watch-level prompt, and then moved to warning followed by an emergency. Table 60 presents the estimated odds ratios for the warning upgrade scenario; in the table, the “\*” symbol is used to depict levels of statistical significance. Figure 24 provides a graphical depiction of the estimates in Table 60 using red text to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** Prototype 1 is significantly less effective than the current system at increasing the protective response selected at the watch level and Prototype 3 is less effective at the warning level. Prototypes 2 – 4 are all significantly more effective the emergency level with the estimated odds ratios for Prototypes 2 and 4 being greater than 2.0.
- **Likelihood of Monitoring.** Prototypes 1 and 3 are significantly less effective than the current system at increasing monitoring at the watch level and Prototype 3 is less effective at the warning level.
- **Likelihood of Preparing.** Prototype 2 is significantly more effective at increasing preparation compared to the current system, at the watch level and Prototype 4 is significantly more effective at the warning level; both are more effective at the emergency level.
- **Likelihood of Acting.** At the warning Prototype 3 is significantly less effective than the current system at increasing the likelihood of action while Prototype 4 is more effective. Prototypes 2 – 4 are all significantly more effective the emergency level with the estimated odds ratios for Prototypes 2 and 4 being greater than 2.0.

Prototypes 2 and 4 appear to be significantly more effective at the emergency level and Prototype 3 appears to be less effective at the warning level.

**Table 60. Estimated Odds Ratios for Warning Upgrade Scenario: Areal Flooding**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.651* (-1.77)	0.549** (-2.25)	1.133 (0.52)	0.723 (-1.43)
Prototype 2	1.129 (0.52)	0.756 (-1.06)	1.489* (1.75)	1.137 (0.58)
Prototype 3	0.825 (-0.81)	0.513*** (-2.64)	1.252 (1.03)	0.839 (-0.77)
Prototype 4	0.822 (-0.88)	0.762 (-0.97)	0.990 (-0.04)	0.809 (-0.91)
<b>Prompt 3: Warning</b>				
Prototype 1	0.975 (-0.12)	0.924 (-0.27)	1.175 (0.75)	0.875 (-0.61)
Prototype 2	1.019 (0.08)	0.862 (-0.55)	1.366 (1.33)	1.068 (0.29)
Prototype 3	0.535*** (-2.80)	0.443*** (-3.03)	0.753 (-1.36)	0.560*** (-2.62)
Prototype 4	1.299 (1.17)	1.397 (1.08)	1.842*** (2.73)	1.762** (2.35)
<b>Prompt 4: Emergency</b>				
Prototype 1	1.292 (1.19)	1.455 (1.18)	1.182 (0.81)	1.355 (1.36)
Prototype 2	2.119*** (3.28)	1.625 (1.61)	1.959*** (2.98)	2.659*** (4.04)
Prototype 3	1.460* (1.82)	1.514 (1.35)	1.323 (1.37)	1.552** (1.99)
Prototype 4	2.016*** (3.09)	1.353 (0.95)	1.845** (2.52)	2.383*** (3.53)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

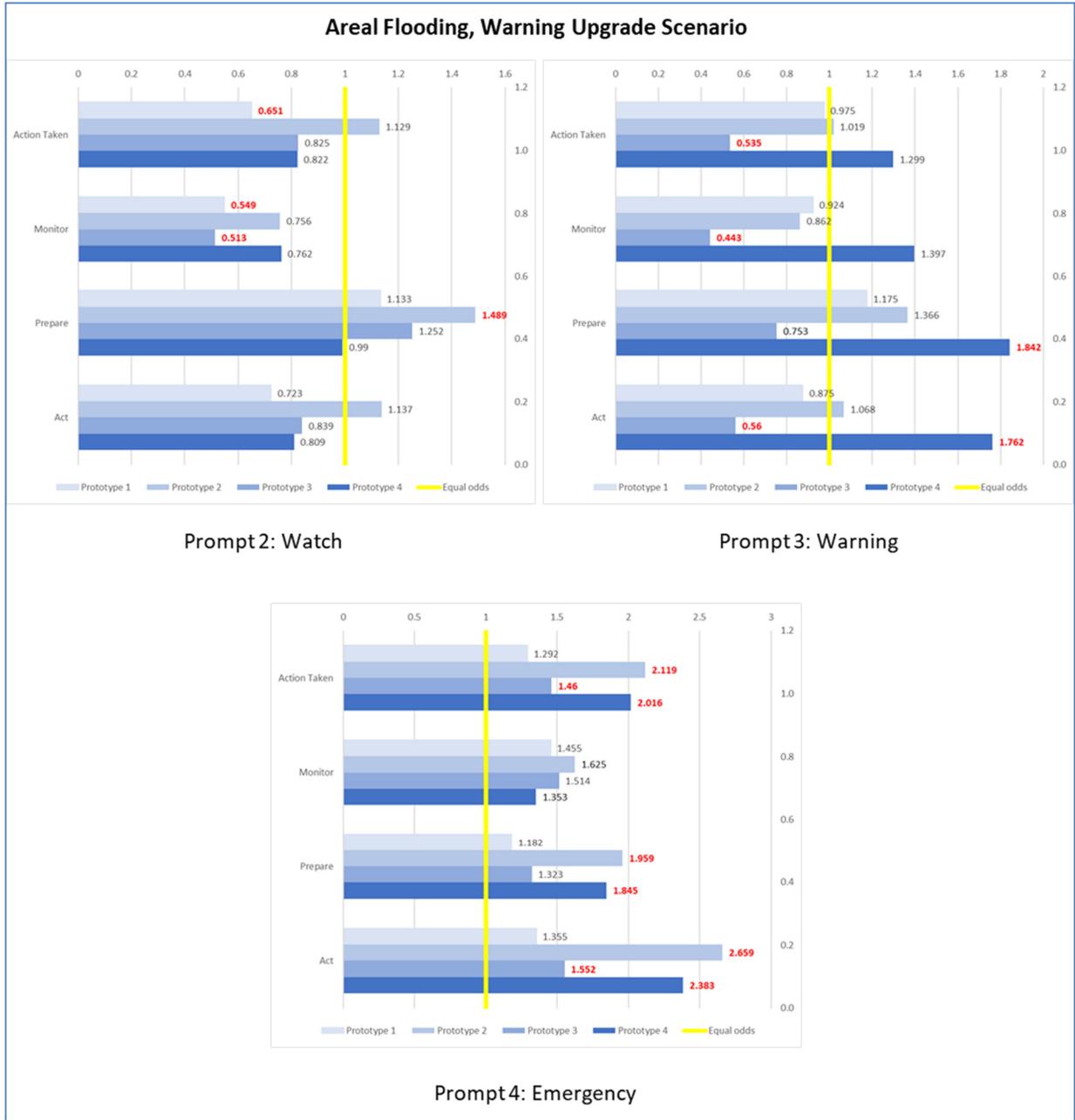


Figure 24. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Areal Flooding Survey

### *11.3.3 Advisory with an Upgrade Scenario*

After the baseline prompt, the advisory with an upgrade scenario started with a watch-level prompt, and then moved to an advisory followed by a warning. Table 61 presents the estimated odds ratios for the advisory upgrade scenario; in the figure, the “\*” symbol is used to depict levels of statistical significance. Figure 25 provides a graphical depiction of the estimates in Table 61 using red text to depict statistical significance. The results for each protective response variable can be described as follows:

- **Action Taken.** Prototype 1 is significantly less effective than the current system at increasing the protective response selected at the watch level and Prototype 3 is less effective at the warning level. Prototype 4 is significantly more effective at the advisory and warning levels with an estimated odds ratio greater than 2.0.
- **Likelihood of Monitoring.** Prototype 1 is significantly less effective than the current system at increasing monitoring at the watch level.
- **Likelihood of Preparing.** Prototype 1 is significantly less effective than the current system at increasing preparation at the watch level and Prototype 3 is less effective at the advisory and warning levels.
- **Likelihood of Acting.** Prototype 1 is significantly less effective than the current system at increasing the likelihood of action at the watch level and Prototype 3 is less effective at the advisory and warning levels. Prototypes 1, 2, and 4 are all more effective at the advisory level and Prototype 4 is again more effective at the warning level.

Overall, Prototype 1 is less effective at the watch level and Prototype 3 is less effective at the advisory and warning levels. Prototype 4 appears to be more effective at increasing actions at the advisory and warning levels.

**Table 61. Estimated Odds Ratios for Advisory Upgrade Scenario: Areal Flooding**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.434*** (-2.98)	0.467*** (-2.84)	0.542*** (-2.59)	0.661* (-1.71)
Prototype 2	0.922 (-0.34)	0.793 (-0.91)	1.408 (1.46)	1.095 (0.37)
Prototype 3	0.932 (-0.30)	0.938 (-0.25)	0.784 (-1.08)	0.788 (-0.98)
Prototype 4	0.823 (-0.83)	0.755 (-1.19)	0.673* (-1.85)	0.876 (-0.53)
<b>Prompt 3: Advisory</b>				
Prototype 1	1.276 (1.10)	1.137 (0.50)	1.384 (1.62)	1.637** (2.38)
Prototype 2	1.276 (1.13)	1.197 (0.68)	1.284 (1.17)	1.705** (2.50)
Prototype 3	0.612** (-2.13)	0.756 (-1.09)	0.524*** (-3.00)	0.707* (-1.67)
Prototype 4	1.634** (2.29)	0.808 (-0.94)	1.259 (1.10)	1.724** (2.43)
<b>Prompt 4: Warning</b>				
Prototype 1	0.760 (-1.23)	0.846 (-0.58)	0.885 (-0.59)	0.884 (-0.58)
Prototype 2	0.956 (-0.20)	1.122 (0.42)	1.138 (0.59)	1.147 (0.62)
Prototype 3	0.670** (-1.99)	0.761 (-0.94)	0.668* (-1.95)	0.521*** (-3.32)
Prototype 4	2.070*** (3.17)	0.700 (-1.40)	1.166 (0.69)	1.490* (1.83)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

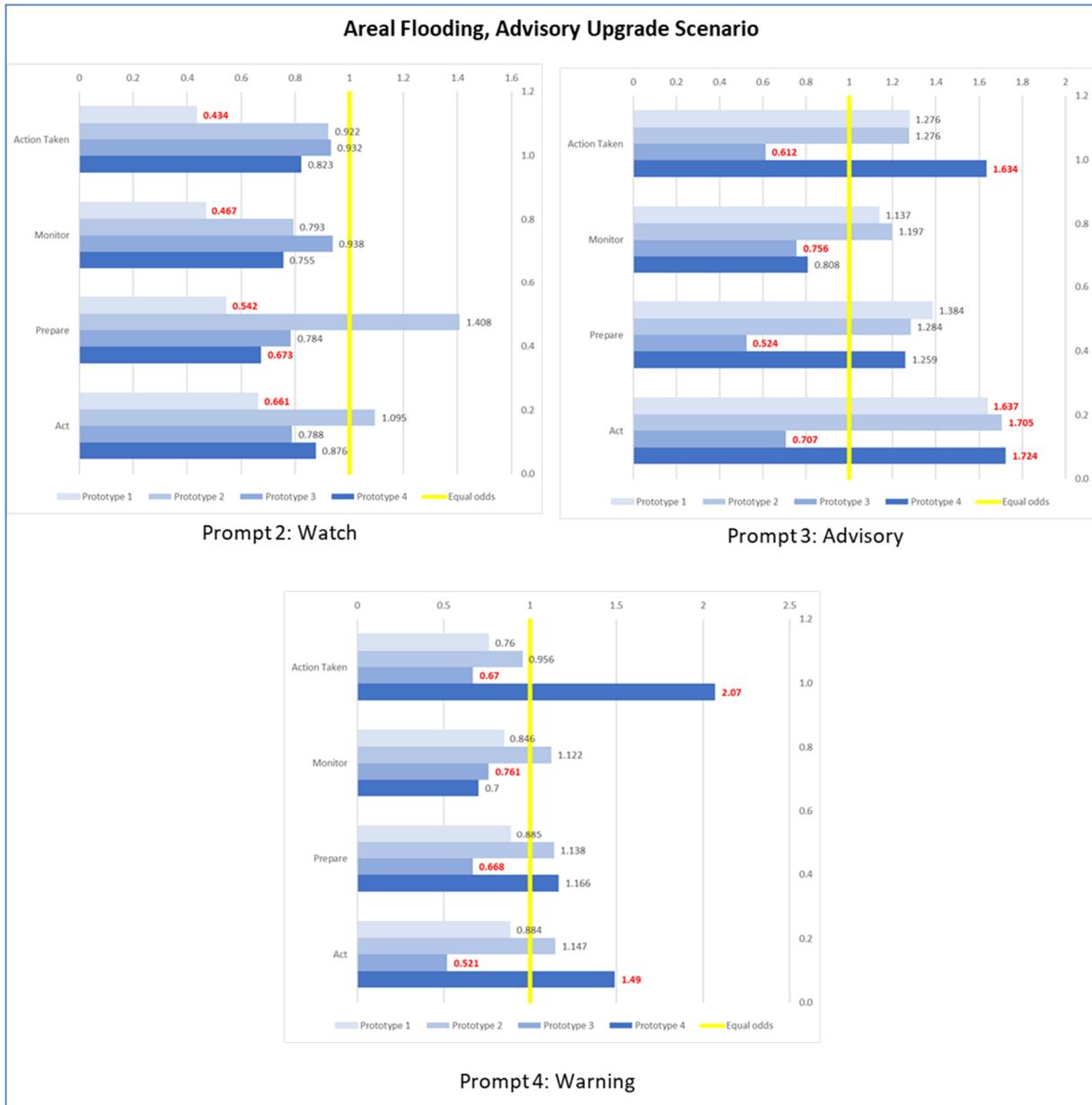


Figure 25. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: Areal Flooding Survey

## 11.4 Summary and Conclusions

Table 62 presents the percentage of estimates for each prototype that were significantly greater or significantly less than 1.0. These tabulations indicate that Prototypes 2 and 4 appear to be more effective than the current system while Prototype 3 is less effective.

**Table 62. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Areal Flooding Survey**

Prototype	All Estimates	
	> 1.0	< 1.0
Prototype 1	8%	17%
Prototype 2	28%	0%
Prototype 3	6%	36%
Prototype 4	39%	3%
Total Number of Estimates [a]	36	

[a] This is the total for each prototype.

Table 63 expands the summary in Table 62 breaking the percentage out by prompt level. These tabulation indicate that Prototypes 2's stronger performance were at the advisory and emergency levels while Prototype 4's stronger performance tended to be at the warning and emergency levels.

**Table 63. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Areal Flooding Survey**

Prototype	Watch		Advisory		Warning		Emergency	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	50%	38%	0%	0%	0%	0%	0%
Prototype 2	17%	0%	63%	0%	0%	0%	75%	0%
Prototype 3	0%	8%	0%	63%	0%	58%	50%	0%
Prototype 4	0%	8%	38%	0%	67%	0%	75%	0%
Total Number of Estimates [a]	12		8		12		4	

[a] This is the total for each prototype.

Table 64 breaks out the percentages by the protective response variable used. These tabulations indicate that the strong results for Prototypes 2 and 4 were more at increasing actions and at increasing preparation and less at increasing monitoring.

**Table 64. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Areal Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	22%	11%	22%	11%	11%	11%	11%
Prototype 2	33%	0%	11%	0%	33%	0%	33%	0%
Prototype 3	11%	56%	0%	22%	0%	22%	11%	44%
Prototype 4	44%	0%	22%	0%	33%	11%	56%	0%
Total Number of Estimates [a]	9		9		9		9	

[a] This is the total for each prototype.

Appendix B provides a cross-tabulation of the information in Table 63 and Table 64.

Based on these summaries and the analyses in this section, some overall conclusions can be drawn.

- Overall, Prototypes 2 and 4 were the most effective.
- Prototype 3 was less effective

## 12.0 Conclusions and Recommendations

This section summarizes the results estimated in the prior sections, draws a set of conclusions based on the estimated over all surveys conducted, and makes recommendations for NWS in moving forward. We begin by summarizing the responses to the current knowledge questions we asked. Next, we summarize the statistical results for the odds ratios over all surveys. We then break out the overall results by prompt level and then by protective response variable. Finally, we develop some recommendations based on the statistical results.

### 12.1 Current Knowledge

Table 65 summarizes the response to the current knowledge questions that were summarized in each survey-specific section.

**For the most part, knowledge of the current terms in use is relatively low.** The surveys we implemented tested 21 separate terms (three in each survey). Of those 21 terms, in eight cases the percentage of respondents who answered correctly was between 40 and 49 percent. In nine cases, the percentage who answered correctly was 50 percent or more, but never more than 70.6 percent; in three of the nine above 50 percent the percentage was between 50 and 60 percent. Finally, in four cases, the percentage who answered correctly was less than 30 percent.

**Table 65. Summary of Current Knowledge Questions**

Survey	Term Tested	Percentage Correct	Term Tested	Percentage Correct	Term Tested	Percentage Correct
Winter Weather, Mild	Winter Storm Warning	43.1%	Winter Storm Advisory	14.5%	Winter Storm Watch	70.6%
Winter Weather, Cold	Winter Storm Warning	43.8%	Winter Storm Advisory	17.4%	Winter Storm Watch	68.9%
Thunderstorms	Severe Thunderstorm Watch	43.5%	Significant Weather Advisory	24.3%	Severe Thunderstorm Warning	56.8%
Tornadoes	Tornado Watch	67.3%	Tornado Warning	70.6%	Tornado Emergency	28.9%
Coastal Flooding	Coastal Flood Watch	41.6%	Coastal Flood Advisory	44.4%	Coastal Flood Warning	55.6%
Flash Flooding	Flood Watch	50.0%	Flash Flood Warning	64.5%	Flash Flood Emergency	62.2%
Areal Flooding	Flood Watch	44.4%	Flood Advisory	42.6%	Flood Warning	43.6%

### 12.2 Overall Results by Prototype and Hazard

Table 66 summarizes the percentages of all odds ratio estimates from all surveys that were significantly greater than or less than 1.0 by prototype. As a reminder, estimates significantly greater than 1.0 indicate the prototype outperformed the current system and estimates significantly less than 1.0 indicate the current system outperformed the prototype.

**Prototypes 2 and 4 performed the best overall relative to the current system.** However, these two prototypes only outperformed the current system in one of every five estimates and were outperformed by the current system in slightly less than one on ten estimates. Thus, although Prototype 2 and 4 were the best performers, the results were not overwhelming.

**Prototypes 1 and 3 performed poorly compared to the current system.** Prototype 1 was outperformed by the current system in one of four estimated models and Prototype 3 was outperformed in one of five (approximately) estimated models. These two prototypes also outperformed the current system in one of ten models we estimated. Thus, as above, the result that these two were the worst performers was not overwhelming.

**Table 66. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: All Surveys Combined**

Prototype	Significantly Greater Than 1.0	Significantly Less Than 1.0
Prototype 1	7.8%	26.5%
Prototype 2	20.1%	9.8%
Prototype 3	10.8%	22.1%
Prototype 4	20.6%	7.8%
Total Number of Estimates [a]	204	204

[a] This is the total for each prototype.

**The best/worst performing prototypes varied to some degree across the hazards.** Table 67, Table 68, and Table 69 provide summaries of the percentage of odds ratios that were significantly above and below 1.0 by hazard.<sup>32</sup> As noted above, Prototypes 2 and 4 were the best performers (relative to the current system) and Prototypes 1 and 3 were the worst performers. This was mirrored in some hazards such as winter weather mild, coastal flooding, and areal flooding. However, Prototype 3 was the best performer in winter weather cold (one in five estimates were better than the current system); despite that, Prototype 3 also had an almost equal number of cases where it was outperformed by the current system in that survey. In thunderstorms, Prototypes 2 and 4 were outperformed more often by the current system than vice versa. Nevertheless, Prototypes 2 and 4 were usually the best performers in a survey or were usually at least as good as the other prototypes.

**Headlines Matter.** The construction of Prototype 1 was designed to test whether respondents would react to the headline words (e.g., “Severe Thunderstorm Warning”) or to the information that was being provided along with the headline. The poor performance of Prototype 1 relative to Prototypes 2 and 4, however, indicates that the headline matters.

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<sup>32</sup> These tables were taken from the corresponding tables from each survey-specific section.

**Table 67. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Winter Weather Mild and Winter Weather Cold Surveys**

Prototypes	Winter Weather, Mild		Winter Weather, Cold	
	Significantly Greater Than 1.0	Significantly Less Than 1.0	Significantly Greater Than 1.0	Significantly Less Than 1.0
Prototype 1	5.6%	8.3%	8.3%	27.8%
Prototype 2	19.4%	2.8%	5.6%	11.1%
Prototype 3	8.3%	5.6%	19.4%	16.7%
Prototype 4	13.9%	0.0%	8.3%	13.9%
Total Number of Estimates [a]	36	36	36	36

[a] This is the total for each prototype.

**Table 68. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Thunderstorms and Tornadoes Surveys**

Prototypes	Thunderstorms		Tornadoes	
	Significantly Greater Than 1.0	Significantly Less Than 1.0	Significantly Greater Than 1.0	Significantly Less Than 1.0
Prototype 1	16.7%	45.8%	0.0%	58.3%
Prototype 2	8.3%	45.8%	8.3%	0.0%
Prototype 3	8.3%	33.3%	8.3%	0.0%
Prototype 4	8.3%	33.3%	8.3%	8.3%
Total Number of Estimates [a]	24	24	12	12

[a] This is the total for each prototype.

**Table 69. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Coastal, Flash, and Areal Flooding Surveys**

Prototypes	Coastal Flooding		Flash Flooding		Areal Flooding	
	Significantly Greater Than 1.0	Significantly Less Than 1.0	Significantly Greater Than 1.0	Significantly Less Than 1.0	Significantly Greater Than 1.0	Significantly Less Than 1.0
Prototype 1	12.5%	12.5%	4.2%	25.0%	8.3%	16.7%
Prototype 2	58.3%	0.0%	8.3%	0.0%	27.8%	0.0%
Prototype 3	29.2%	29.2%	0.0%	33.3%	5.6%	36.1%
Prototype 4	50.0%	4.2%	20.8%	0.0%	38.9%	2.8%
Total Number of Estimates [a]	24	24	24	24	36	36

[a] This is the total for each prototype.

### 12.3 Overall Results by Prompt Level

Table 70 provides a summary of the percentages of estimated odds ratios that were significantly above and below 1.0 by prompt level.

**The term “advisory” was outperformed by Prototypes 1, 2, and 4.** Our analyses indicated that the current system never outperformed Prototypes 1, 2, and 4 at the advisory level; those three prototypes did outperform the current system at the advisory level in approximately one-third of the estimated odds ratios. Prototype 3 used the term “moderate” and tended to be outperformed by the current system.

**The prompt level matters for which prototype was most effective.** The general result that Prototype 2 and 4 were the best performers was not consistently found at each prompt level. At the watch level, Prototype 2 was the best performer, but Prototype 4 *never* outperformed the current system. At the advisory level, Prototype 1 joined Prototype 2 and 4 as a strong performer with each outperforming the current system in one of three models that were estimated. At the warning level, Prototype 4 was the strongest performer. Finally, at the emergency level, Prototypes 2 – 4 outperformed the current system.

**Table 70. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: All Surveys Combined**

Prototype	Watch		Advisory		Warning		Emergency	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0.0%	46.9%	33.3%	0.0%	4.7%	9.4%	3.6%	35.7%
Prototype 2	18.8%	18.8%	33.3%	0.0%	7.8%	6.3%	32.1%	0.0%
Prototype 3	1.6%	20.3%	8.3%	33.3%	17.2%	29.7%	25.0%	0.0%
Prototype 4	0.0%	23.4%	27.8%	0.0%	39.1%	0.0%	25.0%	3.6%
Total Number of Estimates [a]	64		36		64		28	

[a] This is the total for each prototype.

### 12.4 Overall Results by Protective Response

Table 71 summarizes the percentages of estimated odds ratios that were significantly above and below 1.0 by protective response variables.

**Prototype 2 and 4 are both more effective than the current system at compelling action.** For both the “action taken” and the likelihood of acting response variables, Prototype 2 and 4 were the strongest performers.

**Prototype 4 was the most effective at increasing monitoring by respondents.** Prototype 2 was not as effective at increasing monitoring.

**Prototype 2 was more effective at increasing preparation by respondents.** However, Prototype 4 was not ineffective at increasing preparation, but was not as effective as it was in other areas or as effective as Prototype 2.

**Table 71. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: All Surveys Combined**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	10.4%	31.3%	4.2%	16.7%	14.3%	26.2%	5.6%	22.2%
Prototype 2	20.8%	12.5%	8.3%	6.3%	21.4%	9.5%	27.8%	5.6%
Prototype 3	12.5%	31.3%	8.3%	18.8%	11.9%	16.7%	13.0%	24.1%
Prototype 4	29.2%	10.4%	18.8%	6.3%	16.7%	9.5%	22.2%	7.4%
Total Number of Estimates [a]	48		48		42		54	

[a] This is the total for each prototype.

## 12.5 Overall Results by Cross-Tabulated Prompt Levels and Protective Responses

The tables in this section cross-tabulate the information provided in prior two sections. Each table provides the percentages of odds ratios at a specific prompt level that were above and below 1.0 for each prototype for each protective response. These tables are meant to provide information on whether the prototypes are generating appropriate protective responses at the specific prompts. Appendix B provides these same cross-tabulations for each hazard separately.

**Table 72. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Watch Level, by Prototype and Protective Response Variable, All Surveys Combined**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	56%	0%	44%	0%	50%	0%	38%
Prototype 2	25%	25%	0%	19%	25%	19%	22%	13%
Prototype 3	6%	25%	0%	25%	0%	19%	0%	13%
Prototype 4	0%	31%	0%	19%	0%	25%	0%	19%
Total Number of Estimates [a]	16		16		14		18	

[a] This is the total for each prototype.

**Table 73. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Advisory Level, by Prototype and Protective Response Variable, All Surveys Combined**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	33%	0%	11%	0%	56%	0%	33%	0%
Prototype 2	22%	0%	22%	0%	22%	0%	67%	0%
Prototype 3	11%	44%	0%	22%	11%	22%	11%	44%
Prototype 4	44%	0%	22%	0%	22%	0%	22%	0%
Total Number of Estimates [a]	9		9		9		9	

[a] This is the total for each prototype.

**Table 74. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Warning Level, by Prototype and Protective Response Variable, All Surveys Combined**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	13%	19%	6%	6%	0%	6%	0%	6%
Prototype 2	13%	13%	6%	0%	0%	6%	13%	6%
Prototype 3	13%	44%	19%	19%	13%	13%	25%	31%
Prototype 4	50%	0%	38%	0%	19%	0%	44%	0%
Total Number of Estimates [a]	16		16		14		18	

[a] This is the total for each prototype.

**Table 75. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Emergency Level, by Prototype and Protective Response Variable, All Surveys Combined**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	43%	0%	0%	14%	29%	0%	50%
Prototype 2	29%	0%	14%	0%	43%	0%	43%	0%
Prototype 3	29%	0%	14%	0%	29%	0%	29%	0%
Prototype 4	29%	0%	14%	0%	29%	0%	29%	14%
Total Number of Estimates [a]	7		7		5		9	

[a] This is the total for each prototype.

## 12.6 Recommendations

Based on the analyses and the conclusion above, we can make the following recommendations:

**Develop a prototype that combines the most effective aspects of Prototypes 2 and 4.** Table 76 repeats Table from Section 2.1 and highlights the prompt levels where Prototypes 2 and 4 were effective (if both are highlighted, they were both effective at that level). Combining the two will be challenging and not straightforward since Prototype 2 varies the noun in the message while Prototype 4 varies the adjectives used to describe the term warning.

**Table 76. Prototypes and Their Associated Levels**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	Watch	Outlook	Notice	Possible	Possible/Notice
Advisory level	Advisory	Warning	Alert	Moderate	Orange
Warning level	Warning	Warning	Warning	Severe	Red
Emergency level	Emergency	Warning	Emergency	Extreme/ Catastrophic	Purple/ Dark Purple

**Consider alterations to the any prototype that takes into account the effectiveness for specific hazards.** As we have noted in Section 12.2, the effectiveness of the prototypes did vary across hazards. Thus, any final prototype should take into account nuances of when the tested prototypes are effective and not effective.

**Once a new candidate prototype is developed, NWS should have discussions with partners and forecasters.** The survey results indicate what terms tested best, but further research should be done to assess operational feasibility. By necessity, the testing approach in this survey tested the terms individually and not part of a larger risk messaging system. This should take into account other institutional aspects not considered as part of this specific project.

**Implement changes slowly.** ERG recommends that NWS consider implementing any new prototype as an experimental/parallel system, to further test it in different situations and in the context of hazards not included in this effort.

# APPENDIX A:

## Hazard Simplification Survey Instrument

Example Used: Winter (Cold Weather Region),  
Current system, warning with an upgrade scenario

*Notes: This version of the instrument provides a complete version for the winter storms survey (cold region) asking the respondent about perceptions of the current system with a warning upgrade. Details on where the survey differs across hazards is provided in notes through the survey. Within each hazard-specific survey, respondents proceed as follows:*

- *All respondents will see Questions 1 - 18; the order of these varied to some degree in each survey*
- *Respondents see only one question from Question 19 - 21.*
- *Prior to Question 22, respondents are randomly assigned to one of the five message sets (current plus the four new prototypes) and to one of the upgrade/downgrade scenarios. The outcome of the random assignment determines which set of prompts are seen by the respondent.*
- *Questions 22- 33 contain the prototype- and upgrade-specific prompts. This version contains one set for winter storms in a cold climate: the current system with a warning upgrade.*
- *All respondents see Questions 34 - 44*

*Text that appears in red reflects items (or terms) that were customized for specific hazards. These customizations appear at the end of the instrument.*

## 2. Part I - Key Demographics

1. **Using the dropdown list, please select the state where your primary residence is located.**  
[Dropdown list of the states]
2. **Approximately how long have you lived in that state?**
  - 1 - Less than 1 year
  - 2 - 1 to 3 years
  - 3 - 3 to 5 years
  - 4 - 5 to 10 years
  - 5 - More than 10 years
3. **What is your age?**
  - 1 - 18 to 24 years
  - 2 - 25 to 34 years
  - 3 - 35 to 44 years
  - 4 - 45 to 54 years
  - 5 - 55 to 64 years
  - 6 - Age 65 or older
4. **Including yourself, how many adults age 18 and older live at your primary residence?**  
\_\_\_\_\_ adults aged 18 or older
5. **How many children age 17 and younger live at your primary residence?**  
\_\_\_\_\_ children aged 17 or younger
6. **What type of home is your primary residence?**
  - 1 - Apartment
  - 2 - Single family home
  - 3 - Duplex
  - 4 - Mobile home
  - 5 - Condo or townhouse
  - 6 - Other (please specify) [Verbatim]
7. **Which of the following categories best describes the location of your primary residence?**
  - 1 - Urban location in a densely populated area
  - 2 - Suburban location in a neighborhood that is near a densely populated area
  - 3 - Rural location in a sparsely populated area
8. **If applicable, which of the following categories best describes the environment near your residence?**
  - 1 - River, stream, or small creek
  - 2 - Lake or pond
  - 3 - Ocean or coastal community
  - 4 - Mountain
  - 5 - Not applicable

### 3. Part II - General Risk and Weather Questions

9. Using a scale from 1 to 10, where 1 means *no harm* and 10 means *extreme harm*, how do you rate the overall harm from **winter storms** to:

You	1	2	3	4	5	6	7	8	9	10
Your home/apartment	1	2	3	4	5	6	7	8	9	10
Your local community	1	2	3	4	5	6	7	8	9	10

10. Using a scale from 1 to 10, where 1 means *no threat* and 10 means *extreme threat*, how do you rate the overall threat from **winter storms** to:

You	1	2	3	4	5	6	7	8	9	10
Your home/apartment	1	2	3	4	5	6	7	8	9	10
Your local community	1	2	3	4	5	6	7	8	9	10

11. How would you describe your feelings when you hear about an impending:

	<i>Very negative feelings</i>	<i>Rather negative feelings</i>	<i>Neither negative nor positive feelings</i>	<i>Rather positive feelings</i>	<i>Very positive feelings</i>
<b>Snow storm</b>	1	2	3	4	5
<b>3-inch snow storm</b>	1	2	3	4	5
<b>12-inch snow storm</b>	1	2	3	4	5

12. Thinking about **winter storms**, please click on a circle between the pair of words that best describes your feelings.

Stressed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Calm	<input type="radio"/>
Displeased	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Pleased	<input type="radio"/>
Sad	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Happy	<input type="radio"/>
Depressed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Elated	<input type="radio"/>

13. Have you or your family members, neighbors, friends, or associates ever experienced property damage, personal injury, or loss of life from a **winter storm**? Please select all that apply.

- 1 - No
- 2 - Yes, for you personally
- 3 - Yes, for family
- 4 - Yes, for neighbors
- 5 - Yes, for close friends or associates

14. If you were to live in your neighborhood for the rest of your life, what is the probability that you or one of your neighbors will experience property damage, personal injury, or loss of life from a **winter storm**? Please indicate the probability as a *percent*.

\_\_\_\_\_ Percent

15. Using a scale from 1 to 10, where 1 means *strongly disagree* and 10 means *strongly agree*, how do you rate your agreement or disagreement with the following statements:

	Strongly Disagree										Strongly Agree
<i>My car handles snow very well.</i>	1	2	3	4	5	6	7	8	9	10	NA
<i>Driving in the snow makes me nervous.</i>	1	2	3	4	5	6	7	8	9	10	NA
<i>I don't drive if it's snowing.</i>	1	2	3	4	5	6	7	8	9	10	NA
<i>Shoveling snow is a nuisance.</i>	1	2	3	4	5	6	7	8	9	10	NA
<i>I have access to a snowblower.</i>	1	2	3	4	5	6	7	8	9	10	NA
<i>My job allows me to telecommute during bad weather.</i>	1	2	3	4	5	6	7	8	9	10	NA
<i>As an essential employee, I am required to show up for work no matter the weather.</i>	1	2	3	4	5	6	7	8	9	10	NA
<i>It's difficult to find someone to watch the kids when there's a snow day.</i>	1	2	3	4	5	6	7	8	9	10	NA
<i>I can easily stay home to watch my children if there's a snow day.</i>	1	2	3	4	5	6	7	8	9	10	NA
<i>Winter storms influence me to change my schedule.</i>	1	2	3	4	5	6	7	8	9	10	NA
<i>I enjoy snow activities such as skiing, sledding, snowshoeing, etc.</i>	1	2	3	4	5	6	7	8	9	10	NA

16. Using a scale from 1 to 10, where 1 means *strongly disagree* and 10 means *strongly agree*, please rate your agreement or disagreement with the following. Understanding the risks posed by **winter storms** is:

	Strongly Disagree										Strongly Agree
<i>Wise</i>	1	2	3	4	5	6	7	8	9	10	
<i>Useful</i>	1	2	3	4	5	6	7	8	9	10	
<i>Valuable</i>	1	2	3	4	5	6	7	8	9	10	
<i>Beneficial</i>	1	2	3	4	5	6	7	8	9	10	

**17. Using a scale from 1 to 10, where 1 means *strongly disagree* and 10 means *strongly agree*, please rate your agreement or disagreement with the following statements.**

	<i>Strongly Disagree</i>										<i>Strongly Agree</i>									
<i>I can't make sense of information about winter storms.</i>	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
<i>When it comes to information about winter storms, I don't know how to separate facts from fiction.</i>	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
<i>Most information about winter storms is too technical for me to understand.</i>	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
<i>I can't understand information about winter storms even if I make an effort.</i>	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10

**18. Using a scale from 1 to 10, where 1 means *strongly disagree* and 10 means *strongly agree*, please rate your agreement or disagreement with the following statements.**

	<i>Strongly Disagree</i>										<i>Strongly Agree</i>									
<i>My friends expect me to know something about winter storms.</i>	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
<i>Most people who are important to me think I should know something about winter storms.</i>	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
<i>My family expects me to know something about winter storms.</i>	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10

## 4. Part III – Current Knowledge

*Note: Only one question was seen by each respondent.*

19. The National Weather Service issues a **“Winter Storm Warning”** when...

- 1 - A storm that does not pose a direct threat to life or property is imminent.
- 2 - A storm that may cause damage to property or pose life threatening conditions is imminent.
- 3 - A storm that may cause damage to property or pose life threatening conditions is possible.

20. The National Weather Service issues a **“Winter Weather Advisory”** when...

- 1 - A storm that does not pose a direct threat to life or property is imminent.
- 2 - A storm that may cause damage to property or pose life threatening conditions is imminent.
- 3 - A storm that may cause damage to property or pose life threatening conditions is possible.

21. The National Weather Service issues a **“Winter Storm Watch”** when...

- 1 - A storm that does not pose a direct threat to life or property is imminent.
- 2 - A storm that may cause damage to property or pose life threatening conditions is imminent.
- 3 - A storm that may cause damage to property or pose life threatening conditions is possible.

5.

## 6. Part IV – Prototype Testing

Now, we have a few questions about **WINTER WEATHER** MESSAGES and how you might respond to them in the future. In this section of the survey, it is important that you are realistic and honest about how you might respond to the different scenarios. Government officials may consider your responses when making decisions about how to issue messages in the future.

*Note: At this point, respondents are assigned to one of five prototypes:*

- *Current system*
- *Prototype 1*
- *Prototype 2*
- *Prototype 3*
- *Prototype 4*

*Respondents are also assigned to one of the upgrade/downgrade scenarios defined for the hazard. For winter weather, there are three possible upgrade/downgrade scenarios:*

- *Warning with an upgrade*
- *Advisory with an upgrade*
- *Warning with a downgrade*

*The respondents are then asked to respond to four prompts; the first prompt is a baseline prompt and is the same across all surveys and the second to fourth prompts use either the current system or prototype language. As an example of how this works, the following provides the sequence for the current system for a the “warning with an upgrade” scenario.*

*Note: one-half of respondents were provided with background information on how to interpret the prototypes they were assigned. The following is the information provided for the current system used in this example:*

**[Prompt 1: Base information; all respondents see the base information]**

**22. While you are at home on a Sunday, during daylight hours, if you were to learn that the NWS is forecasting the potential for 6-10 inches of snow on Wednesday, which of the following most accurately describes what you would do?**

- 1 - Nothing – I would continue my current activities as usual
- 2 - Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc.
- 3 - Prepare – I would start preparing for the storm such as buying or ensuring I had enough salt, checking snow blower, gassing up the car, purchasing groceries, setting up a babysitter, etc.
- 4 - Take some action – I would continue daily activities, but allow more time
- 5 - Take protective action – I would cancel activities, prepare to telecommute or take a day off from work, etc.

**23. Given the forecast information provided, how likely are you to do the following:**

	<i>Very Unlikely</i>				<i>Very Likely</i>
	1	2	3	4	5
<i>Monitor weather forecasts closely</i>					
<i>Prepare for the storm by buying or ensuring I had enough salt, checking snow blower, gassing up the car, purchasing groceries, setting up a babysitter, etc.</i>	1	2	3	4	5
<i>Take protective action such as canceling activities, preparing to telecommute or taking a day off from work, etc.</i>	1	2	3	4	5

**24. To what extent do you agree with the following statements**

	<i>Strongly disagree</i>							<i>Strongly agree</i>		
	1	2	3	4	5	6	7	8	9	10
The information provided in the forecast was useful										
The information provided in the forecast was understandable	1	2	3	4	5	6	7	8	9	10
I am confident that the forecasted conditions will occur	1	2	3	4	5	6	7	8	9	10

[Prompt 2: NWS issues a “watch”; all respondents see the watch.]

**25. Now imagine that it is still Sunday and that the NWS has issued a WINTER STORM OUTLOOK for your local area with the potential for 6-10 inches of snow, which of the following most accurately describes what you would do?**

- 1 - Nothing – I would continue my current activities as usual
- 2 - Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc.
- 3 - Prepare – I would start preparing for the storm such as buying or ensuring I had enough salt, checking snow blower, gassing up the car, purchasing groceries, setting up a babysitter, etc.
- 4 - Take some action – I would continue daily activities, but allow more time
- 5 - Take protective action – I would cancel activities, prepare to telecommute or take a day off from work, etc.

**26. Given the forecast information provided, how likely are you to do the following:**

	<i>Very Unlikely</i>				<i>Very Likely</i>
	1	2	3	4	5
<i>Monitor weather forecasts closely</i>					
<i>Prepare for the storm by buying or ensuring I had enough salt, checking snow blower, gassing up the car, purchasing groceries, setting up a babysitter, etc.</i>	1	2	3	4	5
<i>Take protective action such as canceling activities, preparing to telecommute or taking a day off from work, etc.</i>	1	2	3	4	5

**27. To what extent do you agree with the following statements**

	<i>Strongly disagree</i>							<i>Strongly agree</i>		
	1	2	3	4	5	6	7	8	9	10
The information provided in the forecast was useful										
The information provided in the forecast was understandable	1	2	3	4	5	6	7	8	9	10
I am confident that the forecasted conditions will occur	1	2	3	4	5	6	7	8	9	10

[Prompt 3: NWS issues a “Warning” or an “Advisory”; what the respondent sees depends on what scenario they are assigned to. This is a warning.]

**28. Now imagine that it is Monday evening and The NWS has issued a WINTER STORM WARNING for 6-10 inches of snow starting Wednesday morning through the evening. Which of the following most accurately describes what you would do?**

- 1 - Nothing – I would continue my current activities as usual
- 2 - Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc.
- 3 - Prepare – I would start preparing for the storm such as buying or ensuring I had enough salt, checking snow blower, gassing up the car, purchasing groceries, setting up a babysitter, etc.
- 4 - Take some action – I would continue daily activities, but allow more time
- 5 - Take protective action – I would cancel activities, prepare to telecommute or take a day off from work, etc.

**29. Given the forecast information provided, how likely are you to do the following:**

	<i>Very Unlikely</i>				<i>Very Likely</i>
	1	2	3	4	5
<i>Monitor weather forecasts closely</i>	1	2	3	4	5
<i>Prepare for the storm by buying or ensuring I had enough salt, checking snow blower, gassing up the car, purchasing groceries, setting up a babysitter, etc.</i>	1	2	3	4	5
<i>Take protective action such as canceling activities, preparing to telecommute or taking a day off from work, etc.</i>	1	2	3	4	5

**30. To what extent do you agree with the following statements**

	<i>Strongly disagree</i>							<i>Strongly agree</i>		
	1	2	3	4	5	6	7	8	9	10
The information provided in the forecast was useful	1	2	3	4	5	6	7	8	9	10
The information provided in the forecast was understandable	1	2	3	4	5	6	7	8	9	10
I am confident that the forecasted conditions will occur	1	2	3	4	5	6	7	8	9	10

[Prompt 4: NWS either upgrades or downgrades the warning/advisory; this is a warning upgrade]

**31. Now imagine that it is Tuesday evening and that you received the following information. "The NWS has changed their forecast to a WINTER STORM WARNING now expecting 14-18 inches of snow starting on Wednesday morning through the evening." Which of the following most accurately describes what you would do?**

- 1 - Nothing – I would continue my current activities as usual
- 2 - Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc.
- 3 - Prepare – I would start preparing for the storm such as buying or ensuring I had enough salt, checking snow blower, gassing up the car, purchasing groceries, setting up a babysitter, etc.
- 4 - Take some action – I would continue daily activities, but allow more time
- 5 - Take protective action – I would cancel activities, prepare to telecommute or take a day off from work, etc.

**32. Given the forecast information provided, how likely are you to do the following:**

	<i>Very Unlikely</i>				5	<i>Very Likely</i>
	1	2	3	4	5	
<i>Monitor weather forecasts closely</i>						
<i>Prepare for the storm by buying or ensuring I had enough salt, checking snow blower, gassing up the car, purchasing groceries, setting up a babysitter, etc.</i>	1	2	3	4	5	
<i>Take protective action such as canceling activities, preparing to telecommute or taking a day off from work, etc.</i>	1	2	3	4	5	

**33. To what extent do you agree with the following statements**

	<i>Strongly disagree</i>							<i>Strongly agree</i>		
	1	2	3	4	5	6	7	8	9	10
The information provided in the forecast was useful										
The information provided in the forecast was understandable	1	2	3	4	5	6	7	8	9	10
I am confident that the forecasted conditions will occur	1	2	3	4	5	6	7	8	9	10

## 7. Part V - Sources

### 34. How closely do you follow ...

<i>Your local weather</i>	Very closely	Somewhat closely	Not very closely	Not at all closely	No Answer
<i>The weather where your friends or family live</i>	Very closely	Somewhat closely	Not very closely	Not at all closely	No Answer
<i>National Weather</i>	Very closely	Somewhat closely	Not very closely	Not at all closely	No Answer

### 35. Thinking about the weather, how often do you get weather information...

<i>a. On a desktop or laptop computer</i>	Often	Sometimes	Hardly Ever	Never	No Answer
<i>b. On a mobile device (such as a smartphone or tablet)</i>	Often	Sometimes	Hardly Ever	Never	No Answer

If 35a = "often," "sometimes," or "hardly ever" AND 35b = "often," "sometimes," or "hardly ever"; then go to 36, else skip to 37.

### 36. How do you prefer to get your weather information?

- 1 - On a desktop or laptop
- 2 - On a mobile device (such as a smartphone or tablet)

### 37. How often do you...

<i>Read weather in print?</i>	Often	Sometimes	Hardly Ever	Never	No Answer
<i>Listen to weather on the radio?</i>	Often	Sometimes	Hardly Ever	Never	No Answer
<i>Watch local television weather?</i>	Often	Sometimes	Hardly Ever	Never	No Answer
<i>Watch national evening network television weather?</i>	Often	Sometimes	Hardly Ever	Never	No Answer
<i>Watch cable television weather (such as The Weather Channel, WeatherNation, or AccuWeather)?</i>	Often	Sometimes	Hardly Ever	Never	No Answer
<i>Get weather from a social networking site (such as Facebook or Twitter)?</i>	Often	Sometimes	Hardly Ever	Never	No Answer
<i>Get weather from a website or application?</i>	Often	Sometimes	Hardly Ever	Never	No Answer

**38. Which of the following would you say you prefer for getting *daily* weather information? (choose one)**

- 1 - Reading weather in a print newspaper
- 2 - Listening to weather on the radio
- 3 - Watching weather on television
- 4 - Getting weather from a social networking site (such as Facebook or Twitter)
- 5 - Getting weather from a website or app

**39. Which of the following would you say you prefer for getting *winter storm* information? (choose one)**

- 1 - Reading weather in a print newspaper
- 2 - Listening to weather on the radio
- 3 - Watching weather on television
- 4 - Getting weather from a social networking site (such as Facebook or Twitter)
- 5 - Getting weather from a website or app

## 8. Part VI – Final Demographics

**40. What is the highest level of education you have completed?**

- 1 – Elementary, junior high or some high school
- 2 - High school graduate/GED
- 3 - Some college/vocational school
- 4 - College graduate
- 5 - Some graduate work
- 6 - Master's degree
- 7 - Doctorate (of any type)
- 8 - Other degree [Verbatim]

**41. Are you male or female?**

- 0 – Female
- 1 – Male

**42. Are you, yourself, of Hispanic or Latino origin or descent, such as Mexican, Puerto Rican, Cuban, or other Spanish background?**

- 0 - No, I am not of Hispanic or Latino origin or descent.
- 1 - Yes, I am of Hispanic or Latino origin or descent.

**43. Which of the following best describes your race?**

- 1 - White
- 2 - Black or African American
- 3 - American Indian or Alaska Native
- 4 - Asian
- 5 - Native Hawaiian or Pacific Islander

**44. Thinking specifically about the past 12 months, what was your annual household income from all sources?**

- 1 - Less than \$24,999
- 2 - \$25,000 – \$49,999
- 3 - \$50,000 – \$99,999
- 4 - \$100,000 – \$199,999
- 5 - \$200,000 or more

End of Survey

### Hazard-Specific Customizations

**Overall:** Throughout the survey instrument above, the term “winter storm” (or some variant) appears in a number of places in the question text and in some response options. The other hazard-based surveys simply replaced that term with the appropriate one for the survey. For example, in the thunderstorms survey, we used “thunderstorms” (or some variant) in place of “winter storm.”

#### Question 11

Survey	Customized Information
Winter Weather Mild	<ul style="list-style-type: none"> <li>• Snow storm</li> <li>• 3-inch snow storm</li> <li>• 12-inch snow storm</li> </ul>
Thunderstorms	<ul style="list-style-type: none"> <li>• Thunderstorm</li> <li>• Thunderstorm with large hail</li> <li>• Thunderstorm with damaging winds</li> </ul>
Tornadoes	<ul style="list-style-type: none"> <li>• 65 - 85 mph (Tornado)</li> <li>• 111 - 135 mph (Strong Tornado)</li> <li>• 166 - 200 mph (Violent Tornado)</li> </ul>
Coastal Flooding	<ul style="list-style-type: none"> <li>• Coastal flood</li> <li>• High tide combined with a storm</li> <li>• Storm surge</li> </ul>
Flash Flooding	<ul style="list-style-type: none"> <li>• Heavy rain event</li> <li>• Flood</li> <li>• Flash flood</li> </ul>
Areal Flooding	<ul style="list-style-type: none"> <li>• Heavy rain event</li> <li>• Flood</li> <li>• River flood</li> </ul>

#### Question 15

Survey	Customized Information
Winter Weather Mild	Same as winter cold
Thunderstorms	<ul style="list-style-type: none"> <li>• My car handles wind and rain very well.</li> <li>• Driving in a thunderstorm makes me nervous.</li> <li>• I have Homeowner's Insurance or Renter's Insurance in case wind, rain, and/or hail damage my home.</li> <li>• I have access to a storm shelter or basement.</li> <li>• My job allows me to telecommute during bad weather.</li> <li>• As an essential employee, I am required to show up for work no matter the weather.</li> <li>• Thunderstorms influence me to change my schedule.</li> <li>• I enjoy staying inside during a thunderstorm (e.g., reading a book, watching a movie, sleeping).</li> <li>• Thunderstorms make me anxious and fearful.</li> <li>• The sounds during a thunderstorm are soothing (e.g., rumbling thunder, falling rain).</li> </ul>

Survey	Customized Information
Tornadoes	<ul style="list-style-type: none"> <li>• As an essential employee, I am required to show up for work no matter the weather.</li> <li>• I feel safe in my home during a tornado.</li> <li>• Potential tornadoes influence me to change my schedule.</li> <li>• I have a plan of action for my family when tornadoes are forecasted.</li> <li>• My job allows me to telecommute during bad weather.</li> <li>• I have access to a tornado shelter or basement.</li> <li>• Potential tornadoes make me anxious and fearful.</li> <li>• I have Homeowner's Insurance or Renter's Insurance in case a tornado damages my home.</li> </ul>
Coastal Flooding	<ul style="list-style-type: none"> <li>• My car handles wind and rain very well.</li> <li>• Driving in heavy rain makes me nervous.</li> <li>• While driving in heavy rain, I would take an alternate route to avoid low-lying areas.</li> <li>• I have Homeowner's Insurance or Renter's Insurance in case flooding damages my home.</li> <li>• My house has a second (or upper floor) that I can access easily.</li> <li>• My job allows me to telecommute during bad weather.</li> <li>• As an essential employee, I am required to show up for work no matter the weather.</li> <li>• Potential flooding influences me to change my schedule.</li> <li>• Hearing about potential flooding makes me anxious and fearful.</li> <li>• I would evacuate my home when instructed by local authorities.</li> <li>• I feel it's important to prepare my home for an impending flood.</li> </ul>
Flash Flooding	<ul style="list-style-type: none"> <li>• My car handles wind and rain very well.</li> <li>• Driving in heavy rain makes me nervous.</li> <li>• While driving in heavy rain, I would take an alternate route to avoid low-lying areas.</li> <li>• I have Homeowner's Insurance or Renter's Insurance in case flooding damages my home.</li> <li>• My house has a second (or upper floor) that I can access easily.</li> <li>• My job allows me to telecommute during bad weather.</li> <li>• As an essential employee, I am required to show up for work no matter the weather.</li> <li>• Potential flooding influences me to change my schedule.</li> <li>• Hearing about potential flooding makes me anxious and fearful.</li> <li>• I would evacuate my home when instructed by local authorities.</li> <li>• I feel it's important to prepare my home for an impending flood.</li> </ul>
Areal Flooding	<ul style="list-style-type: none"> <li>• My car handles wind and rain very well.</li> <li>• Driving in heavy rain makes me nervous.</li> <li>• While driving in heavy rain, I would take an alternate route to avoid low-lying areas.</li> <li>• I have Homeowner's Insurance or Renter's Insurance in case flooding damages my home.</li> <li>• My house has a second (or upper floor) that I can access easily.</li> <li>• My job allows me to telecommute during bad weather.</li> <li>• As an essential employee, I am required to show up for work no matter the weather.</li> <li>• Potential flooding influences me to change my schedule.</li> <li>• Hearing about potential flooding makes me anxious and fearful.</li> <li>• I would evacuate my home when instructed by local authorities.</li> <li>• I feel it's important to prepare my home for an impending flood.</li> </ul>

**Questions 19 - 21: Current Knowledge Questions [a]**

Survey	Text in Question	Response Options
Winter Weather Mild	Winter Storm Warning	Same as example above
	Winter Weather Advisory	
	Winter Storm Watch	
Thunderstorms	When there is the possibility for thunderstorms to produce damaging winds and/or hail	<ul style="list-style-type: none"> <li>• Severe Thunderstorm Watch</li> <li>• Significant Weather Advisory</li> <li>• Severe Thunderstorm Warning</li> </ul>
	When a thunderstorm is producing winds greater than 40 miles per hour and/or pea-sized (1/4-inch) hail	
	When a thunderstorm is producing winds greater than 58 miles per hour and/or quarter-sized (1-inch) hail or larger	
Tornadoes	When there is the possibility of tornadoes	<ul style="list-style-type: none"> <li>• Tornado Watch</li> <li>• Tornado Warning</li> <li>• Tornado Emergency</li> </ul>
	When a tornado has been spotted or indicated on weather radar	
	When a confirmed, life-threatening tornado capable of causing catastrophic damage has been spotted or observed on weather radar	
Coastal Flooding	When there is the possibility for coastal flooding in the next 36 hours	<ul style="list-style-type: none"> <li>• Coastal Flood Watch</li> <li>• Coastal Flood Advisory</li> <li>• Coastal Flood Warning</li> </ul>
	When coastal flooding with limited impacts occurring	
	When coastal flooding is likely to impact buildings and/or roads	
Flash Flooding	When there is the possibility for flash flooding in the next 12 hours	<ul style="list-style-type: none"> <li>• Flood Watch</li> <li>• Flash Flood Warning</li> <li>• Flash Flood Emergency</li> </ul>
	When flash flooding that could impact buildings and/or roads is occurring or expected shortly	
	When life-threatening, catastrophic flash flooding is observed and causing significant impacts to buildings and/or roads	
Areal Flooding	When there is the possibility for flooding in the next 36 hours	<ul style="list-style-type: none"> <li>• Flood Watch</li> <li>• Flood Advisory</li> <li>• Flood Warning</li> </ul>
	When river levels are elevated or flooding with limited impacts occur	
	When flooding is likely to impact buildings and/or roads	

[a] In the two winter weather surveys, respondents were provided with a term in the question and asked to select from definitions. For the other surveys, respondents were provided with a definition and asked to select a term to match.

**Response Option Customizations Questions 22, 25, 28, and 31**

Survey	Customized Responses
Winter Weather Mild	Same as winter cold
Thunderstorms	<ul style="list-style-type: none"> <li>• Nothing – I would continue my current activities as usual</li> <li>• Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc.</li> <li>• Prepare – I would start preparing such as by taking in loose outdoor items, checking that flashlights work (in case I lose power), and reviewing safety information with those in my home</li> <li>• Take some action – I would cancel or move outdoor activities</li> <li>• Take protective action – I would go indoors and stay away from windows, pull over if in a car, etc.</li> </ul>
Tornadoes	<ul style="list-style-type: none"> <li>• Nothing – I would continue my current activities as usual</li> <li>• Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc.</li> <li>• Prepare – I would start preparing such as bringing in loose outdoor items, checking emergency kit, making sure my shelter is ready if needed, and/or reviewing my family communication plan.</li> <li>• Take some action – I would cancel or move outdoor activities.</li> <li>• Take protective action – I would seek shelter in a safe place, avoiding windows.</li> </ul>
Coastal Flooding	<ul style="list-style-type: none"> <li>• Nothing – I would continue my current activities as usual.</li> <li>• Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc.</li> <li>• Get prepared at home – I would start preparing for potential flooding by doing things such as moving in outdoor furniture and filling my car with fuel.</li> <li>• Get prepared to leave – I would get ready to leave the area on short notice, such as by gathering essential papers and supplies.</li> <li>• Take protective action – I would leave the area immediately if it is safe to do so, avoiding bridges and roads that tend to flood.</li> </ul>
Flash Flooding	<ul style="list-style-type: none"> <li>• Nothing – I would continue driving along the route I had planned.</li> <li>• Monitor – I would listen to the radio or have a passenger monitor weather information on their mobile device.</li> <li>• Take action – I would take an alternate route, avoiding bridges and roads that tend to flood.</li> <li>• Take protective action -- I would stop driving, seek a safe place, and try to get more information about which routes are safe to travel.</li> </ul>
Areal Flooding	<ul style="list-style-type: none"> <li>• Nothing – I would continue my current activities as usual.</li> <li>• Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc.</li> <li>• Get prepared at home – I would start preparing for potential flooding by doing things like putting down sandbags and filling my car with fuel.</li> <li>• Get prepared to leave – I would get ready to leave the area on short notice, such as by gathering essential papers and supplies.</li> <li>• Take protective action – I would leave the area immediately if it is safe to do so, avoiding bridges and roads that tend to flood.</li> </ul>

**Response Option Customizations Questions 23, 26, 29, and 32**

Survey	Customized Responses
Winter Weather Mild	Same as winter cold
Thunderstorms	<ul style="list-style-type: none"> <li>• Monitor weather forecasts closely</li> <li>• Prepare by taking in loose outdoor items, checking that flashlights work, and reviewing safety information with those in my home</li> <li>• Take protective action, such as canceling or moving outdoor activities or seeking shelter</li> </ul>
Tornadoes	<ul style="list-style-type: none"> <li>• Monitor weather forecasts closely</li> <li>• Prepare by bringing in loose items, checking emergency kit, making sure my shelter is ready, and/or reviewing my family communication plan</li> <li>• Take protective action, such as canceling or moving outdoor activities or seeking shelter</li> </ul>
Coastal Flooding	<ul style="list-style-type: none"> <li>• Monitor weather forecasts closely</li> <li>• Prepare by moving in outdoor furniture, filling my car with fuel and gathering essential papers and supplies to leave on short notice</li> <li>• Take protective action, such as leaving the area immediately if it is safe to do so</li> </ul>
Flash Flooding	<ul style="list-style-type: none"> <li>• Monitor weather forecasts closely</li> <li>• Take action by using an alternate route to avoid bridges and roads that tend to flood</li> <li>• Take protective action, such as stopping the car, seeking a safe place, and searching for a safer route to travel</li> </ul>
Areal Flooding	<ul style="list-style-type: none"> <li>• Monitor weather forecasts closely</li> <li>• Prepare by putting down sandbags, filling my car with fuel and gathering essential papers and supplies to leave on short notice</li> <li>• Take protective action, such as leaving the area immediately if it is safe to do so</li> </ul>

## APPENDIX B:

### Percentages of Odds Ratios Significantly Greater and Less than 1.0 Cross-Tabulated by Prompt Levels and Protective Response

#### WINTER WEATHER MILD

#### Percentages of All Estimates Significantly Greater and Less than 1.0 at the Watch Level, by Prototype and Protective Response Variable, Winter Mild Survey

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	33%	0%	33%	0%	0%
Prototype 2	0%	0%	0%	0%	33%	0%	33%	0%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	0%	0%	0%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	3		3		3		3	

[a] This is the total for each prototype.

#### Percentages of All Estimates Significantly Greater and Less than 1.0 at the Advisory Level, by Prototype and Protective Response Variable, Winter Mild Survey

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	0%	0%	0%	50%	0%
Prototype 2	0%	0%	0%	0%	0%	0%	100%	0%
Prototype 3	0%	50%	0%	0%	0%	0%	0%	0%
Prototype 4	0%	0%	0%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Warning Level, by Prototype and Protective Response Variable, Winter Mild Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	33%	33%	0%	0%	0%	0%	0%
Prototype 2	0%	33%	0%	0%	0%	0%	33%	0%
Prototype 3	0%	33%	33%	0%	0%	0%	33%	0%
Prototype 4	33%	0%	67%	0%	0%	0%	67%	0%
Total Number of Estimates [a]	3		3		3		3	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Emergency Level, by Prototype and Protective Response Variable, Winter Mild Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 2	0%	0%	0%	0%	100%	0%	100%	0%
Prototype 3	0%	0%	0%	0%	100%	0%	0%	0%
Prototype 4	0%	0%	0%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	1		1		1		1	

[a] This is the total for each prototype.

**WINTER WEATHER COLD**

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Watch Level, by Prototype and Protective Response Variable, Winter Cold Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	67%	0%	33%	0%	67%	0%	67%
Prototype 2	33%	67%	0%	33%	0%	33%	0%	0%
Prototype 3	0%	67%	0%	33%	0%	33%	0%	0%
Prototype 4	0%	67%	0%	33%	0%	0%	0%	33%
Total Number of Estimates [a]	3		3		3		3	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Advisory Level, by Prototype and Protective Response Variable, Winter Cold Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	0%	100%	0%	0%	0%
Prototype 2	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 3	0%	0%	0%	50%	50%	0%	0%	50%
Prototype 4	50%	0%	0%	0%	50%	0%	0%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Warning Level, by Prototype and Protective Response Variable, Winter Cold Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	33%	0%	0%	33%	0%	0%	0%	0%
Prototype 2	33%	0%	0%	0%	0%	0%	0%	0%
Prototype 3	33%	0%	33%	0%	67%	0%	67%	0%
Prototype 4	0%	0%	0%	0%	33%	0%	0%	0%
Total Number of Estimates [a]	3		3		3		3	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Emergency Level, by Prototype and Protective Response Variable, Winter Cold Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	0%	0%	100%	0%	100%
Prototype 2	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	0%	0%	0%	0%	0%	0%	0%	100%
Total Number of Estimates [a]	1		1		1		1	

[a] This is the total for each prototype.

**THUNDERSTORMS**

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Watch Level, by Prototype and Protective Response Variable, Thunderstorms Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	100%	0%	100%	0%	100%	0%	100%
Prototype 2	0%	100%	0%	100%	0%	100%	0%	100%
Prototype 3	0%	100%	0%	100%	0%	100%	0%	100%
Prototype 4	0%	100%	0%	100%	0%	100%	0%	100%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Advisory Level, by Prototype and Protective Response Variable, Thunderstorms Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	100%	0%	0%	0%	50%	0%	50%	0%
Prototype 2	0%	0%	50%	0%	0%	0%	50%	0%
Prototype 3	50%	0%	0%	0%	0%	0%	50%	0%
Prototype 4	50%	0%	0%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Warning Level, by Prototype and Protective Response Variable, Thunderstorms Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	50%	0%	0%	0%	50%	0%	50%
Prototype 2	0%	50%	0%	0%	0%	50%	0%	50%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	0%	0%	50%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each prototype.

**TORNADOES**

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Watch Level, by Prototype and Protective Response Variable, Tornadoes Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	100%	0%	0%	0%	100%	0%	100%
Prototype 2	100%	0%	0%	0%	0%	0%	0%	0%
Prototype 3	100%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	0%	0%	0%	0%	0%	100%	0%	0%
Total Number of Estimates [a]	1		1		1		1	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Warning Level, by Prototype and Protective Response Variable, Tornadoes Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	100%	0%	0%	0%	0%	0%	0%
Prototype 2	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	100%	0%	0%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	1		1		1		1	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Emergency Level, by Prototype and Protective Response Variable, Tornadoes Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	100%	0%	0%	0%	100%	0%	100%
Prototype 2	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	0%	0%	0%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	1		1		1		1	

[a] This is the total for each prototype.

**COASTAL FLOODING**

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Watch Level, by Prototype and Protective Response Variable, Coastal Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	100%	0%	0%	0%	50%	0%	0%
Prototype 2	0%	0%	0%	0%	100%	0%	100%	0%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	0%	50%	0%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Advisory Level, by Prototype and Protective Response Variable, Coastal Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	100%	0%	0%	0%	100%	0%	0%	0%
Prototype 2	100%	0%	0%	0%	100%	0%	100%	0%
Prototype 3	0%	100%	0%	100%	0%	100%	0%	100%
Prototype 4	100%	0%	100%	0%	100%	0%	100%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Warning Level, by Prototype and Protective Response Variable, Coastal Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 2	50%	0%	50%	0%	0%	0%	50%	0%
Prototype 3	50%	50%	50%	0%	0%	50%	50%	50%
Prototype 4	100%	0%	50%	0%	0%	0%	50%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Emergency Level, by Prototype and Protective Response Variable, Coastal Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	0%	100%	0%	0%	0%
Prototype 2	100%	0%	100%	0%	100%	0%	100%	0%
Prototype 3	100%	0%	100%	0%	100%	0%	100%	0%
Prototype 4	100%	0%	100%	0%	100%	0%	100%	0%
Total Number of Estimates [a]	1		1		1		1	

[a] This is the total for each prototype.

**FLASH FLOODING**

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Watch Level, by Prototype and Protective Response Variable, Flash Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	50%	0%	0%
Prototype 2	50%	0%	0%	0%	25%	0%
Prototype 3	0%	0%	0%	0%	0%	0%
Prototype 4	0%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	2		2		4	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Warning Level, by Prototype and Protective Response Variable, Flash Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	50%	0%	0%	0%	0%	0%
Prototype 2	0%	0%	0%	0%	0%	0%
Prototype 3	0%	100%	0%	100%	0%	100%
Prototype 4	100%	0%	50%	0%	50%	0%
Total Number of Estimates [a]	2		2		4	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Emergency Level, by Prototype and Protective Response Variable, Flash Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	100%	0%	0%	0%	75%
Prototype 2	0%	0%	0%	0%	0%	0%
Prototype 3	0%	0%	0%	0%	0%	0%
Prototype 4	0%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	2		2		4	

[a] This is the total for each prototype.

**AREAL FLOODING**

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Watch Level, by Prototype and Protective Response Variable, Areal Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	67%	0%	67%	0%	33%	0%	33%
Prototype 2	33%	0%	0%	0%	33%	0%	0%	0%
Prototype 3	0%	0%	0%	33%	0%	0%	0%	0%
Prototype 4	0%	0%	0%	0%	0%	33%	0%	0%
Total Number of Estimates [a]	3		3		3		3	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Advisory Level, by Prototype and Protective Response Variable, Areal Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	50%	0%	50%	0%	50%	0%
Prototype 2	50%	0%	50%	0%	50%	0%	100%	0%
Prototype 3	0%	100%	0%	0%	0%	50%	0%	100%
Prototype 4	50%	0%	50%	0%	0%	0%	50%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Warning Level, by Prototype and Protective Response Variable, Areal Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 2	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 3	0%	100%	0%	33%	0%	33%	0%	67%
Prototype 4	67%	0%	33%	0%	67%	0%	100%	0%
Total Number of Estimates [a]	3		3		3		3	

[a] This is the total for each prototype.

**Percentages of All Estimates Significantly Greater and Less than 1.0 at the Emergency Level, by Prototype and Protective Response Variable, Areal Flooding Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 2	100%	0%	0%	0%	100%	0%	100%	0%
Prototype 3	100%	0%	0%	0%	0%	0%	100%	0%
Prototype 4	100%	0%	0%	0%	100%	0%	100%	0%
Total Number of Estimates [a]	1		1		1		1	

[a] This is the total for each prototype.



# Hazard Simplification Project:

Generalizable Survey for Excessive Heat and High Winds

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## Final Report

*Prepared for:*  
National Weather Service  
Silver Spring, MD

*Prepared by:*  
Castle Williams, Ph.D. Student  
University of Georgia  
NSF GRIP Intern

**June 1, 2018**

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## Executive Summary

The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings to the United States to protect life and property. This is accomplished by issuing **watches, warnings, advisories (WWA)**, and other information products to communicate the threats posed by hazardous weather situations. With previous studies acknowledging that many members of the general public may not understand the distinctions between the watch, warning, and advisory terminology, the NWS embarked on an extensive research endeavor (called the **Hazard Simplification Project**) to begin addressing some of these concerns. With initial efforts on this project dating back to 2011, the infusion of social science engagement in 2013/2014 ignited further inquiry into the status of the WWA system. As a result, several projects have emerged that have sought to better understand the knowledge and use of the WWA system among all end users. Until this point, a majority of the research efforts sponsored by the NWS have been devoted to understanding the WWA system from the perspective of their partners and stakeholders. While these research projects were an important first step, it is also imperative to obtain the general public's perspective on any and all proposed changes to our weather warning system. As a result, the following research report describes and documents an evaluation of our current WWA language and proposed alternative weather warning language among a generalizable sample of the public.

Through funding provided by the National Science Foundation's (NSF) Graduate Research Internship Project (GRIP), **the following report offers an extension of Eastern Research Group's (ERG) research efforts on the Hazard Simplification Project by investigating additional hazards (i.e., excessive heat – warm regions, excessive heat – cold regions, and high winds)**. Although a separate research endeavor, this report should be treated as a companion piece and as such considerable effort was given to remaining uniform in the development and implementation of these generalizable surveys.

### **Methods:**

In collaboration with various NOAA social scientists, ERG, the NWS, and previous research efforts, a generalizable survey was designed that assessed the following:

- Several easy demographic questions: State of primary residence, primary residence type, environment near residence, number of adults in household, number of children in household.
- General risk and weather-related questions: perceived susceptibility, perceived severity, risk perception as affect, previous hazard experience, adaptive behaviors, gathering capacity, and subjective norms.
- Current WWA knowledge<sup>1</sup>
- A first prototype testing scenario
- A second prototype testing scenario
- Weather information habits: how do individuals receive weather information, frequency of receiving weather information from various sources, etc.

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<sup>1</sup> The surveys developed in this separate research project did not specifically ask about current WWA knowledge; however, additional questions were included that are able to provide some information on this topic.

- Finally, several additional demographic questions were asked: gender, race, age, educational background, Hispanic origin, and annual household income.

The main goal of this survey was to test alternative language to the current WWA system; therefore, four prototypes were developed that sought to examine alternative WWA headlines in comparison to the current system. In all, the generalizable survey assessed five prototypes - current system plus the four newly developed prototypes. Table ES-1 provides a breakdown of the five prototypes, and the goals of each prototype can be described as follows:

- **Current System:** Gathering data on the public’s understanding of the current system.
- **Prototype 1: Outlook, Warning, Warning, Warning:** This prototype was used for theoretical purposes. Specifically, we wanted to test whether people anchor to headlines *or* information. Thus, we used the *same* “Warning” headline for every level, but only changed the information we gave them. This prototype also allows for testing a new headline for “Watch” – “Outlook.”
- **Prototype 2: Notice, Alert, Warning, Emergency:** This prototype follows a similar pattern to our current system; however, allows us to change the headlines for “Watch” and “Advisory” as previous research has found these headlines in the current system to be problematic.
- **Prototype 3: Possible X Event, (Minor), Moderate, Severe, Extreme Warnings.** This prototype is a larger overhaul of the system. It changes the word for “Watch” to “Possible X Event,” where X is the hazard (e.g., Possible Winter Weather Event). The headline “Warning” is maintained while using adjectives to convey different levels of risk.
- **Prototype 4: Possible X Conditions, Level Orange, Level Red, Level Purple Warnings.** This prototype is also a larger overhaul of the system. It changes the word “Watch” to “Possible X Conditions,” where X is the hazard (e.g., Possible Winter Weather Conditions). The word “Warning” is maintained while using colors to denote different levels of risk.

**Table ES-1. Five Prototypes Assessed in the Generalizable Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	X Watch	X Outlook	X Notice	Possible X Event	Possible X Conditions
Advisory level	X Advisory	X Warning	X Alert	Moderate X Warning	Level Orange X Warning
Warning level	X Warning	X Warning	X Warning	Severe X Warning	Level Red X Warning
Emergency level	X Emergency	X Warning	X Emergency	Extreme X Warning	Level Purple X Warning

Thinking specifically about the hazards tasked by this research endeavor, it was decided in collaboration with the NWS that the surveys and prototypes would address the following:

**Excessive Heat (both regions):**

- The current WWA messages (i.e., Excessive Heat Watch, Heat Advisory, and Excessive Heat Warning) would constitute the current system prototype.

- The excessive heat prototypes would be split into two surveys: Excessive Heat – Warm Regions and Excessive Heat – Cold Regions. This would allow us to account for the use of headlines across different geographical areas, with different issuance criteria.
- The excessive heat prototypes would only retain the “Advisory” headline and “Warning” headline.
- The excessive heat prototypes would only progress linearly and would not account for downgrades. Therefore, respondents saw a continuance of the “Advisory” level condition to keep the number of prompt levels consistent across all hazards.
- The excessive heat prototypes would account for the upcoming consolidation efforts by dropping “Excessive” from the new prototype headlines.
- Details about the prototypes associated with the excessive heat surveys can be found in Table ES-2.

**Table ES-2. Prototypes Assessed in the Excessive Heat Surveys (Warm and Cold Regions)**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level (“Advisory,” except Current System)	Excessive Heat Watch	Heat Warning	Heat Alert	Severe Heat Warning	Level Orange Heat Warning
Advisory level (Continuance of the “Advisory”)	Heat Advisory	Heat Warning	Heat Alert (Cont.)	Severe Heat Warning (Cont.)	Level Orange Heat Warning (Cont.)
Warning level	Excessive Heat Warning	Heat Warning	Heat Warning	Extreme Heat Warning	Level Red Heat Warning

**High Wind:**

- The current WWA messages (i.e., High Wind Watch, Wind Advisory, and High Wind Warning) would constitute the current system prototype.
- Two scenarios would be used: Advisory with an Upgrade and Warning with a Downgrade.
- The high wind prototypes would account for the upcoming consolidations efforts by dropping “High” from the new prototype headlines.
- Details about the prototypes associated with the high wind survey can be found in Table ES-3.

**Table ES-3. Prototypes Assessed in the High Wind Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	High Wind Watch	Wind Outlook	Wind Notice	Possible Wind Event	Possible High Winds
Advisory level	Wind Advisory	Wind Warning	Wind Alert	Moderate Wind Warning	Level Orange Wind Warning
Warning level	High Wind Warning	Wind Warning	Wind Warning	Severe Wind Warning	Level Red Wind Warning

To effectively evaluate the newly-designed prototypes and the current system, it was determined that it would be best to have members of the general public walkthrough a real-world weather scenario that was hypothetically threatening them and their family. Therefore, these surveys included two<sup>2</sup> possible scenarios:

- **Advisory with an Upgrade (AU)** – NWS issues an advisory and then upgrades the situation by issuing a warning in a subsequent message.
- **Warning with a Downgrade (WD)** – NWS issues a warning and then downgrades the situation to an advisory in a subsequent message.

The survey asked about the actions that respondents would take in response to four prompts associated with the scenarios. All participants began with a “Baseline” prompt that only provided weather information, and then progressed through different prompts (i.e., Watch, Advisory, and Warning) based on their randomly assigned scenario (i.e., Advisory with an Upgrade or Warning with a Downgrade). Respondents could select from five actions (1) nothing, (2) monitor, (3) prepare, (4) take some action, and (5) take protective action. The specifics of each action differ by hazard. In addition to their overall action taken, respondents were also asked to provide the likelihood that they would monitor additional forecast information, prepare, and take protective action. Respondents were asked to indicate (on a scale from 1 to 5) their likelihood of performing these actions. Finally, my survey also included several perception variables (perceived risk, perceived urgency, perceived confidence, and probability of occurrence) that assist in understanding an individual’s response to each prototype and their knowledge of the current WWA system.

To analyze these data, we used ordered logistic regression to estimate odds ratios. An *ordered logistic regression analysis* correlates a set of ordered response categories (e.g., overall action taken, likelihood to monitor, likelihood to prepare, and likelihood to act) with a set of explanatory variables (e.g., the prototype the respondent saw, demographics, responses to other questions) to determine the factors that lead to respondents selecting higher or lower categories. The results we present are phrased in terms of odds ratios for the included variables. Odds ratios reflect the increased probability of being in a “higher” response category for increased values of the variable. For example, we estimated odds ratios associated with seeing Prototypes 1-4 relative to seeing the current system; thus, our results allow us to make statements such as “those who saw prototype 1 were 1.5 times more likely to select a more protective action than those who saw the current system wording.” In that example, the odds ratio is the value 1.5. The key value in an odds ratio is 1.0; estimates below 1.0 reflect decreased probabilities of being in higher categories and values above 1.0 reflect increased probabilities of being in higher categories<sup>3</sup>. The statistical significance of an odds ratio is judged by comparing the value to 1.0; values that are significantly different than one are considered statistically significant.

Given this statistical analysis approach, the following results are offered:

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<sup>2</sup> The hazards (excessive heat and high winds) specifically discussed in this report did not have a “Warning with an Upgrade” scenario. In the companion piece, authored by ERG, some hazards include the “Warning with an Upgrade” scenario.

<sup>3</sup> By design, odds ratios cannot be below zero.

## **Findings from the Excessive Heat and High Wind Surveys:**

### ***Overall Results for Current WWA Knowledge:***

**Participants seem to be responding appropriately to the current excessive heat WWA headlines.** This conclusion can be drawn based on the means associated with behavior (i.e., overall action, monitoring, prepare, and protective action) increasing linearly across the conditions. Further, a similar trend is observed among the perception variables (i.e., risk, confidence, urgency, and probability). This conclusion is observed in both the excessive heat cold and warm region surveys.

**Respondents appear to misunderstand the “Wind Advisory” headline in the current system – for both the upgrade and downgrade scenarios.** Instead of an increase in all of the perception variables, respondents perceived less risk, confidence, urgency, and probability when an “Advisory” headline was seen. In fact, their response to these variables was lower than their response to the “Watch” headline.

### ***Overall Results by Prototype and Hazard:***

**Prototypes 1, 2, and 4 performed the best overall in comparison to the current system.** However, Prototype 1 also had several estimates that were significantly less than 1.0 – this should be taken into consideration. It is important to keep in mind that these prototypes only outperformed the current system in roughly one out of five estimates (i.e., Prototype 1), one out of ten estimates (i.e., Prototype 2), and one out of every four estimates (i.e., Prototype 4). While these three prototypes outperformed the current system at times, it was not a staggering result.

**Prototype 3 performed poorly in comparison to the current system.** Prototype 3 only received two estimates that were significantly greater than 1.0 and six estimates that were less than 1.0. Again, this lack of performance was not overwhelming – but noteworthy.

**Table ES-4. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Excessive Heat and Wind Surveys Combined**

<b>Prototype</b>	<b>Significantly Greater Than 1.0</b>	<b>Significantly Less Than 1.0</b>
Prototype 1	17%	10%
Prototype 2	10%	4%
Prototype 3	4%	13%
Prototype 4	25%	10%
Total Number of Estimates [a]	48	

[a] This is the total for each Prototype

### ***Overall Results by Prompt Level:***

**Prototype performance varied by hazard; however, overall they agreed with the conclusions presented above.** The excessive heat surveys from warm and cold regions did not completely agree. Prototypes 1, 2, and 4 outperformed the current system in the Warm Regions, whereas Prototypes 2 and 4 outperformed the current system in the Cold Regions. Again, this outperformance was not an

overwhelming result. For the high wind hazard, Prototype 4 outperformed the current system and the other prototypes. While it also possessed estimates that were significantly less than 1.0, these values were isolated to the “Watch level.”

**The prototypes perform differently within each prompt level.** Although Prototypes 1, 2, and 4 performed best overall, this result varies by prompt level. For example, Prototypes 1 and 4 perform best at the “Advisory level” for High Winds, but Prototypes 2 and 4 perform best when issuing an “Advisory” headline within Excessive Heat. This breakdown by prompt level (in this report and the companion report authored by ERG) may prove beneficial if crafting a “Frankenstein” operational prototype is desirable by the NWS.

**The current wind “Watch” headline (i.e., High Wind Watch) outperforms all of the high wind prototypes at the “Watch level.”** This is evident in Table ES-5 under the “High Wind Estimates” portion of the table, where a high percentage of odds ratio estimates were significantly less than 1.0 at the “Watch level.”

**Table ES-5. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Excessive Heat and Wind Surveys Combined**

Prototype	High Wind Estimates						Excessive Heat Estimates [b]					
	Watch		Advisory		Warning		Watch		Advisory		Warning	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	13%	63%	0%	0%	38%	13%	0%	0%	0%	13%	0%
Prototype 2	0%	13%	25%	0%	0%	13%	25%	0%	0%	0%	13%	0%
Prototype 3	0%	50%	0%	0%	0%	0%	13%	13%	13%	0%	0%	0%
Prototype 4	0%	63%	63%	0%	25%	0%	25%	0%	0%	0%	13%	0%
Total Number of Estimates [a]	8		8		8		8		8		8	

[a] This is the total for each Prototype

[b] The hazards were separated because the Excessive Heat Prototypes did not test “Watch” headlines.

**Overall Results by Protective Response Variable:**

**Prototypes 1 and 4 were both more effective at eliciting action in comparison to the current system.** For both the “Action Taken” and “Likelihood of Acting” response variables, Prototypes 1 and 4 performed the best.

**Prototypes 2 and 4 were both better at increasing the monitoring of weather forecast information in comparison to the current system.** For the “Likelihood of Monitoring” response variable, Prototypes 2 and 4 had a greater percentage of estimates that were significantly larger than 1.0. However, both of these prototypes did have a couple of estimates that were significantly less than 1.0.

**Prototype 4 was more effective at increasing preparation in comparison to the current system.** For the “Likelihood of Preparing” response variable, Prototype 4 had the greatest percentage of estimates that were significantly larger than 1.0. However, this prototype also had a fairly large percentage of estimates than were significantly less than 1.0. Upon further investigation, almost all of the estimates

that were significantly lower than 1.0 occurred under the “Watch” headline, where all prototypes failed to outperform the current system.

**Table ES-6. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Excessive Heat and Wind Surveys Combined**

	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	17%	0%	25%	25%	8%	17%	8%	0%
Prototype 2	8%	0%	17%	8%	8%	8%	8%	0%
Prototype 3	0%	25%	8%	17%	8%	8%	0%	8%
Prototype 4	25%	8%	25%	8%	25%	17%	17%	8%
Total Number of Estimates [a]	12		12		12		12	

[a] This is the total for each Prototype

**Overall Results by Protective Response Variable and Prompt Level:**

Tables ES-7, ES-8, and ES-9 further breakdown the percentages by looking at both protective response variable (i.e., Action taken, Likelihood to Monitor, Likelihood to Prepare, and Likelihood to Act) and prompt level (i.e., Watch level, Advisory level, Warning level). These tables offer additional information to better determine if individuals are taking the *most appropriate actions* at each prompt level. These tables only reflect the high wind surveys, due to the prompt level differences that exist within the excessive heat surveys.

**Prototype 4 performs well at both the “Advisory level” and “Warning level.”** In comparison to the other prototypes, Prototype 4 consistently performs well at both the “Advisory” (Table ES-8) and “Warning level” (Table ES-9). Specifically, at the “Advisory level”, Prototype 4 performs well across all of the protective response variables. At the “Warning level,” Prototype 4 is effective at eliciting action.

**Table ES-7. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Watch level, by Prototype and Protective Response Variable: High Wind Survey**

WATCH LEVEL								
Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	50%	0%	50%	0%	0%
Prototype 2	0%	0%	0%	0%	0%	50%	0%	0%
Prototype 3	0%	50%	0%	100%	0%	100%	0%	50%
Prototype 4	0%	50%	0%	50%	0%	50%	0%	50%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each Prototype

[b] Due to the differences in the excessive heat prototypes, only the breakdown for high winds is shown.

**Table ES-8. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Advisory level, by Prototype and Protective Response Variable: High Wind Survey**

ADVISORY LEVEL								
Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	100%	0%	50%	0%	50%	0%	50%	0%
Prototype 2	50%	0%	0%	0%	0%	0%	50%	0%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	100%	0%	50%	0%	100%	0%	50%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each Prototype

[b] Due to the differences in the excessive heat prototypes, only the breakdown for high winds is shown.

**Table ES-9. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Warning level, by Prototype and Protective Response Variable: High Wind Survey**

WARNING LEVEL								
Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	100%	0%	50%	0%	0%
Prototype 2	0%	0%	0%	50%	0%	0%	0%	0%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	50%	0%	0%	0%	0%	0%	100%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each Prototype

[b] Due to the differences in the excessive heat prototypes, only the breakdown for high winds is shown.

**Recommendations:**

After examining the results and conclusions from the companion report authored by ERG and considering the conclusions described above, the following recommendations are offered:

- **Fixing the “problem” words (i.e., Watch and Advisory) can be a possible solution.**

When examining the overall results by prompt level, Prototype 2 appears to be more effective at the “Watch” level and the “Advisory” level – in comparison to the current system. The goal of

Prototype 2 was to evaluate a similar system to the current one; however, it allowed us to test alternative headlines for “Watch” and “Advisory.” Considering that previous Hazard Simplification projects have noted that emergency managers and broadcast meteorologists were interested in only making minor changes, this could be an solution that considers those needs. **After further examination of the results across different prompt levels, it appears that the transition from “Alert” to “Warning” does not provoke much behavior change. Therefore, replacing “Advisory” with “Alert” may only lead to individuals performing “Warning” level behaviors at the “Advisory” level. As a result, this change may fail to improve the spectrum of understanding that exists surrounding our current weather warning system. This should be strongly considered when thinking about this as a possible solution.**

- **Develop a new message sequence that combines Prototypes 2 and 4.**

As described in both reports, Prototypes 2 and 4 consistently performed better than the current system and other prototypes. However, when examining the overall results by prompt level, Prototype 2 appears to be more effective at the “Watch” level and the “Emergency” level and Prototype 4 consistently performs well at the “Advisory,” and “Warning” levels. To maximize the results of these two prototypes, it is suggested that a new prototype combine the two. Table ES-10 provides one option for a possible “Operational Prototype” when combining Prototype 2 and 4. **The message sequence in the combined column would, based on the data analyses, generate the greatest preparation and protective action response. However, this is only one option for combining the two prototypes.** Additional conversations and further discussion with NWS will be conducted to determine the best approaches to consider.

**Table ES-10. Combined Prototype 2 and 4 Based on Data Analysis Results**

Prompt Level	Prototype 2	Prototype 4	Combined
Watch	X Notice	Possible X Conditions	X Notice
Advisory	X Alert	Level Orange X Warning	Level Orange X Warning
Warning	X Warning	Level Red X Warning	Level Red X Warning
Emergency	X Emergency	Level Purple X Warning	X Emergency

**Additional Thoughts:**

- **Headlines matter.** Prototype 1 was specifically designed to evaluate whether individuals anchor to weather information or the weather-related headlines. Because Prototype 1 performs poorly across most of the hazards, this survey effort reveals the importance of weather headlines when communicating with a general public audience.
- **Any changes to the prototypes should take into account all hazards.** As discussed in the results, the success of the prototypes varied by hazard. Therefore, strong consideration should be given

to each hazard when deciding on a final “Operational Prototype.” Further, other hazards that were not considered during this survey process (i.e., Tropical hazards) should also be considered when deciding on a final “Operational Prototype.” Ask questions such as: Does this prototype make sense for all hazards? Are we staying consistent across all program areas? Will the tropical hazards fit into this “Operational Prototype?”

- **The NWS should continue thinking about the meteorological attributes that will drive each headline change.** The survey discussed in this report mapped meteorological criteria that is currently used by NWS policy to issue *watches, warnings, and advisories*. Therefore, considerable effort should be given to the meteorological attributes that would drive each headline change in a new or modified weather warning system. For example, would it be focused around impacts, confidence, or even a matrix system combining both impacts and confidence? This should be strongly considered as the NWS moves forward with additional testing.

### **Next Steps:**

Given these recommendations, several next steps are proposed for consideration as the NWS continues to evaluate alternatives to the current WWA system:

***Discuss the results of the generalizable survey with members of the weather community, partners, and stakeholders.***

- **Hazard Simplification Workshop 2.0:** Consider conducting another workshop similar to the [Hazard Simplification Workshop in 2015](#). Given the various options and recommendations for creating an “Operational Prototype,” NWS participants, emergency managers, broadcast meteorologists, social scientists, and other relevant partners could assist in finalizing an appropriate “Operational Prototype” that could be evaluated via additional operational testing in the Hazardous Weather Testbed. However, it will be *very important* to develop a core set of goals ahead of the workshop to ensure that a “Operational Prototype” is obtained at the end of the workshop.
- **Hazard Simplification Webinar:** Since the Hazard Simplification Workshop 2.0 would only allow a select number of participants and would ultimately require travel, webinar(s) in conjunction with the workshop may be considered to obtain feedback from a larger community perspective. This activity could act as a mini “listening tour” to better understand the partner’s/stakeholder’s perspective on the finalized “Operational Prototype.” For example, the NWS could team up with members of the NWA Societal Impacts Committee to co-host a NWA Webinar Wednesday by creating an interactive, online focus group with various members of the community. This could produce additional opportunities to obtain feedback from the weather enterprise, while collaborating with professional organizations in our community.

***Utilize the Hazardous Weather Testbed (HWT) to evaluate the operational viability of a finalized “Operational Prototype.”***

- **Testing operational feasibility of “Operational Prototype” in the HWT:** Consider conducting another operational feasibility study in collaboration with the HWT to test the “Operational Prototype” with NWS forecasters, emergency managers, and broadcast meteorologists using past events and real-world examples. The proposed “Operational Prototype” may seem appropriate on paper, but caveats and shortcomings of the newly proposed system may only arise through further operational testing.
- **Incorporate members of the general public into the HWT process:** Although the results of the generalizable survey allow us to understand the warning language that best resonates with the public, that data only used hypothetical situations. Therefore, it is recommended that members of the general public be included in the HWT process. To my knowledge, this has never been done before. However, if it is important to evaluate the “Operational Prototype” among NWS forecasters, emergency managers, and broadcast meteorologists using past events, then this process should also be conducted with members of the public. This exercise may reveal additional details about the proposed “Operational Prototype” that did not arise when members of the public completed the generalizable survey.
- **Evaluate the feasibility of the “Operational Prototype” in relation to the other NOAA/NWS initiatives:** The use of further testing within the HWT could also provide an opportunity to evaluate the Hazard Simplification “Operational Prototype” with other NOAA/NWS initiatives (e.g., FACETS, PHI, Hazard Services). All of these different projects are progressing independently; however, collaborating with the HWT would allow for feasibility testing of the “Operational Prototype” with these other initiatives. This process was extremely insightful during the previous Hazard Simplification Testbed evaluation; therefore, it is recommended that further testing be conducted that combines all of these initiatives.

***Offer remote and/or on-site internship or research opportunities for students to continue analyzing the Hazard Simplification survey data.***

- The Hazard Simplification survey data collected by myself and ERG contains a plethora of variables and demographic information that was not able to be completely investigated. Therefore, NWS should invest in internship and/or research opportunities for students and early career professionals. For example, the NWS may consider advertising on the [National Science Foundation \(NSF\) Graduate Research Internship Program \(GRIP\)](#) website. This dataset would also be optimal for further investigation by a Masters or Ph.D. student. This could promote further collaborations between the NWS and the academic sectors of the weather enterprise.

***Develop and implement an extensive public education campaign to inform the general public of any changes to the weather warning system.***

- **Conduct focus groups, interviews, and/or surveys to evaluate the audience and test messages.** If changes are made to the weather warning system, then extensive educational

research will need to be conducted. This could involve focus groups, interviews, and/or surveys to better understand your audience and to test any messages developed. Prior to implementing any changes to the weather warning system, this research will need to be conducted and evaluated to better understand the best way to convey and communicate these changes to the general public. Only then, can a major marketing effort occur.

- **Revise K-12 curriculum to emphasize any new changes to the weather warning system.** Since individuals learn about our weather warning system in school, it will be incredibly important to update the K-12 curriculum in schools across the United States. Further, K-12 students can be used as a vehicle to discuss the changes to the weather warning system with their families. This could include sending information home with students, assignments to be completed with the entire family, as well as projects such as creating a family emergency plan.

***Coordinate with all sectors of the weather enterprise and partners/stakeholders to assist with transition to new weather warning system.***

- **Develop a task force or advisory group to assist with weather warning system transition:** If any changes are made to the weather warning system, the NWS may consider developing a taskforce, advisory group, or subcommittee to assist with the transition. This task force/advisory group should be charged with stimulating ideas and activities on matters that pertain to the interests and transition of the weather warning system across all sectors of the weather enterprise and partners/stakeholders. This task force/advisory group should also promote consistency across the entirety of the weather enterprise, to ensure we are all working together toward a common goal. The task force/advisory group should consist of members drawn from the academic, private, emergency manager, and government sectors of our enterprise. Specifically, the government sectors should include representatives from other governmental partners (e.g., Department of Transportation, National Parks Service, and other entities that convey weather-related warnings).
- **Collaborate with professional organizations (e.g., American Meteorological Society, National Weather Association, etc.) and develop subcommittees to assist with weather warning system transition:** If a task force or advisory group is not preferred, the NWS could consider collaborating with several relevant committees within different professional organizations. Some relevant boards/committees include: [AMS Board on Enterprise Communication](#), [AMS Committee on Effective Communication of Weather and Climate Information](#), [NWA Societal Impacts Committee](#), etc. In addition to these professional organizations, NWS may consider reaching out to the [Alliance for Integrative Approaches to Extreme Environmental Events](#) – a newly formed entity that seeks to serve as an organizing mechanism among the various sectors and stakeholders in the hazards community.

## 1.0 Introduction and Overview

The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States in order to protect life and property. A key component of that mission lies in the NWS' ability to effectively communicate weather-related warnings and alerts to various end users. Currently, this is accomplished through the use of **watches, warnings, and advisories (WWA)**. These products are designed to inform communities of impending weather-related hazards and prompt response. Further, watches, warnings, and advisories are communicated to various end users through the NWS website, smart phones (WEA alerts), NOAA Weather Radios, and through other meteorologists and members of the weather community via television and/or radio programs. These end users include, but are not limited to: members of the weather community, transportation and aviation officials, emergency managers, as well as broadcast meteorologists and other media personnel.

With previous studies acknowledging that many members of the general public may not understand the distinctions between the watch, warning, and advisory terminology, the NWS embarked on an extensive research endeavor (called the **Hazard Simplification Project**) to begin addressing some of these concerns. With initial efforts on this project dating back to 2011, the infusion of social science engagement in 2013/2014 ignited further inquiry into the status of the WWA system. As a result, several projects have emerged that seek to better understand the knowledge and use of the WWA system among partners and the general public:

- **Phase 1: HazSimp Focus Groups.** During the summer of 2014, NWS sponsored 20 focus groups at four different locations across the United States. The goal of these focus groups was to obtain stakeholder perspectives (i.e., emergency managers, broadcast meteorologists, other media professionals, NWS Weather Forecast Office (WFO) staff, and members of the general public) and better understand how end users receive and perceive weather and water hazard information – including the WWA system. Major takeaways from this phase of the project include: (1) A spectrum of understanding exists surrounding the current WWA system, ranging from comprehension to complete lack of understanding, (2) a variety of support for either changing the WWA system or leaving it the same, and (3) there was considerable support for additions to the WWA system – including the addition of color and simple explanatory language.
- **Phase 2: AMS Feedback on Prototypes and Case Studies.** During 2015, NWS sponsored two research endeavors: (1) the collection of feedback on the initial prototypes designed as alternatives to the current WWA system at the annual American Meteorological Society (AMS) meeting in Phoenix, AZ and (2) the creation and release of a survey targeting NWS partners. Obtaining feedback from the community at the AMS conference provided some insights and possible paths forward within the Hazard Simplification Project. Specifically, respondents preferred prototypes that suggested more change than those interested in minor changes to the current WWA system. To examine the partner's perspective in more detail, NWS sponsored the release of a survey that examined how NWS and its stakeholders perceive and use the current WWA system. Highlights from this research study include: (1) Emergency managers preferred the current WWA system, while NWS forecasters and media partners desired more change, (2) there was general support for simplifying and reducing the current number of

WWA products, as well as improving the formatting and using concise language, (3) the rigid criteria for issuing WWA products can present collaboration and coordination challenges among WFOs and may contribute to inconsistent messaging.

- **Phase 3: Hazard Simplification Workshop.** The NWS hosted a 3-day Hazard Simplification workshop that included a wide variety of NWS partners (e.g., emergency managers, broadcast meteorologists, members of the private sector, and the social science community) in late 2015. The goals of the workshop were two-fold: (1) develop a set of language-based prototypes that could be tested to replace some or all of the WWA system and (2) to suggest ideas for WWA enhancements that could simplify current NWS hazard messages in the short-term. The results of the Hazard Simplification Workshop were consistent with feedback from several other projects, and included: Participants suggesting to only focus on some of the “problem” language (i.e., Advisory) and others recommended replacing all WWA terms with colors, tiers, and/or actionable phrases. In the short-term, a majority of partners were in favor of consolidating and/or eliminating various hazard message headlines.
- **Phase 3: Hazardous Weather Testbed.** At the suggestion of several workshop participants, some of the prototypes developed during the Hazard Simplification Workshop were examined in the Hazardous Weather Testbed (HWT). The testbed environment provided the opportunity to integrate the prototypes into other NOAA initiatives (PHI, FACETS, etc.). The HWT creates an environment where different NWS partners get to work together using past events and real-time severe weather events to better understand the operational components of these newly developed systems. Within this testbed process, three prototypes – that were developed during the workshop – were evaluated. Major takeaways from the HWT include: (1) the current WWA system is ingrained in forecasters and forecasters had difficulty mapping the newly designed “Be Aware” or “Take Action” headlines to meteorological criteria, (2) the HazSimp alert-level language also influenced the forecasters’ probability choices, such that forecasters tended to choose the HazSimp level first and then draw the probability, and (3) the blending of HazSimp and the Probabilistic Hazard Information (PHI) created some messaging inconsistencies that frustrated broadcast meteorologists and emergency managers.
- **Phase 3: Institutional Study.** In 2016, the NWS sponsored the creation and release of a survey to gauge the degree that different WWA terminology (i.e., watch, warning, and advisory) is embedded or “institutionalized” in organizational decision-making, laws, policies, operating procedures, bylaws, or other activities or processes. Nearly 4,500 responses from 32 sectors (i.e., emergency management, transportation, telecommunication, utilities, etc.) were collected. The study found that “advisory” terminology was the least institutionalized term, and that, on average, organizations need at least a three-month timeframe to incorporate any changes to the current WWA system in their departments. However, this time frame does not include the time needed to educate the public and partners on any changes – and even then three months may not be a realistic timeframe for all organizations.
- **Phase 4: Generalizable Surveys of the General Public.** Until this point, a majority of the the research efforts sponsored by the NWS have been devoted to understanding the WWA system

from the perspective of their partners and stakeholders. These research projects were important, as thinking through the intricacies and caveats of a new weather warning system can best be accomplished with members of the weather community, partners, and stakeholders. However, before pressing forward with newly developed prototypes, it is imperative to obtain the general public's perspective of these alternative approaches and truly gauge their understanding of the current WWA system. As a result, the following research report describes and documents the testing of several weather warning system prototypes among members of the general public.

Through funding provided by the National Science Foundation's (NSF) Graduate Research Internship Project (GRIP), **the following report offers an extension of Eastern Research Group's (ERG) research efforts on the Hazard Simplification Project by investigating additional hazards (i.e., excessive heat – warm regions, excessive heat – cold regions, and high winds)**. Although a separate research endeavor, this report should be treated as a companion piece and as such considerable effort was given to remaining uniform in the development and implementation of these generalizable surveys. Therefore, this final report describes in detail the methodological approach that was taken in creating the questionnaire and study design (Section 2.0), the sampling approach and inclusionary/exclusionary criteria when selecting members of the public to complete these generalizable surveys (Section 3.0), an in-depth discussion of the statistical approach used to evaluate the prototypes shown to the general public (Sections 4.0), followed by a discussion of the results associated with each hazard (Section 5.0 – Section 7.0), a small discussion surrounding the educational component (Section 8.0) and finally a section devoted to conclusions, recommendations, suggested next steps, and lessons learned throughout this process (Section 9.0).

## 2.0 Generalizable Survey Approach and Methodology

The following sections provide a general overview of the methodological approach taken to examine various messaging prototypes. Because this research project offers an extension of ERG’s research efforts in the Hazard Simplification Project, considerable effort was given to remaining uniform with the proposed methodological approach, questionnaire design, and sampling techniques. It is our hope that this uniformity will offer generalizable results comparable to those produced by ERG. This section will begin with a general overview of the prototypes examined (Section 2.1), provide a brief discussion of the scenario-based methodology utilized in the generalizable survey (Section 2.2.), and finally elaborate on the questionnaire design and the survey items used to assess how respondents react to existing WWA headlines compared to the proposed prototypes (Section 2.3).

### 2.1 Prototypes

In collaboration with various NOAA social scientists, ERG, the NWS, and previous Hazard Simplification Project research efforts, four prototypes were developed that sought to examine alternative WWA headlines in comparison to the current system. Taken together, the generalizable survey assessed five prototypes - current system plus the four newly developed prototypes. Table 1 provides a breakdown of the five prototypes, and the goals of each prototype can be described as follows:

- **Current System:** Gathering data on the public’s understanding of the current system.
- **Prototype 1: Outlook, Warning, Warning, Warning:** This prototype was used for theoretical purposes. Specifically, we wanted to test whether people anchor to headlines *or* information. Thus, we used the *same* “Warning” headline for every level, but only change the information in each prompt. This prototype also allows for testing a new headline for “Watch” – “Outlook.”
- **Prototype 2: Notice, Alert, Warning, Emergency:** This prototype follows a similar pattern to our current system; however, allows us to change the headlines for “Watch” and “Advisory” as previous research has found these headlines in the current system to be problematic.
- **Prototype 3: Possible X Event, (Minor), Moderate, Severe, Extreme Warnings.** This prototype is a larger overhaul of the system. It changes the word for “Watch” to “Possible X Event,” where X is the hazard (e.g., Possible Winter Weather Event). The headline “Warning” is maintained while using adjectives to convey different levels of risk.
- **Prototype 4: Possible X Conditions, Level Orange, Level Red, Level Purple Warnings.** This prototype is also a larger overhaul of the system. It changes the word “Watch” to “Possible X Conditions,” where X is the hazard (e.g., Possible Winter Weather Conditions). The word warning is maintained while using colors to denote different levels of risk.

**Table 1. Five Prototypes Assessed in the Generalizable Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	X Watch	X Outlook	X Notice	Possible X Event	Possible X Conditions
Advisory level	X Advisory	X Warning	X Alert	Moderate	Level Orange X Warning
Warning level	X Warning	X Warning	X Warning	Severe	Level Red X Warning
Emergency level	X Emergency	X Warning	X Emergency	Extreme	Level Purple X Warning

Thinking specifically about the hazards tasked by this research project (i.e., excessive heat and high winds), it was decided in collaboration with the NWS that the prototypes would address the following:

**Excessive Heat (both regions):**

- The current WWA messages (i.e., Excessive Heat Watch, Heat Advisory, and Excessive Heat Warning) would constitute the current system prototype.
- The excessive heat prototypes would only retain the “Advisory” headline and “Warning” headline.
- The excessive heat prototypes would only progress linearly and would not account for downgrades. Therefore, respondents saw a continuance of the “Advisory” level condition to keep the number of prompt levels consistent across all hazards.
- The excessive heat prototypes would account for the upcoming consolidation efforts by dropping “Excessive” from the new prototype headlines.

**High Wind:**

- The current WWA messages (i.e., High Wind Watch, Wind Advisory, and High Wind Warning) would constitute the current system prototype.
- Two scenarios would be used: Advisory with an Upgrade and Warning with a Downgrade.
- The high wind prototypes would account for the upcoming consolidation efforts by dropping “High” from the new prototype headlines.

## 2.2 Scenarios and Prompts

To effectively evaluate the newly-designed prototypes and the current system, it was determined that it would be best to have members of the general public walkthrough a real-world weather scenario that was hypothetically threatening them and their family. The scenarios reflected upgrades or downgrades in the risk overtime, and each of the weather hazards had between one and two scenarios. Each real world-scenario was divided into four prompts. The first prompt was a *baseline condition*, where participants were provided with *only* weather information and timing information regarding the hazard being surveyed. This *baseline condition* was exactly the same across all scenarios within a particular weather hazard. The second prompt was always a “*Watch-level*” prompt (see Table 1) and included specific prototype language.

The third and fourth prompts provided either upgrades, continuances, or downgrades that reflect real-life weather situations. Table 2 provides a summary of the prompt sequences used in each scenario for excessive heat and high winds.

**Table 2. Prompt Sequences Associated with Each Upgrade/Downgrade Scenario**

Weather Event	Scenario	Prompt Level Sequence [a]		
		Prompt 2	Prompt 3	Prompt 4
Excessive Heat – Warm	Advisory with upgrade (AU)	Advisory <sup>[b]</sup>	Advisory Cont.	Warning
Excessive Heat – Cold	Advisory with upgrade (AU)	Advisory <sup>[b]</sup>	Advisory Cont.	Warning
High Winds	Warning with downgrade (WD)	Watch	Warning	Advisory
	Advisory with upgrade (AU)	Watch	Advisory	Warning

[a] Prompt #1 is always a baseline prompt is not prototype-specific.

[b] For the excessive heat hazard, respondents saw an “Advisory” headline at Prompt 2 and a continuance of the “Advisory” headline at Prompt 3.

This surveys associated with examining excessive heat and high wind hazards included two types of scenarios, **Advisory with an Upgrade** and **Warning with a Downgrade**:

- **Advisory with an Upgrade (AU) – Excessive Heat:** For the excessive heat hazard, the scenario included a continuance of the “Advisory” headline at Prompt 3 and then an upgrade to a “Warning” headline at Prompt 4.
- **Advisory with an Upgrade (AU) – High Winds:** The high wind hazard followed a more normal progression. Within this scenario, participants saw an “Advisory” headline that was then upgrade to a “Warning” headline.
- **Warning with a Downgrade (WD) – High Winds:** In this situation, the high wind hazard seems more severe; therefore, the NWS would issue a “Warning” headline and then downgrade the situation to an “Advisory” headline.

The scenarios were designed to elicit a real-world response to the proposed prototype language; therefore, it was especially important to achieve consistency between the prompts, scenarios, and surveys. As a result, considerable attention was given during the creation of the prompts and the survey instrument. Specifically, cognitive interviews and a pilot survey deployment were used to improve the scenario wording and identify any ordering effects or priming that occurred. This process identified that the respondents experienced difficulty progressing through the scenarios. However, this external validation of the scenario language allowed us to make several changes to the scenario language and better frame the scenarios to ensure respondents effectively progressed through time.

To provide an example of the language used in the excessive heat and high winds surveys, the following prompts are offered:

**Prompt #1:** Imagine you are home on a Saturday. You learn that the National Weather Service is forecasting the potential for high winds on Sunday with sustained wind speeds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.

**Prompt #2:** Suppose it is still Saturday and the National Weather Service has issued a **HIGH WIND WATCH** for Sunday with the potential for sustained wind speeds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.

**Prompt #3:** Now, it is Sunday at 10:00am and the National Weather Service has issued a **HIGH WIND WARNING** from Sunday at 10:00am through Sunday at 8:00pm for sustained winds greater than 40 miles per hour or winds gusting to 58 miles per hour.

**Prompt #4:** Now, imagine it is 4 hours later (Sunday at 2:00pm), and you receive the following information: “The National Weather Service has changed their forecast to a **WIND ADVISORY** lasting from Sunday at 2:00pm through Sunday at 8:00pm, now expecting sustained wind speeds ranging from 30 to 39 miles per hour.

In order to increase exposure to the five prototypes, each respondent was randomly assigned to two prototypes and went through the four prompts described above. Although ERG identified the sequence at which individuals saw each prototype, this research project did not.

Finally, to investigate the intuitiveness of each prototype, participants were randomly assigned to receive additional information about the warning headlines. It was anticipated that this would also provide some insight on the influence of further educational outreach toward improving the use of the current system and/or any future changes to the WWA system.

In sum, participants were randomly assigned to (1) two of five prototypes, (2) a scenario condition (e.g., advisory with an upgrade) for each prototype, and (3) either receive additional information about the proposed prototype headlines or not.

### 2.3 Protective Response Questions

After seeing each prompt as described above, participants were asked to complete several protective response questions that evaluated how they would respond behaviorally. The first question asked participants to acknowledge the action that they would take given the forecast information described in each prompt. Here, respondents were only allowed to select *one* action – the one they believed best described their behavioral response.

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a unique description of what each type of action meant for the particular hazard being surveyed.

In addition to their overall action taken, respondents were also asked to provide the likelihood that they would monitor additional forecast information, prepare, and take protective action. Further, the variable *likelihood to take some action* was added for the High Winds survey only. It was included based on NWS’ interest in investigating the importance of the “Wind Advisory” and the behavioral response associated with this WWA headline. These additional protective response variables allow us to better understand the respondent’s likelihood of performing *more than one behavior*. Because the action taken variable requires that respondents select one action to perform, it was important to also assess other behaviors that participants may want to perform simultaneously.

- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecast information given the scenario provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of taking some action**<sup>4</sup> – Respondents in the high wind survey were asked how likely they were to take some action given the information provided and could select a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

Finally, several perception questions were asked at each prompt level to obtain additional information that may provide further insight on the respondent’s behavioral response. Due to OMB restrictions, these questions were removed from ERG’s survey instrument. However, my IRB process did not require these questions to be removed. As a result, these questions were included when respondents assessed each prompt level within each prototype.

- **Perceived risk of the forecast** – Respondents were asked about their perceived risk given the forecast information provided and could select from a ten-point scale with one indicating “no risk” and ten indicating “extreme risk.”
- **Perceived confidence in the forecast** – Respondents were asked about their perceived confidence in the forecast information provided and could select from a ten-point scale with one indicating “no confidence” and ten indicating “extreme confidence.”
- **Perceived urgency of the forecast** – Respondents were asked about their perceived urgency given the forecast information and could select from a ten-point scale with one indicating “no urgency” and ten indicating “extreme urgency.”
- **Probability of Occurrence** – Respondents were asked to describe the probability that they would see excessive heat or high winds given the forecast information provided and could select from a sliding scale from one to one hundred.

## 2.4 Current Knowledge Questions

Due to time differences in survey deployment, a set of questions specifically asking respondents about their current knowledge of the watch, warning, advisory system (WWA) was not included in these surveys. However, the inclusion of the perception questions described above (i.e., perceived risk, perceived confidence, perceived urgency, and probability of occurrence) in conjunction with the participant’s behavioral response to the current system prototype, offer additional insight on the current knowledge of the WWA system for the excessive heat and high wind hazards.

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<sup>4</sup> **Note:** This variable was only included in the High Winds survey. It was added based on the NWS’ interest in investigating the importance of the “Wind Advisory” and the behavioral response associated with this WWA headline.

A discussion about the current knowledge of each hazard can be found in their respective result sections.

## 2.5 Questionnaire Overview

To remain consistent with the survey developed by ERG, the questionnaire was created in collaboration with NWS and ERG. Therefore, the overall goal of the questionnaire was to effectively evaluate how respondents react to existing excessive heat and high wind WWA messages compared to the developed HazSimp prototypes. Beyond testing the prototype language, a larger survey existed that asked respondents a variety of questions. Several theoretical variables were utilized from the Theory of Planned Behavior (Ajzen, 1985<sup>5</sup>, 1991<sup>6</sup>) and the Risk Information Seeking and Processing model (Griffin et al. 1999<sup>7</sup>). In addition to these theoretical risk variables, participants completed demographic questions, the protective response variables associated with the prototypes, and questions that assessed weather information habits. For more information on the questionnaire used, please see Appendix A. The questionnaire sequence was as follows:

- The survey began with several easy demographic questions: State of primary residence, primary residence type, environment near residence, number of adults in household, number of children in household.
- Participants were then asked to complete the various theoretical risk variables: perceived susceptibility, perceived severity, risk perception as affect, previous hazard experience, adaptive behaviors, gathering capacity, and subjective norms.
- A first prototype testing scenario; see Sections 2.1.-2.3
- A second prototype testing scenario; see Sections 2.1-2.3
- After completing the prototype testing process, participants were asked various questions about their weather information habits: how do individuals receive weather information, frequency of receiving weather information from various sources, etc.
- Finally, several additional demographic questions were asked: gender, race, age, educational background, Hispanic origin, and annual household income.

After completing the survey, participants were debriefed and provided information on the current warning system and additional links for further information that described the watch, warning, and advisory terminology in more detail and provided appropriate protective actions given each headline.

## 2.6 External Validation of Questionnaire

To offer an external validation of the questionnaire and study design, college students from a southeastern university were used to pilot the study. Pretesting occurred in two phases: cognitive interviewing and pilot survey deployment. First, a small sample of students ( $n = 20$ ) completed the questionnaire in a one-on-one setting and were asked to describe their thoughts while completing the

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<sup>5</sup> Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In *Action control* (pp. 11-39). Springer Berlin Heidelberg.

<sup>6</sup> Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211.

<sup>7</sup> Griffin, R. J., Dunwoody, S., & Neuwirth, K. (1999). Proposed model of the relationship of risk information seeking and processing to the development of preventive behaviors. *Environmental research*, 80(2), S230-S245.

study. This technique, known as cognitive interviewing, was used to uncover problems with question wording, order effects, priming, and questionnaire length (Collins, 2003<sup>8</sup>). Specifically, this process identified that the respondents experienced difficulties progressing through the prototype prompts. However, this process allowed us to make several changes to the scenario language and better frame the scenarios to ensure respondents understood the progression through time. Next, the survey instrument was piloted with a larger sample of college students ( $n = 961$ ) to evaluate the study design, questionnaire, and total time needed to complete the study. Finally, a small sample of the generalizable sample was obtained from Qualtrics. This additional pilot testing phase (i.e., a soft launch) allowed us to look for inconsistencies in the responses among a general public sample, and correct anything out of the ordinary. Overall, these validation efforts offered guidance for improving the quality of the survey instrument.

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<sup>8</sup> Collins, D. (2003). Pretesting survey instruments: an overview of cognitive methods. *Quality of life research*, 12(3), 229-238.

## 3.0 Sampling Approach

The following sections describe the sampling approach that was taken to obtain participants. A generalizable sample of the public was purchased from Qualtrics. In other words, Qualtrics selected a random sample of individuals who have opted-in to take their online surveys. However, we provided various inclusionary criteria to assist in screening potential participants – this often was used to account for geographical differences in hazard frequency (Section 3.1). Using this sample information, Qualtrics made individuals in these areas aware of the project and managed all eligibility parameters. As an incentive for participating, Qualtrics respondents received an incentive based on the length of the survey, their specific panelist profile and target acquisition difficulty. The remainder of this section will provide a rationale for the geographic areas selected (Section 3.1), offer total sample sizes (Section 3.2), and address the logistical details of survey deployment (Sections 3.3 and 3.4). Table 3 offers a summary of the survey collection efforts for both the excessive heat and high wind survey samples.

**Table 3. Summary of Survey Collection Efforts**

Weather Hazard	Survey Parameters	Dates	Targeted Sample	Collected Sample
Excessive heat – warm regions	<ul style="list-style-type: none"> <li>AL, AZ, AR, CA, FL, GA, KY, LA, MS, NV, NM, NC, OK, SC, TN, TX, and VA.</li> <li>Adults aged 18+</li> </ul>	12/4/17 – 12/5/17	275	275
Excessive heat – cold regions	<ul style="list-style-type: none"> <li>CO, CT, DE, ID, IL, IN, KS, ME, MD, MA, MI, MN, MO, NE, NH, NJ, NY, ND, OH, OR, PA, RI, SD, UT, VT, WA, and WV.</li> <li>Adults aged 18+</li> </ul>	12/4/17 – 12/5/17	275	277
High Winds	<ul style="list-style-type: none"> <li>All Contiguous U.S. States</li> <li>Adults aged 18+</li> </ul>	2/20/18 – 2/22/18	1,080	1,079 [a]

[a] A response was thrown out for being incomplete.

### 3.1 Geographic Areas

When selecting the geographic areas of interest for both the excessive heat and high wind hazards, the NWS was consulted.

#### 3.1.1 Excessive Heat

To evaluate the excessive heat prototypes in both warm and cold regions, the geographical criteria was determined based on temperature climatologies, NWS policy, and criteria for the issuance of excessive heat products across the country. Given this distinction, the contiguous U.S. were split up into *warm region states* and *cold region states*. See Figure 1 for a map of the warm and cold region states.

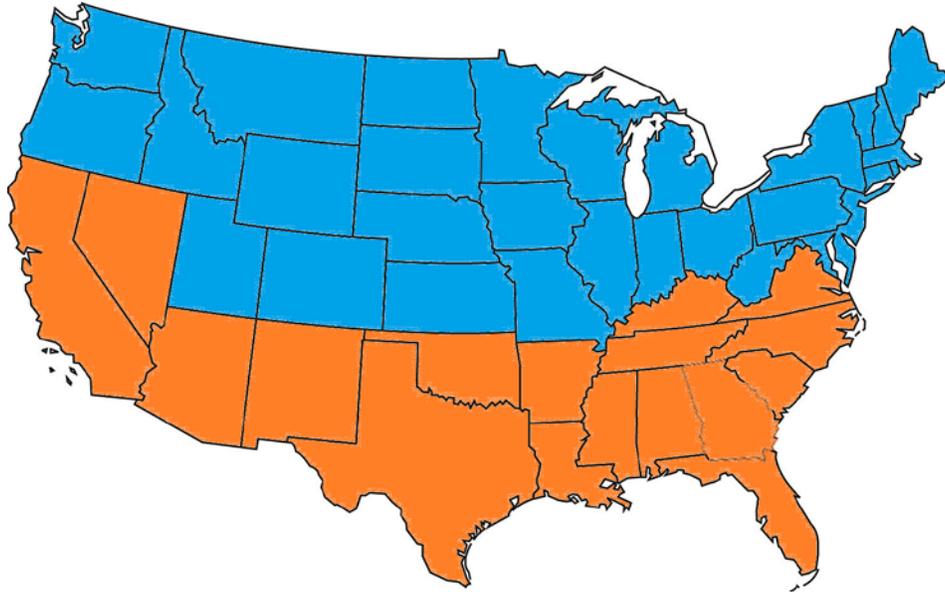


Figure 1. Sampling map of warm region states (orange) and cold region states (blue).

### 3.1.1 High Winds

Obtaining a sample to evaluate the high wind prototypes had less geographical restrictions, in comparison to the excessive heat prototypes. After collaborating with the NWS, it was determined that there were not specific states that experienced high winds more frequently than others. In a similar vein, the diverse high wind issuance criteria across the United States made it difficult to narrow down specific geographical parameters. Therefore, participants across the entire contiguous United States were eligible to participate in the survey. To encourage a diverse sample, an East/West sampling technique was employed to ensure the survey sample was representative of states across the entire country. In short, Qualtrics pulled an equal number of participants from the western and eastern United States.

## 3.2 Sample Sizes

The overall sample size was determined based on the budgetary restrictions determined by the NSF GRIP program. Therefore, my budget only allowed for a sample of 1,630 members of the public. Given this budget and potential sample size, decisions were made in collaboration with the NWS to allocate respondents across the three surveys (i.e., excessive heat – cold regions, excessive heat – warm regions, and high winds).

### Excessive Heat:

- Because excessive heat events usually only warrant upgrade scenarios, it was determined that both excessive heat surveys would only evaluate an **Advisory with an Upgrade** condition. As a result, the sampling needs of these two surveys were minimal ( $n = 275$  each; total 550).

## High Winds:

- Because high wind events do not currently have an “Emergency level,” it was determined that the high wind survey would only evaluate two scenarios: **Warning with a Downgrade** and **Advisory with an Upgrade**. Given the need to test two scenarios, a majority of the sample was devoted to the high wind hazard ( $n = 1,080$ ).

### 3.3 Mode

The survey was implemented on the web-based Qualtrics platform drawing from publicly available samples. Qualtrics was provided with all of the specifications that have been described thus far and Qualtrics drew random samples from each in-scope state. Additionally, it was determined that mobile users *would not be targeted* based on the poor formatting of the excessive heat and high wind surveys on a mobile device. As a result, survey participants were encouraged to complete the survey on a computer-based platform. This methodological caveat may need to be considered when evaluating the weather information habits demographic information.

### 3.4 Timeframes

Table 3 above summarizes the time frames and final sample sizes. The excessive heat surveys were soft launched on December 1, 2017. After checking for inconsistencies, both excessive heat surveys were officially deployed on December 4, 2017 and successfully completed data collection on December 5, 2017.

The high wind survey was soft launched on January 2, 2018 and January 3, 2018. After checking for data inconsistencies, the high wind survey was officially deployed on January 3, 2018 and successfully completed data collection on January 4, 2018.

## 4.0 Statistical Analysis Approach

The following section describes the statistical analysis that was performed to analyze the survey data collected to assess the prototypes developed by the NWS. Considerable effort was given to remaining consistent with the statistical analysis approach proposed by ERG; therefore, this section is very similar to the report offered by ERG. The only difference lies in the absence of the *Sequence* variable. My study did not take the sequence with which individuals saw the prototypes into consideration. After conducting initial analyses, ERG noted that the sequence variable was not overwhelmingly important; however, it is an important caveat to note.

This section begins with a discussion of the outcome variables and the treatments that we use in the statistical analysis (Section 4.1), then we discuss the procedure associated with the statistical analyses used to evaluate the outcome variables and treatments (Section 4.2), and the section concludes by discussing the other variables used to explain the variation in the outcome variables (Section 4.3).

### 4.1 Outcome Variables and Treatments

The survey we developed was designed to assess how respondents' protective responses (outcomes) differed between groups that saw different prototypes (treatments). As discussed in Section 2.3, several variables were used to gauge the protective response of the survey participants:

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a unique descriptions of what each type of action meant for the particular hazard being surveyed.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecast information given the scenario provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very unlikely.”
- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

These four variables form the basis of our analyses in order to compare the effectiveness of the four prototypes and the current system.

### 4.2 Ordered Logistic Regression

Because each protective response variable contains five discrete categories that are ordered from least to most, a statistical method called *ordered logistic regression analysis* was used to assess these data. An ordered logistic analysis correlates a set of ordered response categories with a set of explanatory variables (e.g., demographics, responses to other variables, etc.) to determine factors that lead to

respondents selecting higher or lower categories. As with any logistic regression, the ordered logistic model is a probability model. In sum, we are assessing the probability of respondents being in certain categories and identifying the factors that make it more (or less) likely for respondents to be in higher categories.

The primary explanatory factor in our analysis revolves around the prototype that the respondent saw. Therefore, an ordered logistic regression analysis will tell us which prototypes are associated with respondents being more likely to select a higher-order protective action. For example, this type of analysis will allow us to determine whether individuals who saw “Prototype 1” would be more or less likely to take protective action in comparison to the current system.

An additional consideration in our analysis is that respondents are represented twice in our datasets because they each saw two prototypes. Therefore, we have two sets of responses to the protective response variables – one set for each prototype that the respondent saw. Although this effectively doubles the sample size we can use for the statistical analysis, it requires an adjustment to the estimated variances for the fact that our  $n$  analytical data points are derived from only  $n/2$  survey respondents. There are well-documented procedures for doing this and we follow the one in the statistical software we used (Stata).<sup>9</sup>

To better interpret the results from the ordered logistic regression analyses, the results we present are phrased in terms of odds ratios. Odds ratios reflect the increased probability of being in a “higher” response category when odds ratios are a larger number. For example, we will be presenting the odds ratios associated with seeing prototypes 1-4 relative to seeing the current system; thus, we will be generating results that say things such as “those who saw prototype 1 were 1.5 times more likely to select a more protective action than those who saw the current system wording.” In that example, the odds ratio is the value 1.5. The key value in an odds ratio is 1.0; estimates below 1.0 reflect decreased probabilities of being in higher categories and values above 1.0 reflect increased probabilities of being in higher categories.<sup>10</sup> The statistical significance of an odds ratio is judged by comparing the value to 1.0; values that are significantly different (i.e., more or less) than one are considered statistically significant.

### 4.3 Other Explanatory Variables

When conducting ordered logistic regression analyses, you are essentially creating a model that allows you to consider other factors that may help explain the outcome variable – in this case the protective response variables. For example, the survey includes several demographic variables (e.g., gender, educational background, race, etc.) and theoretical risk variables (e.g., risk perception, affective response, adaptive behavior, etc.). Although my survey instrument collected responses to several additional variables, considerable effort was given to remaining consistent with the modeling efforts provided by ERG. Therefore, the explanatory factors included in this report are uniform with those used by ERG. The explanatory factors included in our modeling efforts include:<sup>11</sup>

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<sup>9</sup> <https://www.stata.com/manuals13/u20.pdf#u20.21Obtainingrobustvarianceestimates>.

<sup>10</sup> By design, odds ratios are never less than zero.

<sup>11</sup> The factors included were based on a detailed statistical specification analysis.

- *The baseline protective response.* Each respondent was prompted with a baseline statement prior to seeing the prototype language. All respondents saw the same baseline statement. We used the respondents baseline protective response for the scenario as the first control variable.
- *Respondents' perceived susceptibility and severity to hazard-specific risk.* The survey asked respondents to rate their *perceived harm* and their *perceived threat* from the hazard to (1) themselves personally, (2) their home, and (2) their local community to the hazard, each on a scale of 1 (no likely risk) to 10 (extremely likely risk) (six total questions). An index value was calculated by adding together the response to each of six questions for each respondent. Higher values for this scale indicate respondents perceive they are at higher risk.
- *Affective response, part 1.* The survey asked respondents to rate their feelings (negative to positive) about varying degrees of the weather hazards (e.g., a 90-100 degree day, multiple days with temperatures about 105 degrees, etc.). An index value was calculated by adding the values together for each respondent. Higher values of this index indicate the respondent is less worried about the surveyed weather hazard.
- *Affective response, part 2.* The survey asked respondents to describe their feelings about the weather hazards (e.g., excessive heat). Respondents selected from four five-point scales (calm/stressed, pleased/displeased, happy/sad, and elated/depressed). An index value was calculated by adding the values together for each respondent. Higher values of this index indicate the respondent is less worried about the surveyed weather hazard.
- *Adaptive behavior.* The survey asked respondents to rate their preparedness and ability to adapt to the hazard in a series of questions that varied by hazard (e.g., I don't feel safe leaving my house to find a place to stay cool during excessive heat). An index value was calculated for each respondent by adding the responses together. Higher values of this variable indicate that respondents may be more prepared or have thought or performed precautionary measures in the past.
- *Past experience.* The survey asked respondents whether they had been experienced property damage or personal injury in the past from the specific hazard. This variable was measured as a yes/no question in the analysis.
- *Attentiveness.* The respondents were asked whether it was (1) wise, (2) useful, (3) valuable, and (4) beneficial to understand the risk posed by the weather hazard using a 10-point scale for each aspect (e.g., wise). This response was converted to an index value by adding over the four for each respondent. Higher values of this index indicate the respondent sees value in staying informed on the surveyed weather hazard.
- *Information gathering capacity.* The survey asked respondents to agree or disagree with a series of four statements that asked about the ease of understanding weather information. An index was formed based on the responses to the four questions. The questions were phrased in the negative, so higher values reflect respondents who have lower capacities to gather/understand weather information.

- *Subjective norms.* The survey asked respondents about whether they felt friends and family looked to them to understand weather-related information. An index was formed by summing over the three questions. Higher values reflect respondents who feel that others look to them to understand the surveyed weather hazard.
- *The respondent's age.* We measured age using the age category selected by the respondent. The values ranged from 1 (aged 18-24) to 6 (65 and older) using 10-year intervals in between.
- *Presence of children in the home.* This variable measured the presence (yes or no; one or zero, respectively) of children in the respondent's home. We assumed that those with children would be more likely to take a protective action.
- *Gender.* This was set equal to one if the respondent was female and zero otherwise.
- *College education.* This was set equal to one if the respondent indicated he/she had completed a college degree.
- *Race.* This was set equal to one if the respondent was white.
- *Information on prototype.* This was set equal to one if the respondent was provided with information on how to interpret the current system or the prototype prior to the scenario. One half of respondents were provided with this information.
- **\*\*Scenario sequence:** Although ERG considered this in their analysis, ***I did not*** account for the sequence with which individuals saw a given prototype.

## 5.0 Excessive Heat: Warm Regions

This section discusses the results from the excessive heat warm regions survey. To account for differences in excessive heat warning issuance criteria, it was decided between the researcher and the NWS, that the excessive heat survey would need to be implemented in two different surveys: one for colder regions and one for warmer regions. The warm regions survey was implemented in states that experience higher extreme heat, and therefore, have a higher threshold for the issuance of excessive heat warnings.

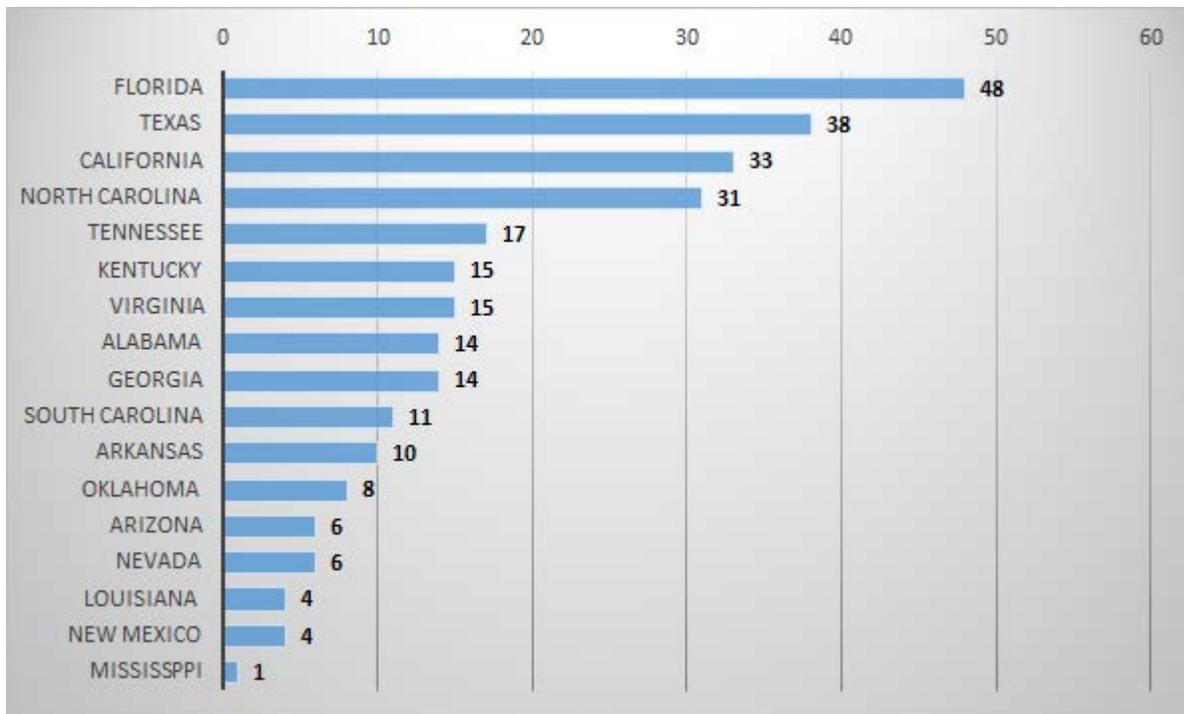
**States:** AL, AZ, AR, CA, FL, GA, KY, LA, MS, NV, NM, NC, OK, SC, TN, TX, and VA.

**Respondents:** 275

**Collection time frame:** 12/4/17 – 12/5/17

### 5.1 Basic Demographics

Figure 2 provides a summary of the states and the total number of respondents from each state that completed the excessive heat warm region survey. The largest number of participants lived in Florida (48), and the least resided in Mississippi (1).



**Figure 2.** Number of respondents from States in the Excessive Heat Warm Region Survey

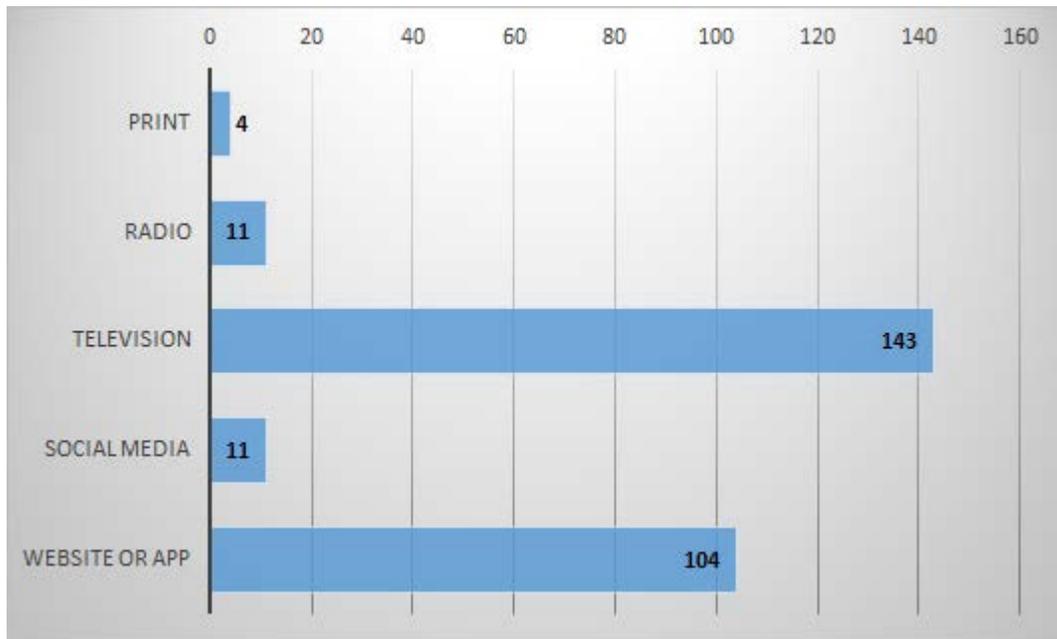
Table 4 provides a summary of the demographics assessed in the excessive heat warm region survey. Overall, the sample contains more females and Caucasian Americans. However, the sample seems to be fairly balanced across income levels, educational background, and age. For a complete breakdown of all the demographic variables collected within the excessive heat warm region sample, please see Appendix 2.

**Table 4. Basic Demographics for the Excessive Heat Warm Region Survey**

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
<b>Age</b>		<b>Race</b>	
20-24	8.0%	White	81.5%
25-34	16.7%	Black/African-American	12.0%
35-44	16.7%	Asian	5.1%
45-54	13.8%	American Indian or Alaska Native	1.1%
55-64	22.9%	<b>Income</b>	
65+	21.8%	Less than \$24,999	25.8%
<b>Gender</b>		\$25,000 - \$49,999	34.9%
Female	76.2%	\$50,000 - \$99,999	28.0%
Male	23.1%	\$100,000 - \$199,999	9.5%
<b>Education</b>		More than \$200,000	1.8%
Less than college degree	61.4%	<b>Home Location</b>	
College degree	26.7%	Urban	23.7%
Graduate work/degree	13.0%	Suburban	48.5%
<b>Hispanic origin</b>		Rural	27.7%
Yes	8.7%	<b>Average number of adults in home</b>	<b>1.98</b>
No	91.3%	<b>Average number of children in home</b>	<b>0.67</b>

## 5.2 Weather Information Use

Figure 3 provides an overview of the participants’ preference for receiving *daily* weather information. Participants overwhelmingly reported the use of television and a website/app for receiving their *daily* weather information.



**Figure 3. Participant’s preference for receiving daily weather information**

Figure 4 provides an overview of the participants' preference for receiving *information about excessive heat*. Similar to daily weather information, a large majority of participants reported the use of television and a website/app for receiving information about *excessive heat*.

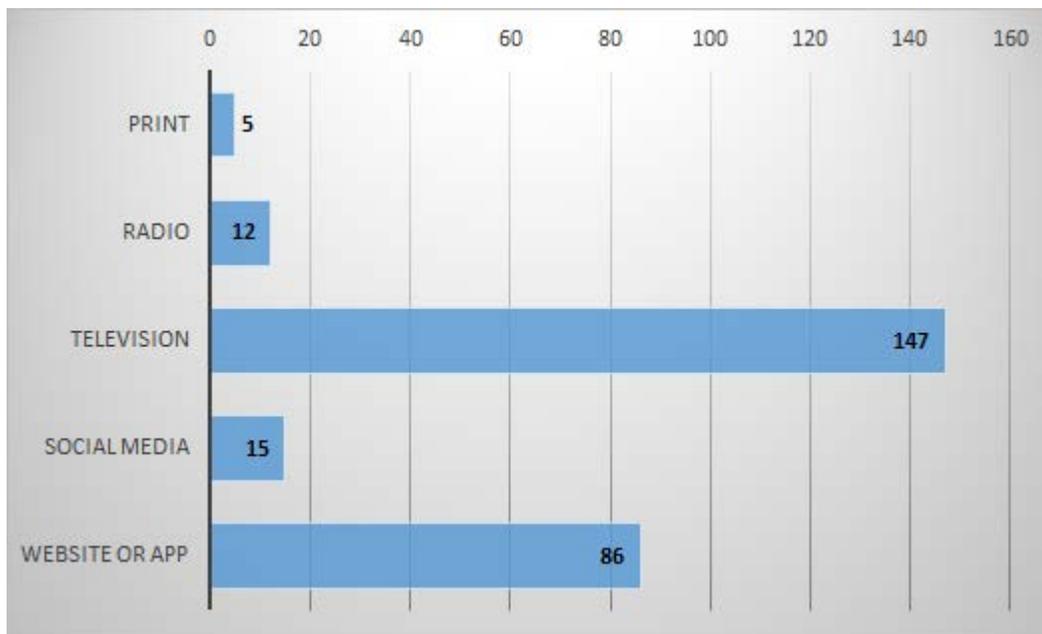


Figure 4. Participant's preference for receiving information about excessive heat

### 5.3 Current Knowledge

As discussed in Section 2.4, the current knowledge questions were developed after the deployment of the excessive heat warm region survey; however, additional questions were included that provide some insight into the participants' current knowledge of the excessive heat products. Taken together, the following questions were used to assess knowledge of the Excessive Heat Watch, Heat Advisory, and Excessive Heat Warning:

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a unique descriptions of what each type of action meant for the particular hazard being surveyed.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecast information given the scenario provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select a five-point scale with one indicating “very unlikely” and five indicating “very likely.”

- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Perceived risk of the forecast** – Respondents were asked about their perceived risk given the forecast information provided and could select from a ten-point scale with one indicating “no risk” and ten indicating “extreme risk.”
- **Perceived confidence in the forecast** – Respondents were asked about their perceived confidence in the forecast information provided and could select from a ten-point scale with one indicating “no confidence” and ten indicating “extreme confidence.”
- **Perceived urgency of the forecast** – Respondents were asked about their perceived urgency given the forecast information and could select from a ten-point scale with one indicating “no urgency” and ten indicating “extreme urgency.”
- **Probability of Occurrence** – Respondents were asked to describe the probability that they would see excessive heat given the forecast information provided and could select from a sliding scale from one to one hundred.

Using these questions, we can examine different aspects of the participants’ knowledge of the current watch, warning, advisory system. Table 5 provides a summary of the means associated with all of these variables for individuals who saw the current system. Overall, the respondents appear to be responding appropriately to the excessive heat WWA headlines and weather scenarios. This conclusion can be drawn based on the means associated with behavior (i.e., overall action, monitoring, prepare, and protective action) increasing linearly across the conditions. Further, a similar trend is observed among the perception variables (i.e., risk, confidence, urgency, and probability).

**Note:** A previous report noted that adding the “Watch” headline decreases perceived confidence, urgency, and probability of occurrence; however, further statistical analyses were conducted and these means are not significantly different from the base condition.

**Table 5. Knowledge of the Current System using Behavioral and Perception Variables**

<b>Current System</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.80	2.78	3.21	3.55
Monitor	4.04	3.96	4.14	4.24
Prepare	3.74	3.76	4.03	4.04
Prot. Action	3.59	3.65	3.90	4.21
Risk	7.34	7.29	7.64	7.92
Confidence	7.97	7.80	8.10	8.27
Urgency	7.17	7.08	7.72	7.94
Probability	72.92	72.22	78.24	79.86

To further examine the behavioral response associated with each WWA headline, a breakdown of **actions taken** is shown in Table 6. Overall, the behavioral response seems appropriate given the goal of each warning headline: (1) A majority of individuals are monitoring and preparing after a “Watch” headline, (2) A majority of individuals are preparing, taking some action, and/or protective action following the “Advisory” headline, and (3) a large majority of respondents indicated they would take protective action following a “Warning” headline.

**Table 6. Percentage Breakdown of Actions associated with each WWA Headline**

<b>Current System - Action Breakdown (%)</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Nothing	26.5	21.2	12.4	9.8
Monitor	16.8	23.0	18.6	12.5
Prepare	26.5	26.5	27.4	25.9
Some Action	10.6	15.0	18.6	16.1
Prot. Action	19.5	14.2	23.0	35.7

## 5.4 Prototype Analyses

This section presents the results of the ordered logistic regression analyses we performed on the prototype testing. The methods are discussed in Section 4.0. We analyzed data from the first four questions described in the previous section: **Action taken, Likelihood of monitoring, Likelihood of preparing, and Likelihood of acting.**

The goal of the analyses was to determine whether those who saw certain prototypes were more or less likely to take protective actions compared to the current system using those four questions to measure different responses. As noted in Section 4.2, the analyses resulted in the estimation of odds ratios that indicate the degree to which the four new prototypes performed against the current system. An odds ratio of 1.0 indicates that a prototype is just as protective as the current system, odds ratios below 1.0 indicate the prototype is less protective, and odds ratios above 1.0 indicate the prototype is more protective. By design, odds ratios cannot be below zero.

As discussed in Section 2.2, it was decided that excessive heat would only examine one scenario: **Advisory with an Upgrade.** Therefore, the next section will provide an in-depth discussion of the results for this scenario. We present odds ratios for each prompt within the scenario. The results are organized by the protective response variables listed above. The specific prototypes tested for the excessive heat warm regions survey appear in Table 7.

**Recall:** It was decided by NWS that the excessive heat prototypes would only retain the “Advisory” and “Warning” headlines. As a result, respondents saw an “Advisory” headline at the “Watch level” and a continuance of the “Advisory” headline at the “Advisory level.” Further, it was decided that Prototype 3 would avoid using “Moderate” to describe the “Advisory,” and instead use “Severe” and “Extreme” to describe the threat of excessive heat. Table 6 reflects these decisions.

**Table 7. Specific Prototype Language Tested for Excessive Heat Warm Region Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	Excessive Heat Watch	Heat Warning	Heat Alert	Severe Heat Warning	Level Orange Heat Warning
Advisory level	Heat Advisory	Heat Warning	Heat Alert (continued)	Severe Heat Warning (continued)	Level Orange Heat Warning (continued)
Warning level	Excessive Heat Warning	Heat Warning	Heat Warning	Extreme Heat Warning	Level Red Heat Warning

### 5.4.1 Advisory with an Upgrade Scenario

After a baseline prompt, the advisory with an upgrade scenario started with an advisory-level prompt<sup>12</sup>, and then progressed through time with a continuance of the advisory-level prompt followed by an upgrade to a warning. Table 8 presents the estimated odds ratios for the advisory upgrade scenario; in the table, the “\*” symbol depicts statistical significance. Figure 5 provides a graphical depiction of the estimates in Table 8 and using red text and the “\*” again to depict statistical significance. The results of each protective response variable can be described as follows:

#### Action Taken

- Overall, the prototypes appear to be less protective or equally as protective in terms of the action selected by respondents. This was especially true at the “Advisory level” (i.e., advisory continued) and “Warning level,” where Prototypes 3 and 4 were close to significance.
- Interestingly, at the “Watch level” (i.e., advisory), those who saw Prototype 3 were *more likely* to take a more protective action compared to those who saw the current system.

#### Likelihood of Monitoring

- Those who saw Prototype 1, 2, or 4 were significantly more likely to monitor at both the “Watch level” (i.e., advisory) and “Warning level,” in comparison to those who saw the current system.
- There were no significant results at the “Advisory level” (i.e., advisory continued); however, Prototypes 1, 2, and 4 again outperformed the current system.

#### Likelihood of Preparing

- At the “Watch level” (i.e., advisory) and “Warning level,” the prototypes provided more or less the same level of protective response. However, at the “Advisory level” (i.e., advisory continued), all prototypes had odds ratios below 1.0 – but none were significant.

<sup>12</sup> Remember, the Current System Prototype first saw a Watch-level prompt, followed by an upgrade to an advisory and another upgrade to a warning.

## Likelihood of Acting

- The prototypes provided more or less the same level of protective response. However, Prototype 3 consistently had odds ratios below 1.0 at the “Advisory level” (i.e., advisory continued) and “Warning level” – but none were significant.

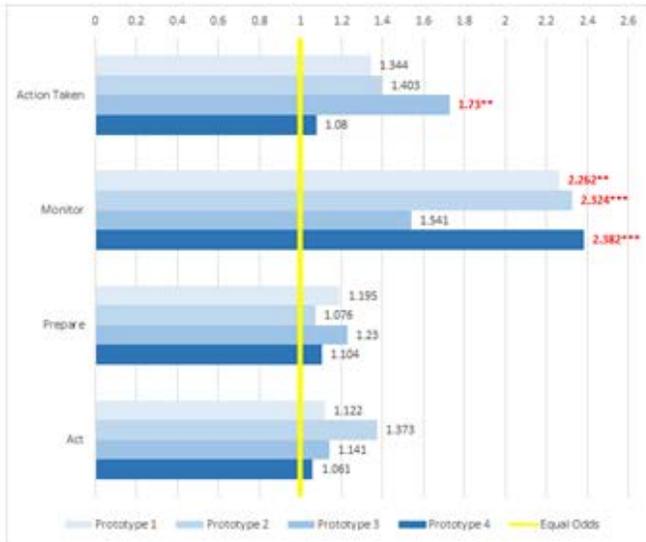
**Table 8. Estimated Odds Ratios for Advisory Upgrade Scenario: Excessive Heat Warm Regions**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Advisory</b>				
Prototype 1	1.344 (1.10)	2.262** (2.54)	1.195 (0.58)	1.122 (0.40)
Prototype 2	1.403 (1.26)	2.324*** (2.67)	1.076 (0.24)	1.373 (1.10)
Prototype 3	1.730** (2.04)	1.541 (1.40)	1.230 (0.69)	1.141 (0.46)
Prototype 4	1.080 (0.29)	2.382*** (2.72)	1.104 (0.33)	1.061 (0.21)
<b>Prompt 3: Advisory Cont.</b>				
Prototype 1	0.980 (-0.08)	1.550 (1.39)	0.763 (-0.91)	1.159 (0.50)
Prototype 2	0.807 (-0.82)	1.395 (1.08)	0.709 (-1.15)	1.128 (0.41)
Prototype 3	0.878 (-0.50)	1.127 (0.40)	0.758 (-0.93)	0.825 (-0.67)
Prototype 4	0.676 (-1.54)	1.254 (0.75)	0.663 (-1.41)	0.931 (-0.25)
<b>Prompt 4: Warning</b>				
Prototype 1	1.086 (0.32)	2.013** (2.15)	1.124 (0.41)	1.268 (0.80)
Prototype 2	1.234 (0.79)	2.140** (2.35)	1.453 (1.30)	1.126 (0.41)
Prototype 3	0.758 (-1.09)	1.272 (0.78)	1.202 (0.65)	0.832 (-0.64)
Prototype 4	1.008 (0.03)	2.268** (2.53)	1.348 (1.06)	1.161 (0.52)

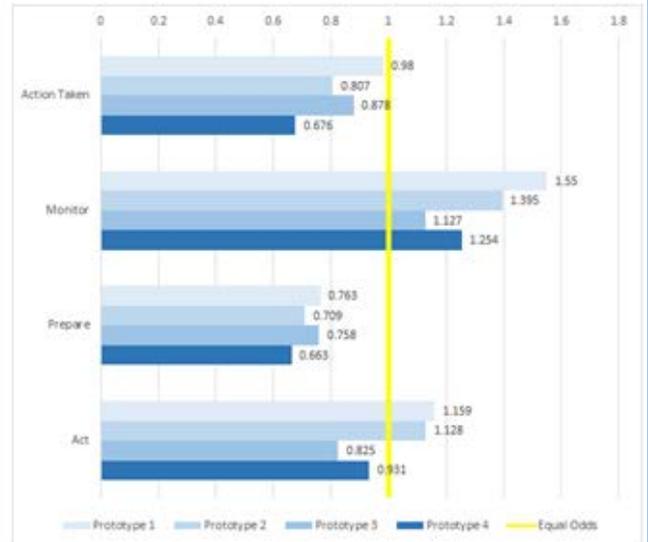
Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

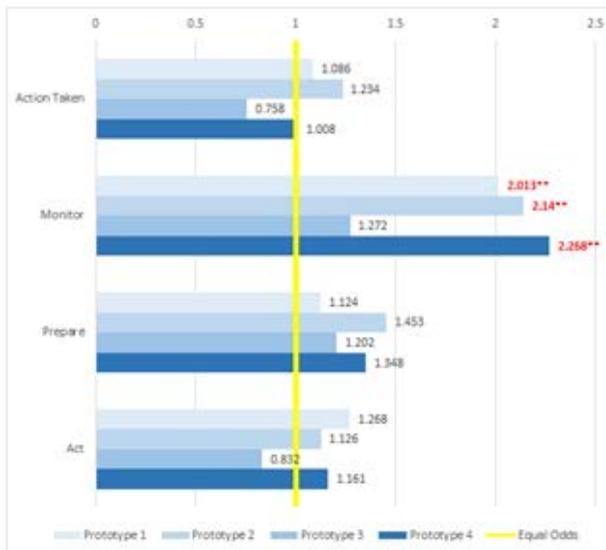
### Excessive Heat – Warm Regions, Advisory Upgrade Scenario



Prompt 2: Advisory



Prompt 3: Advisory Continued



Prompt 4: Warning

Figure 5. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: Excessive Heat Warm Regions Survey

### 5.5 Summary and Conclusions

To offer a summary of the results provided in this section, Table 9 presents the percentages of estimates for each prototype that were significantly greater or significantly less than 1.0. Based on Table 8, Prototype 1, 2, and 4 had the same percentage of estimates greater than 1.0; however, Prototype 3 also had one estimate that was significantly greater than 1.0.

**Table 9. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Heat Warm Survey**

Prototype	All Estimates	
	> 1.0	< 1.0
Prototype 1	16%	0%
Prototype 2	16%	0%
Prototype 3	8%	0%
Prototype 4	16%	0%
Total Number of Estimates [a]	12	

[a] This is the total for each Prototype

Table 10 expands the summary in Table 9 by breaking the percentages down by prompt level (i.e., Watch, Advisory, Warning). **Remember:** for the Excessive Heat Warm Regions Prototypes, a “Watch Level” involved an “Advisory” headline, the “Advisory level” involved the continuance of an “Advisory” headline, and the “Warning level” involved a “Warning” headline. In Table 10, we see that all of Prototype 1, 2 and 4’s estimates that were significantly greater than 1.0 were at the “Watch level” and “Warning level.” Further, we see that Prototype 3’s estimate that was significantly greater also occurred at the “Watch level.”

**Table 10. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Heat Warm Survey**

Prototype	Watch		Advisory		Warning	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	25%	0%	0%	0%	25%	0%
Prototype 2	25%	0%	0%	0%	25%	0%
Prototype 3	25%	0%	0%	0%	0%	0%
Prototype 4	25%	0%	0%	0%	25%	0%
Total Number of Estimates [a]	4		4		4	

[a] This is the total for each Prototype

Table 11 expands the summary in Tables 9 and 10 by breaking the percentages down by protective response variable (i.e., Action taken, Likelihood to Monitor, Likelihood to Prepare, and Likelihood to Act). These data reveal that all of the estimates that were significantly greater than 1.0 were concentrated on increasing the monitoring of forecast information. Further, Prototype 3’s estimate that was significantly

greater than 1.0 was associated with the action a respondent indicated they would take given the forecast information.

**Table 11. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Heat Warm Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	66%	0%	0%	0%	0%	0%
Prototype 2	0%	0%	66%	0%	0%	0%	0%	0%
Prototype 3	33%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	0%	0%	66%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	3		3		3		3	

[a] This is the total for each Prototype

Based on this summary and the results presented in the above sections, some overall conclusions can be drawn.

- Prototypes 1, 2, and 4 consistently improve the likelihood of monitoring weather information, in comparison to the current system, across the “Watch” (i.e., advisory), “Advisory” (i.e., advisory continued), and “Warning” levels. However, these odds ratios are only significant at the “Watch” and “Warning” levels.
- Prototypes 1, 2, and 4 consistently outperform the current system – but do not show statistical significance. Further, these prototypes usually perform similarly across all response variables. The only exception is the “Advisory” level (i.e., advisory continued), where the odds ratios for **action taken and likelihood to prepare** are less than 1.0 – signifying the current system was more effective (albeit not significantly).
- Prototype 3 consistently underperforms across all response variables in comparison to the current system and other prototypes. However, those who saw Prototype 3 at the “Watch” level (i.e., advisory) were **more likely** to take a more protective action compared to those who saw the current system. This leads to the question: **Does the language associated with Prototype 3 encourage taking a more protective action too soon, especially in the case of a long-term hazard?**

## 6.0 Excessive Heat: Cold Regions

This section discusses the results from the excessive heat cold regions survey. To account for differences in excessive heat warning issuance criteria, it was decided between the researcher and the NWS, that the excessive heat survey would need to be implemented in two different surveys: one for colder regions and one for warmer regions. The cold regions survey was implemented in states that experience extreme heat less frequently, and therefore, have a lower threshold for the issuance of excessive heat warnings.

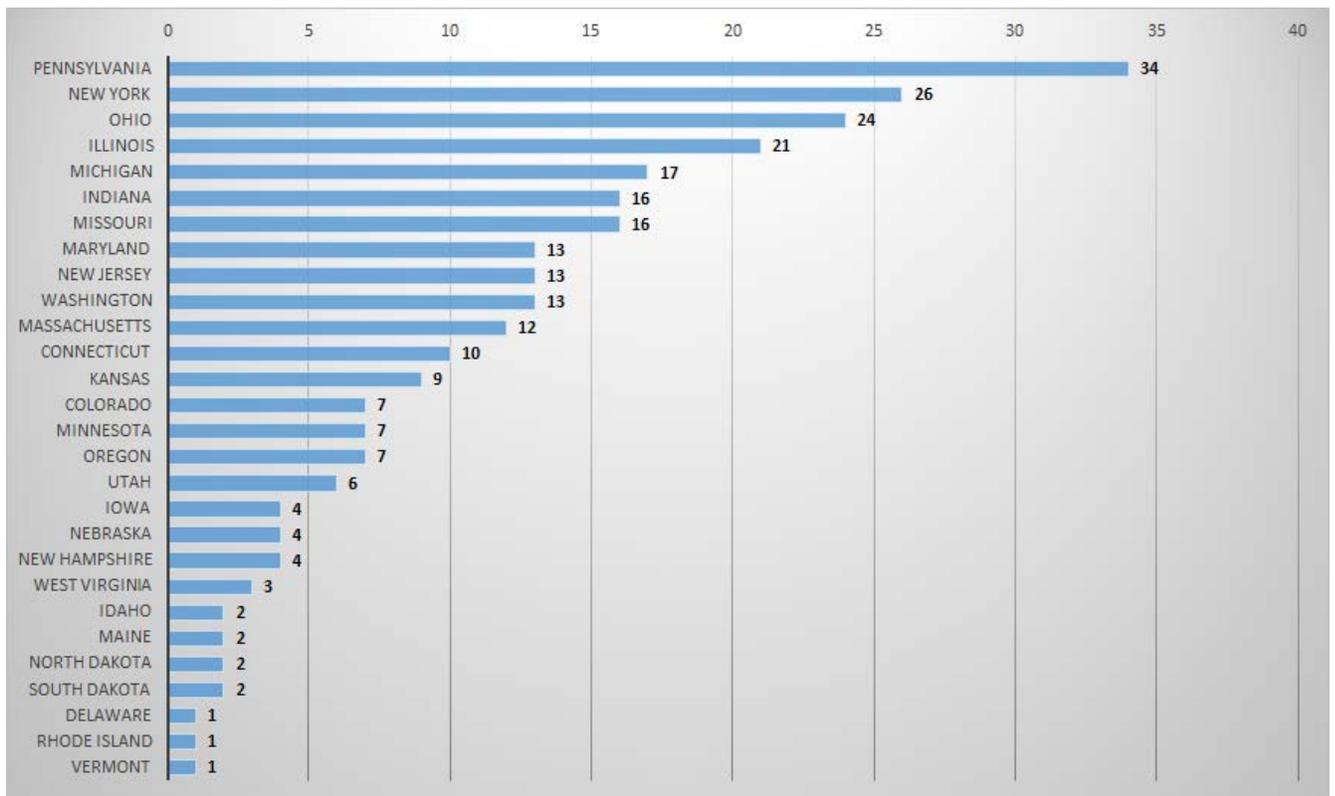
**States:** CO, CT, DE, ID, IL, IN, KS, ME, MD, MA, MI, MN, MO, NE, NH, NJ, NY, ND, OH, OR, PA, RI, SD, UT, VT, WA, and WV.

**Respondents:** 277

**Collection time frame:** 12/4/17 – 12/5/17

### 6.1 Basic Demographics

Figure 6 provides a summary of the states and the total number of respondents from each state that completed the excessive heat cold region survey. The largest number of participants lived in Pennsylvania (34), and the least resided in Delaware, Rhode Island, and Vermont (1).



**Figure 6.** Number of respondents from States in the Excessive Heat Cold Region Survey

Table 12 provides a summary of the demographics assessed in the excessive heat cold region survey. Overall, the sample contains more females and Caucasian Americans. It is also fairly skewed toward an older age group; however, that can be seen as a strength of this dataset – as this group is often considered a vulnerable population. The sample seems to be fairly balanced across income and education level. For a complete breakdown of all the demographic variables collected within the excessive heat cold region sample, please see Appendix 3.

**Table 12. Basic Demographics for the Excessive Heat Cold Region Survey**

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
<b>Age</b>		<b>Race</b>	
20-24	7.2%	White	86.6%
25-34	17.0%	Black/African-American	9.4%
35-44	11.9%	Asian	3.2%
45-54	14.8%	Other	1.4%
55-64	22.0%	<b>Income</b>	
65+	27.1%	Less than \$24,999	29.0%
<b>Gender</b>		\$25,000 - \$49,999	34.1%
Female	68.8%	\$50,000 - \$99,999	29.3%
Male	30.1%	\$100,000 - \$199,999	6.9%
<b>Education</b>		More than \$200,000	0.7%
Less than college degree	61.4%	<b>Home Location</b>	
College degree	26.7%	Urban	26.4%
Graduate work/degree	11.9%	Suburban	46.7%
<b>Hispanic origin</b>		Rural	26.8%
Yes	6.5%		
No	93.5%	<b>Average number of adults in home</b>	<b>2.01</b>
		<b>Average number of children in home</b>	<b>0.38</b>

## 6.2 Weather Information Use

Figure 7 provides an overview of the participants' preference for receiving *daily* weather information. Participants overwhelmingly reported the use of television and a website/app for receiving their *daily* weather information.

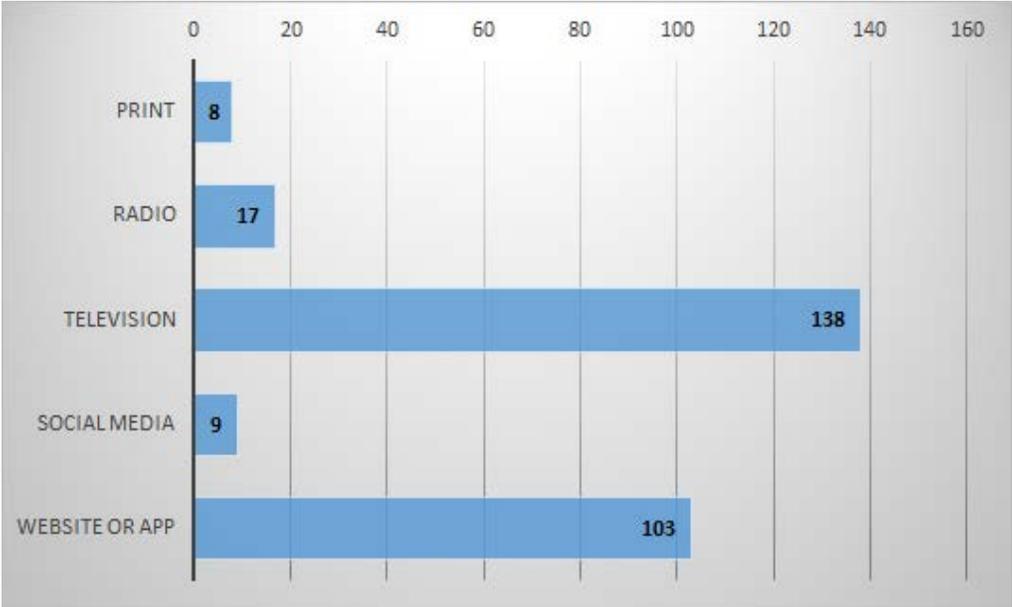


Figure 7. Participant's preference for receiving daily weather information

Figure 8 provides an overview of the participants' preference for receiving *information about excessive heat*. Similar to daily weather information, a large majority of participants reported the use of television and a website/app for receiving information about *excessive heat*.

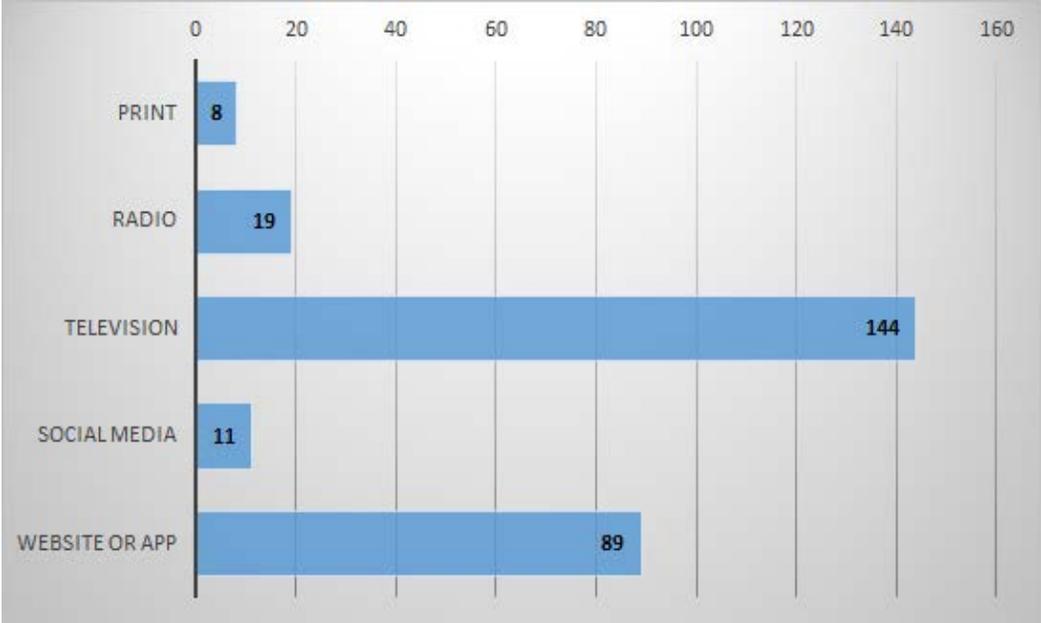


Figure 8. Participant's preference for receiving information about excessive heat

### 6.3 Current Knowledge

As discussed in Section 2.4, the current knowledge questions were developed after the deployment of the excessive heat cold region survey; however, additional questions were included that provide some insight into the participants' current knowledge of the excessive heat products. Taken together, the following questions were used to assess knowledge of the Excessive Heat Watch, Heat Advisory, and Excessive Heat Warning:

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a unique descriptions of what each type of action meant for the particular hazard being surveyed.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecast information given the scenario provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Perceived risk of the forecast** – Respondents were asked about their perceived risk given the forecast information provided and could select from a ten-point scale with one indicating “no risk” and ten indicating “extreme risk.”
- **Perceived confidence in the forecast** – Respondents were asked about their perceived confidence in the forecast information provided and could select from a ten-point scale with one indicating “no confidence” and ten indicating “extreme confidence.”
- **Perceived urgency of the forecast** – Respondents were asked about their perceived urgency given the forecast information and could select from a ten-point scale with one indicating “no urgency” and ten indicating “extreme urgency.”
- **Probability of Occurrence** – Respondents were asked to describe the probability that they would see excessive heat given the forecast information provided and could select from a sliding scale from one to one hundred.

Using these questions, we can examine different aspects of the participants' knowledge of the current watch, warning, advisory system. Table 13 provides a summary of the means associated with all of these variables for individuals who saw the current system. Overall, the respondents appear to be responding appropriately to the excessive heat WWA headlines and weather scenarios. This conclusion can be drawn based on the means associated with behavior (i.e., overall action, monitoring, prepare, and

protective action) increasing linearly across the conditions. Further, a similar trend is observed among the perception variables (i.e., risk, confidence, urgency, and probability).

**Note:** A previous report noted that adding the “Watch” headline decreases perceived confidence, urgency, and probability of occurrence; however, further statistical analyses were conducted and these means are not significantly different from the base condition.

**Table 13. Knowledge of the Current System using Behavioral and Perception Variables**

Current System				
	Base	Watch	Advisory	Warning
Overall Action	2.53	2.75	2.98	3.60
Monitor	3.69	3.76	3.95	4.06
Prepare	3.65	3.52	3.72	3.84
Prot. Action	3.42	3.42	3.70	4.01
Risk	6.36	6.66	6.94	7.44
Confidence	7.06	7.28	7.69	8.00
Urgency	6.39	6.69	7.04	7.52
Probability	69.81	69.88	75.89	80.95

To further examine the behavioral response associated with each WWA headline, a breakdown of the **actions taken** is shown in Table 14. Overall, the behavioral response seems appropriate given the goal of each warning headline: (1) A majority of individuals are monitoring and preparing after a “Watch” headline, (2) A majority of individuals are preparing, taking some action, and/or protective action following the “Advisory” headline, and (3) a large majority of respondents indicated they would take some action or protective action following a “Warning” headline.

**Table 14. Percentage Breakdown of Actions associated with each WWA Headline**

Current System - Action Breakdown (%)				
	Base	Watch	Advisory	Warning
Nothing	29.2	21.4	13.3	10.7
Monitor	22.1	24.1	22.1	7.1
Prepare	27.4	29.5	31.9	26.8
Some Action	8.8	8.0	18.6	22.3
Prot. Action	12.4	17.0	14.2	33.0

## 6.4 Prototype Analyses

This section presents the results of the ordered logistic regression analyses we performed on the prototype testing. The methods are discussed in Section 4.0. We analyzed data from the first four questions described in the previous section: **Action taken, Likelihood of monitoring, Likelihood of preparing, and Likelihood of acting.**

The goal of the analyses was to determine whether those who saw certain prototypes were more or less likely to take protective actions compared to the current system using those four questions to measure different responses. As noted in Section 4.2, the analyses resulted in the estimation of odds ratios that indicate the degree to which the four new prototypes performed against the current system. An odds ratio of 1.0 indicates that a prototype is just as protective as the current system, odds ratios below 1.0 indicate the prototype is less protective, and odds ratios above 1.0 indicate the prototype is more protective. By design, odds ratios cannot be below zero.

As discussed in Section 2.2, it was decided that excessive heat would only examine one scenario: **Advisory with an Upgrade**. Therefore, the next section will provide an in-depth discussion of the results for this scenario. We present odds ratios for each prompt within the scenario. The results are organized by the protective response variables listed above. The specific prototypes tested for the excessive heat warm regions survey appear in Table 15.

**Recall:** It was decided by NWS that the excessive heat prototypes would only retain the “Advisory” and “Warning” headlines. As a result, respondents saw an “Advisory” headline at the “Watch level” and a continuance of the “Advisory” headline at the “Advisory level.” Further, it was decided that Prototype 3 would avoid using “Moderate” to describe the “Advisory,” and instead use “Severe” and “Extreme” to describe the threat of excessive heat. Table 15 reflects these decisions.

**Table 15. Specific Prototype Language Tested for Excessive Heat Cold Region Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	Excessive Heat Watch	Heat Warning	Heat Alert	Severe Heat Warning	Level Orange Heat Warning
Advisory level	Heat Advisory	Heat Warning	Heat Alert (continued)	Severe Heat Warning (continued)	Level Orange Heat Warning (continued)
Warning level	Excessive Heat Warning	Heat Warning	Heat Warning	Extreme Heat Warning	Level Red Heat Warning

### 6.4.1 *Advisory with an Upgrade Scenario*

After a baseline prompt, the advisory with an upgrade scenario started with an advisory-level prompt<sup>13</sup>, and then progressed through time with a continuance of the advisory-level prompt followed by an upgrade to a warning. Table 16 presents the estimated odds ratios for the advisory upgrade scenario; in the table, the “\*” symbol depicts statistical significance. Figure 9 provides a graphical depiction of the estimates in Table 16 and using red text and the “\*” again to depict statistical significance. The results of each protective response variable can be described as follows:

#### Action Taken

- Overall, the prototypes appear to be less protective or equally as protective as the current system in terms of the action selected by respondents. This was especially true at the “Watch level” (i.e., advisory) and the “Advisory level” (i.e., advisory continued) where those who saw

<sup>13</sup> **Remember:** The Current System Prototype first saw a Watch-level prompt, followed by an upgrade to an advisory and another upgrade to a warning.

Prototype 3 were less likely to take a more protective action in comparison to those who saw the current system. This result was significant at the “Watch level” and *close to significance* at the “Advisory level.”

#### **Likelihood of Monitoring**

- There were no significant results at the “Watch, Advisory, or Warning levels;” however, Prototype 4 consistently performed well at the “Watch level” (i.e., advisory) and “Warning level.”
- At the “Advisory level” (i.e., advisory continued), Prototype 3 performed better than the current system and other prototypes – although not significantly.

#### **Likelihood of Preparing**

- At the “Watch level” (i.e., advisory), all of the prototypes outperformed the current system; however, those who saw Prototype 2 and 4 were significantly more likely to prepare.
- At the “Advisory level” (i.e., advisory continued), all of the prototypes outperformed the current system; however, those who saw Prototype 3 were significantly more likely to prepare.
- At the “Warning level,” those who saw Prototype 3 and 4 were more likely to prepare. However, these results were not significant – although Prototype 4 was *close to significance*.

#### **Likelihood of Acting**

- The prototypes provided more or less the same level of protective response. However at the “Watch level” (i.e., advisory), those who saw Prototype 4 were more likely to take protective action. Although not significant, this result was *extremely close* to significance.

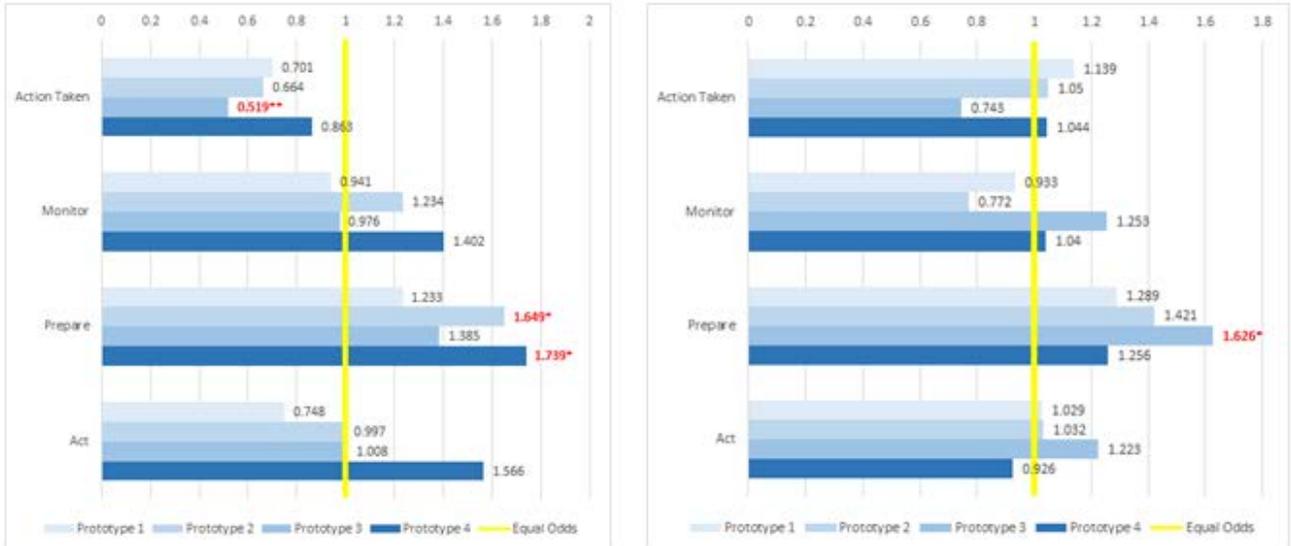
**Table 16. Estimated Odds Ratios for Advisory Upgrade Scenario: Excessive Heat Cold Regions**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Advisory</b>				
Prototype 1	0.701 (-1.32)	0.941 (-0.22)	1.233 (0.75)	0.748 (-1.05)
Prototype 2	0.664 (-1.51)	1.234 (0.72)	1.649* (1.73)	0.997 (-0.01)
Prototype 3	0.519** (-2.44)	0.976 (-0.09)	1.385 (1.14)	1.008 (0.03)
Prototype 4	0.863 (-0.56)	1.402 (1.19)	1.739* (1.94)	1.566 (0.21)
<b>Prompt 3: Advisory Cont.</b>				
Prototype 1	1.139 (0.52)	0.933 (-0.25)	1.289 (0.95)	1.029 (0.11)
Prototype 2	1.050 (0.19)	0.722 (-0.92)	1.421 (1.28)	1.032 (0.12)
Prototype 3	0.743 (-1.17)	1.253 (0.78)	1.626* (1.75)	1.223 (0.74)
Prototype 4	1.044 (0.17)	1.040 (0.14)	1.256 (-1.41)	0.926 (-0.29)
<b>Prompt 4: Warning</b>				
Prototype 1	0.841 (-0.69)	1.031 (0.11)	1.082 (0.29)	1.128 (0.45)
Prototype 2	0.667 (-1.57)	0.908 (-0.34)	0.972 (-0.10)	0.864 (-0.54)
Prototype 3	0.871 (-0.53)	1.058 (0.19)	1.282 (0.91)	0.911 (-0.33)
Prototype 4	0.801 (-0.87)	1.257 (0.77)	1.529 (1.53)	1.174 (0.58)

Exponentiated coefficients; z statistics in parentheses

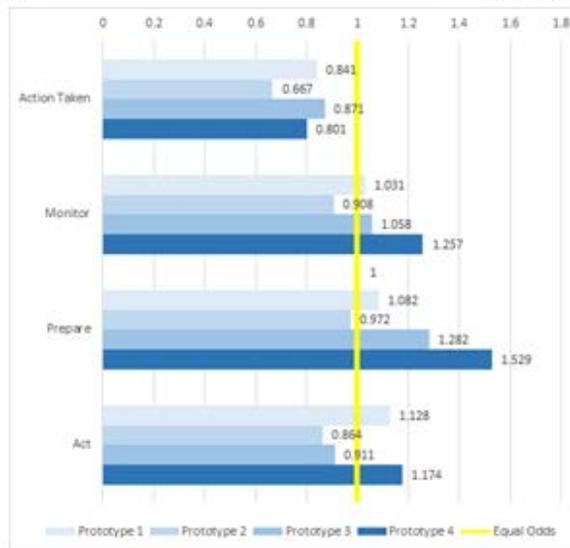
\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

### Excessive Heat – Cold Regions, Advisory Upgrade Scenario



Prompt 2: Advisory

Prompt 3: Advisory Continued



Prompt 4: Warning

Figure 9. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: Excessive Heat Cold Regions Survey

### 6.5 Summary and Conclusions

To offer a summary of the results provided in this section, Table 17 presents the percentages of estimates for each prototype that were significantly greater or significantly less than 1.0. Based on Table 17, Prototype 2, 3, and 4 had the same percentage of estimates greater than 1.0; however, Prototype 3 also had an estimate that was significantly less than 1.0.

**Table 17. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Heat Cold Survey**

Prototype	All Estimates	
	> 1.0	< 1.0
Prototype 1	0%	0%
Prototype 2	8%	0%
Prototype 3	8%	8%
Prototype 4	8%	0%
Total Number of Estimates [a]	12	

[a] This is the total for each Prototype

Table 18 expands the summary in Table 17 by breaking the percentages down by prompt level (i.e., Watch, Advisory, Warning). **Remember:** for the Excessive Heat Cold Regions Prototypes, a “Watch Level” involved an “Advisory” headline, the “Advisory level” involved the continuance of an “Advisory” headline, and the “Warning level” involved a “Warning” headline. In Table 18, we see that all of Prototype 2 and 4’s estimates that were significantly greater than 1.0 were at the “Watch level.” However, we see that Prototype 3’s estimate that was significantly greater occurred at the “Advisory level.”

**Table 18. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Heat Cold Survey**

Prototype	Watch		Advisory		Warning	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	0%	0%	0%
Prototype 2	25%	0%	0%	0%	0%	0%
Prototype 3	0%	25%	25%	0%	0%	0%
Prototype 4	25%	0%	0%	0%	0%	0%
Total Number of Estimates [a]	4		4		4	

[a] This is the total for each Prototype

Table 19 expands the summary in Tables 17 and 18 by breaking the percentages down by protective response variable (i.e., Action taken, Likelihood to Monitor, Likelihood to Prepare, and Likelihood to Act). These data reveal that all of the estimates that were significantly greater than 1.0 were concentrated on

increasing preparation. Further, Prototype 3’s estimate that was significantly less than 1.0 was associated with the action a respondent indicated they would take given the forecast information.

**Table 19. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Heat Cold Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 2	0%	0%	0%	0%	33%	0%	0%	0%
Prototype 3	0%	33%	0%	0%	33%	0%	0%	0%
Prototype 4	0%	0%	0%	0%	33%	0%	0%	0%
Total Number of Estimates [a]	3		3		3		3	

[a] This is the total for each Prototype

Based on this summary and the results presented in the above sections, some overall conclusions can be drawn.

- Across all levels and prototypes for the **action taken response variable**, the current system consistently performed better or equal to the prototype language. Specifically, the odds ratio values were all below or close to equaling one in the “Watch, Advisory, and Warning levels.”
- Prototype 3 offered mixed results. At the “Watch level” (i.e., advisory), those who saw Prototype 3 were significantly less likely to take a more protective action in comparison to those who saw the current system. However, in the “Advisory level” (i.e., advisory continued), Prototype 3 consistently performed well for the **likelihood to monitor, prepare, and take protective action response variables**. Specifically, it was significant for the **likelihood to prepare**.
- Prototype 4 consistently performed well at the “Watch level” (i.e., advisory) and “Warning level” for the **likelihood to monitor, prepare, and take protective action response variables**. Specifically, it was significant for the **likelihood to prepare** at the “Watch level” and *close to significance* at the “Warning level.”

### 6.6 Summary and Conclusions for Both Excessive Heat Surveys

To offer a summary results of both excessive heat surveys (cold and warm regions), Table 20 presents the percentages of estimates for each prototype that were significantly greater or significantly less than 1.0. Based on Table 20, Prototype 2 and 4 had the same percentage of estimates greater than 1.0; however, Prototype 3 was the only prototype to have an estimate that was significantly less than 1.0.

**Table 20. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Both Excessive Heat Surveys**

Prototype	All Estimates	
	> 1.0	< 1.0
Prototype 1	8%	0%
Prototype 2	13%	0%
Prototype 3	8%	4%
Prototype 4	13%	0%
Total Number of Estimates [a]	24	

[a] This is the total for each Prototype

Table 21 expands the summary in Table 20 by breaking the percentages down by prompt level (i.e., Watch, Advisory, Warning). **Remember:** for the Excessive Heat Warm and Cold Region Prototypes, a “Watch Level” involved an “Advisory” headline, the “Advisory level” involved the continuance of an “Advisory” headline, and the “Warning level” involve a “Warning” headline. In Table 21, we see that Prototype 2 and 4’s estimates that were significantly greater than 1.0 occurred at the “Watch level” and “Warning level.” However, we see that Prototype 3’s estimate that was significantly less than 1.0 occurred at the “Watch level.”

**Table 21. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Both Excessive Heat Surveys**

Prototype	Watch		Advisory		Warning	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	13%	0%	0%	0%	13%	0%
Prototype 2	25%	0%	0%	0%	13%	0%
Prototype 3	13%	13%	13%	0%	0%	0%
Prototype 4	25%	0%	0%	0%	13%	0%
Total Number of Estimates [a]	8		8		8	

[a] This is the total for each Prototype

Table 22 expands the summary in Tables 20 and 21 by breaking the percentages down by protective response variable (i.e., Action taken, Likelihood to Monitor, Likelihood to Prepare, and Likelihood to Act). These data reveal that all of the estimates that were significantly greater than 1.0 were concentrated on increasing monitoring and preparation. Further, Prototype 3 offered mixed results: In the Cold Region

Survey, the estimate that was significantly less than 1.0 was associated with the action a respondent indicated they would take given the forecast information. However, in the Warm Region Survey, Prototype 3 produced an estimate that was significantly more than 1.0 for the action taken.

**Table 22. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Both Excessive Heat Surveys**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	33%	0%	0%	0%	0%	0%
Prototype 2	0%	0%	33%	0%	17%	0%	0%	0%
Prototype 3	17%	17%	0%	0%	17%	0%	0%	0%
Prototype 4	0%	0%	33%	0%	17%	0%	0%	0%
Total Number of Estimates [a]	6		6		6		6	

[a] This is the total for each Prototype

Based on this summary and the results presented in the two survey sections, some overall conclusions about the excessive heat hazard can be drawn.

- **Across all levels, prototypes, and regions, the current system consistently performed better or equal to the prototype language for the likelihood of taking protective action response variable.** Specifically, the odds ratio values were generally below or close to equaling one in the “Watch, Advisory, and Warning levels.” The only exception was Prototype 4, at the “Watch level”, in the Cold Regions Survey, which was *extremely close to significance*. However, do we want respondents taking protective action this early on?
- **There is no clear prototype winner across both excessive heat surveys.** For the Cold Regions, Prototype 4 consistently performed well at the “Watch level” and “Warning level” for the likelihood to monitor, prepare, and take protective action response variables. For the Warm Regions, Prototype 2 consistently performed well across the “Watch level” and “Warning level” for the likelihood to monitor, prepare, and take protective action response variables.
- **Prototype 3 offered mixed results.** For Cold Regions, those who saw Prototype 3 – at the “Watch level” - were significantly less likely to take a more protective action in comparison to those who saw the current system. For Warm Regions, those who saw Prototype 3 – at the “Watch level” were significantly *more likely* to take a more protective action compared to those who saw the current system. Beyond the significant estimates, generally Prototype 3 performs poorly in comparison to the current system and other prototypes.

## 7.0 High Winds

This section discusses the results from the high winds survey. Based on the wide variety of high wind warning issuance criteria across the United States, it was decided between the researcher and the NWS, that there would not be any geographic limits to sampling for the high wind survey. Therefore, all contiguous U.S. States were surveyed. To ensure equal distribution and representation of a variety of U.S. states, an East/West sampling technique was employed.

**States:** All Contiguous U.S. States

**Respondents:** 1,079

**Collection time frame:** 1/2/18 – 1/4/18

### 7.1 Basic Demographics

Table 23 provides a summary of the demographics assessed in the high winds survey. Overall, the sample contains more females and Caucasian Americans. The sample seems to be fairly balanced across income, age, and education level. For a complete breakdown of all the demographic variables collected within the high winds sample, please see Appendix 4.

**Table 23. Basic Demographics for the High Winds Survey**

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
<b>Age</b>		<b>Race</b>	
18-24	10.4%	White	83.8%
25-34	19.0%	Black/African-American	7.3%
35-44	17.5%	Asian	5.1%
45-54	15.3%	Other	3.8%
55-64	20.1%	<b>Income</b>	
65+	17.6%	Less than \$24,999	20.3%
<b>Gender</b>		\$25,000 - \$49,999	32.1%
Female	67.3%	\$50,000 - \$99,999	24.1%
Male	32.4%	\$100,000 - \$199,999	10.6%
<b>Education</b>		More than \$200,000	2.9%
Less than college degree	49.0%	<b>Home Location</b>	
College degree	32.2%	Urban	23.3%
Graduate work/degree	18.6%	Suburban	50.2%
<b>Hispanic origin</b>		Rural	26.5%
Yes	8.6%	<b>Average number of adults in home</b>	<b>2.05</b>
No	91.4%	<b>Average number of children in home</b>	<b>0.52</b>

Figure 10 provides a summary of the states and the total number of respondents from each state that completed the high wind survey. The largest number of participants resided in California (111), and the least number lived in Delaware (2), New Hampshire (2), and Wyoming (1).

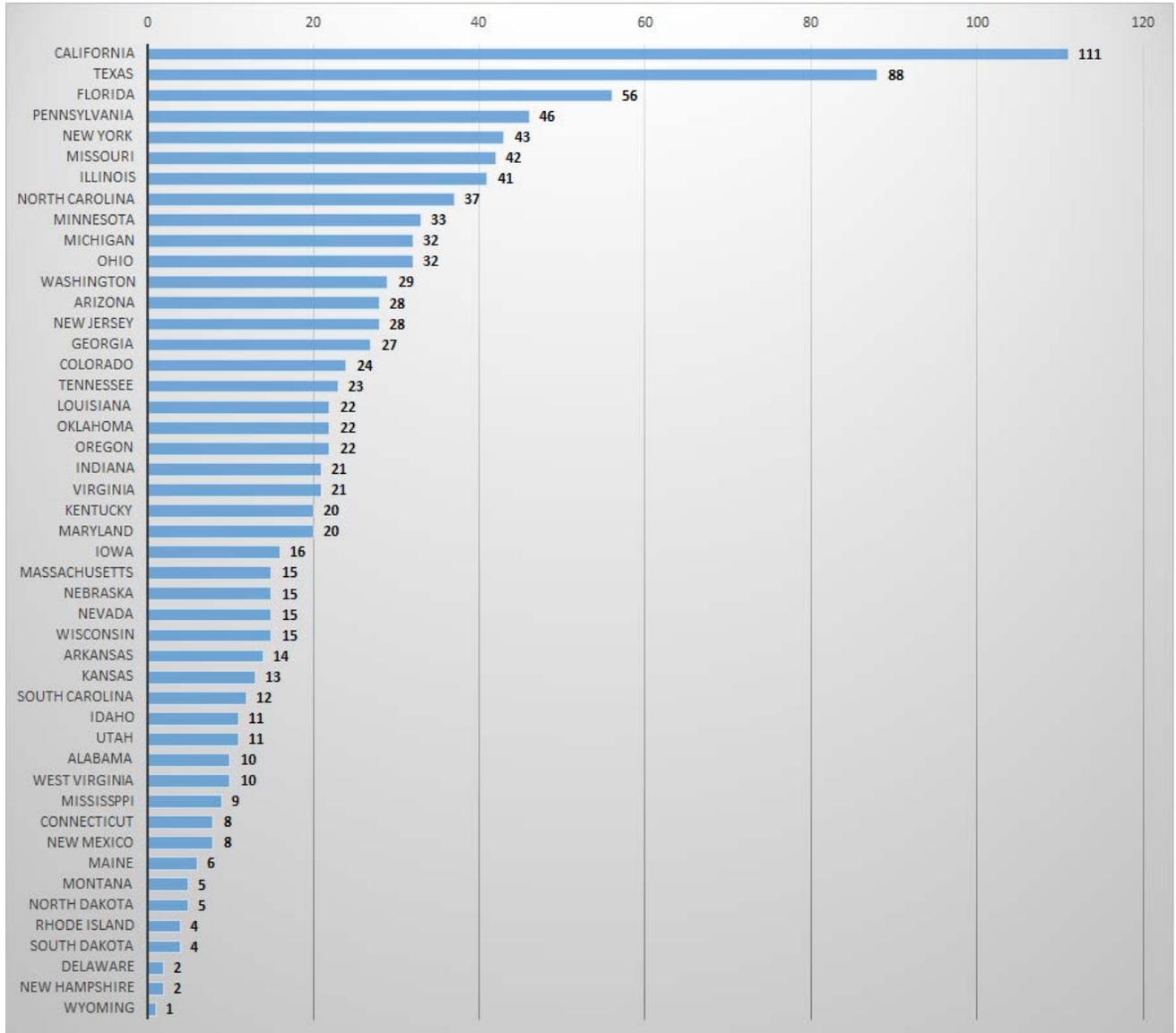


Figure 10. Number of respondents from States in the High Winds Survey

## 7.2 Weather Information Use

Figure 11 provides an overview of the participants' preference for receiving *daily* weather information. Participants overwhelmingly reported the use of television and a website/app for receiving their *daily* weather information. However, more individuals noted that they prefer to receive their daily weather information from a website/app.

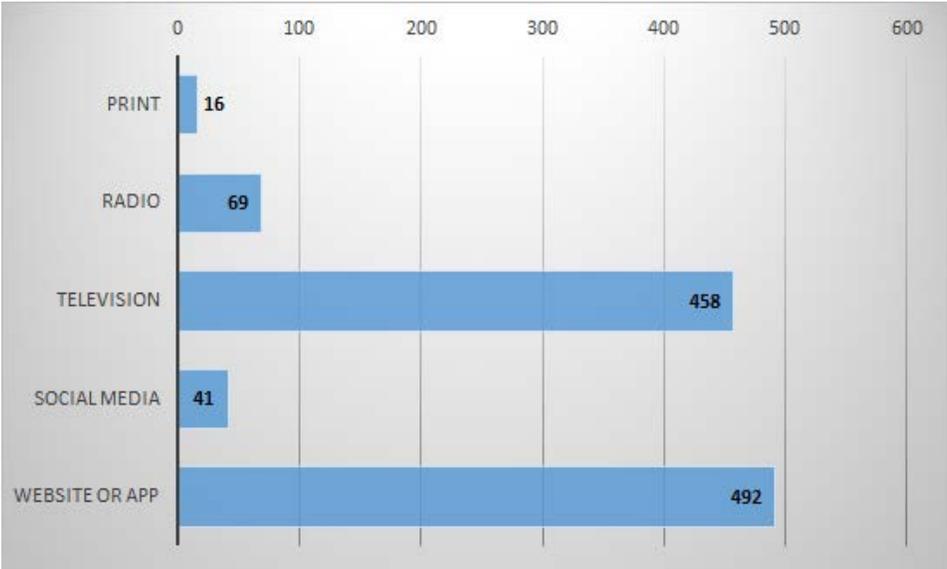


Figure 11. Participant's preference for receiving daily weather information

Figure 12 provides an overview of the participants' preference for receiving *information about excessive heat*. Similar to daily weather information, a large majority of participants reported the use of television and a website/app for receiving information about *high winds*. However, more individuals noted that they prefer to receive their *high wind information* from television sources.

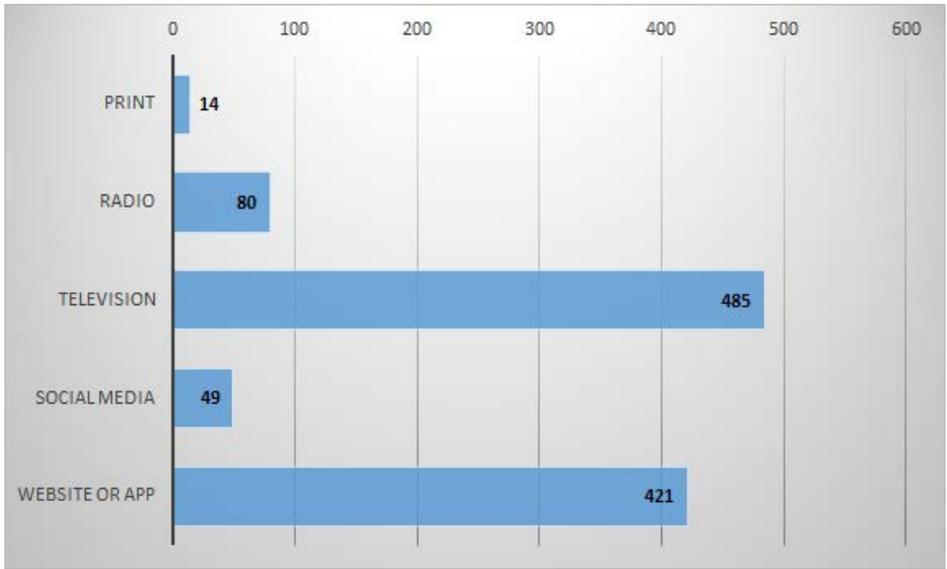


Figure 12. Participant's preference for receiving information about high winds

### 7.3 Current Knowledge

As discussed in Section 2.4, the current knowledge questions were developed after the deployment of the high wind survey; however, additional questions were included that provide some insight into the participants' current knowledge of the high wind products. Taken together, the following questions were used to assess knowledge of the High Wind Watch, Wind Advisory, and High Wind Warning:

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included (1) do nothing, (2) monitor, (3) prepare, (4) take some action, or (5) take protective action. Each survey provided a unique descriptions of what each type of action meant for the particular hazard being surveyed.
- **Likelihood of monitoring** – Respondents were asked how likely they were to monitor forecast information given the scenario provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of preparing** – Respondents were asked how likely they were to prepare given the information provided and could select a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Likelihood of taking some action** – Respondents were asked how likely they were to take some action given the information provided and could select a five-point scale with one indicating “very unlikely” and five indicating “very likely.” **This variable was added based on the NWS’ interest in investigating the importance of the “Wind Advisory” and the behavioral response associated with this WWA headline.**
- **Likelihood of acting** – Respondents were asked how likely they were to take a protective action given the information provided and could select from a five-point scale with one indicating “very unlikely” and five indicating “very likely.”
- **Perceived risk of the forecast** – Respondents were asked about their perceived risk given the forecast information provided and could select from a ten-point scale with one indicating “no risk” and ten indicating “extreme risk.”
- **Perceived confidence in the forecast** – Respondents were asked about their perceived confidence in the forecast information provided and could select from a ten-point scale with one indicating “no confidence” and ten indicating “extreme confidence.”
- **Perceived urgency of the forecast** – Respondents were asked about their perceived urgency given the forecast information and could select from a ten-point scale with one indicating “no urgency” and ten indicating “extreme urgency.”
- **Probability of Occurrence** – Respondents were asked to describe the probability that they would see high winds given the forecast information provided and could select from a sliding scale from one to one hundred.

Using these questions, we can examine different aspects of the participants’ knowledge of the current watch, warning, advisory system. Table 24 provides a summary of the means of these variables for individuals who saw the Warning with a Downgrade Scenario and Table 25 provides a summary of the means associated with the Advisory with an Upgrade Scenario. **Overall, the respondents appear to be misunderstanding the “Wind Advisory” in both the Warning with a Downgrade and Advisory with an Upgrade conditions. Instead of an increase in forecast certainty, respondents perceived less risk, confidence, urgency, and probability when an “Advisory” headline was seen. In fact, their response to these variables was lower than their response to the “Watch” headline.** This conclusion can be drawn based on the means associated with the “Advisory level” being lower than both the “Watch level” and “Warning level.” This pattern is evident across *all response variables*. Specifically, there does not appear to be much difference in the overall action taken when transitioning from the “Watch level” to “Advisory level” in the Advisory with an Upgrade condition.

**Table 24. Knowledge of the Current System using Behavioral and Perception Variables for the Warning with a Downgrade Scenario**

<b>Current System – Warning with a Downgrade</b>				
	<b>Base</b>	<b>Watch</b>	<b>Warning</b>	<b>Advisory</b>
Overall Action	2.76	2.85	3.29	2.73
Monitor	3.79	3.85	4.06	3.50
Prepare	3.62	3.67	3.84	3.04
Some Action	3.49	3.50	3.76	2.87
Prot. Action	3.30	3.21	3.71	2.99
Risk	6.16	6.11	6.70	5.45
Confidence	6.78	6.80	7.23	6.54
Urgency	6.36	6.29	7.03	5.56
Probability	55.40	56.85	68.06	51.30

**Table 25. Knowledge of the Current System using Behavioral and Perception Variables for the Advisory with an Upgrade Scenario**

<b>Current System – Advisory with an Upgrade</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.69	2.71	2.76	3.32
Monitor	3.76	3.87	3.54	4.02
Prepare	3.71	3.72	3.32	3.84
Some Action	3.54	3.49	3.09	3.76
Prot. Action	3.20	3.21	2.94	3.62
Risk	6.18	6.31	5.76	7.01
Confidence	6.91	7.00	6.79	7.60
Urgency	6.44	6.44	5.80	7.08
Probability	59.04	59.63	59.15	69.31

To further examine the behavioral response associated with each WWA headline, a breakdown of the **actions taken** is shown in Tables 26 and 27. A similar trend is observed, the behavioral response seems appropriate for the “Watch” and “Warning” levels; however, the response to the “Advisory” headline seems uncharacteristic given the goals of this WWA headline: (1) We are seeing a majority of respondents monitoring the situation and (2) a very small percentage of respondents are correctly responding to this headline by preparing and/or taking some action.

**Table 26. Percentage Breakdown of Actions associated with each WWA Headline for the Warning with a Downgrade Scenario**

<b>Current System – Warning with an Downgrade - Action Breakdown (%)</b>				
	<b>Base</b>	<b>Watch</b>	<b>Warning</b>	<b>Advisory</b>
Nothing	17.3	14.5	10.1	10.0
Monitor	20.9	31.8	20.2	43.6
Prepare	36.4	25.5	29.4	28.2
Some Action	12.7	13.6	14.7	7.3
Prot. Action	12.7	14.5	25.7	10.9

**Table 27. Percentage Breakdown of Actions associated with each WWA Headline for the Advisory with an Upgrade Scenario**

<b>Current System – Advisory with an Upgrade - Action Breakdown (%)</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Nothing	14.6	10.7	9.3	7.4
Monitor	28.2	36.4	44.4	22.3
Prepare	35.2	29.0	19.6	28.4
Some Action	17.4	18.7	14.5	14.9
Prot. Action	4.7	5.1	12.1	27.0

## 7.4 Prototype Analyses

This section presents the results of the ordered logistic regression analyses we performed on the prototype testing. The methods are discussed in Section 4.0. We analyzed data from the first few questions described in the previous section: **Action taken, Likelihood of monitoring, Likelihood of preparing, and Likelihood of acting**. To remain consistent with the ordered logistic regression analyses employed by ERG, the **Likelihood of taking some action** was not included in this analysis and was only used to provide additional information regarding the sample’s current knowledge of the WWA headlines.

The goal of the ordered logistic regression analyses was to determine whether those who saw certain prototypes were more or less likely to take protective actions compared to the current system using those four questions to measure different responses. As noted in Section 4.2, the analyses resulted in

the estimation of odds ratios that indicate the degree to which the four new prototypes performed against the current system. An odds ratio of 1.0 indicates that a prototype is just as protective as the current system, odds ratios below 1.0 indicate the prototype is less protective, and odds ratios above 1.0 indicate the prototype is more protective. By design, odds ratios cannot be below zero.

As discussed in Section 2.2, the high wind survey examined two scenarios: **Warning with a Downgrade** and **Advisory with an Upgrade**. Therefore, the next section will provide an in-depth discussion of the results for these two scenarios. We present odds ratios for each prompt within the scenario. The results are organized by the protective response variables listed above. The specific prototypes tested for the high wind survey appear in Table 28.

**Table 28. Specific Prototype Language Tested for High Winds Survey**

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	High Wind Watch	Wind Outlook	Wind Notice	Possible Wind Event	Possible High Winds
Advisory level	Wind Advisory	Wind Warning	Wind Alert	Moderate Wind Warning	Level Orange Wind Warning
Warning level	High Wind Warning	Wind Warning	Wind Warning	Severe Wind Warning	Level Red Wind Warning

### 7.4.1 Warning with a Downgrade Scenario

After a baseline prompt, the warning with a downgrade scenario started with a watch-level prompt, and then progressed to a warning-level prompt followed by an downgrade to an advisory. Table 29 presents the estimated odds ratios for the warning downgrade scenario; in the table, the “\*” symbol depicts statistical significance. Figure 13 provides a graphical depiction of the estimates in Table 29 and using red text and the “\*” again to depict statistical significance. The results of each protective response variable can be described as follows:

#### Action Taken

- At the “Watch level,” all of the prototypes are less protective than the current system. This was especially true for Prototype 3 and 4 as those who saw these prototypes were significantly less likely to take a more protective action in comparison to those who saw the current system.
- At the “Advisory level” and “Warning level,” Prototype 4 consistently performed better than the current system. Also, Prototype 1 performed better than the current system – but only at the “Warning level.”

#### Likelihood of Monitoring

- At the “Watch level,” the current system outperformed all of the prototypes in terms of monitoring. Specifically, those who saw Prototypes 1 and 3 were significantly less likely to monitor.
- At the “Advisory level,” those who saw Prototypes 1 and 2 were significantly less likely to monitor. However, those who saw Prototype 4 performed better than the current system and other prototypes – although not significantly.

### **Likelihood of Preparing**

- At the “Watch level,” the current system outperformed all of the prototypes in terms of preparation. Specifically, those who saw Prototypes 1, 2, and 4 were significantly less likely to prepare – in comparison to those who saw the current system.
- At the “Advisory level,” the current system outperformed Prototypes 1, 2, and 3. Specifically, those who saw Prototype 1 were significantly less likely to prepare – in comparison to those who saw the current system. Those who saw Prototype 4 performed better than the current system and other prototypes – although not significantly.
- At the “Warning level,” those who saw Prototype 4 were significantly more likely to prepare.

### **Likelihood of Acting**

- Again, at the “Watch level,” the current system outperformed all of the prototypes in terms of eliciting action. However, those who saw Prototype 4 were significantly more likely to act at the “Advisory level” and “Warning level.”

**Table 29. Estimated Odds Ratios for Warning Downgrade Scenario: High Winds**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	0.764 (-1.42)	0.716* (-1.65)	0.579*** (-2.87)	0.830 (-1.00)
Prototype 2	0.829 (-0.98)	0.782 (-1.21)	0.677** (-2.04)	0.954 (-0.25)
Prototype 3	0.708* (-1.79)	0.673* (-1.95)	0.734 (-1.63)	0.835 (-0.96)
Prototype 4	0.711* (-1.79)	0.789 (-1.16)	0.610*** (-2.62)	0.756 (-1.49)
<b>Prompt 3: Warning</b>				
Prototype 1	1.035 (0.19)	0.674* (-1.96)	0.623** (-2.56)	0.793 (-1.25)
Prototype 2	0.893 (-0.62)	0.703* (-0.84)	0.853 (-0.84)	0.984 (-0.09)
Prototype 3	1.237 (1.17)	0.963 (-0.20)	0.963 (-0.20)	1.132 (0.65)
Prototype 4	1.812*** (3.20)	1.235 (1.11)	1.235 (1.11)	1.453* (-0.29)
<b>Prompt 4: Advisory</b>				
Prototype 1	1.654*** (2.71)	1.274 (1.31)	1.288 (1.41)	1.409* (1.90)
Prototype 2	1.247 (1.20)	1.085 (0.43)	1.212 (1.07)	1.280 (1.37)
Prototype 3	1.080 (0.42)	1.175 (0.87)	1.007 (0.04)	0.973 (-0.15)
Prototype 4	1.505** (2.20)	1.671*** (2.72)	1.459** (1.53)	1.525** (2.33)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

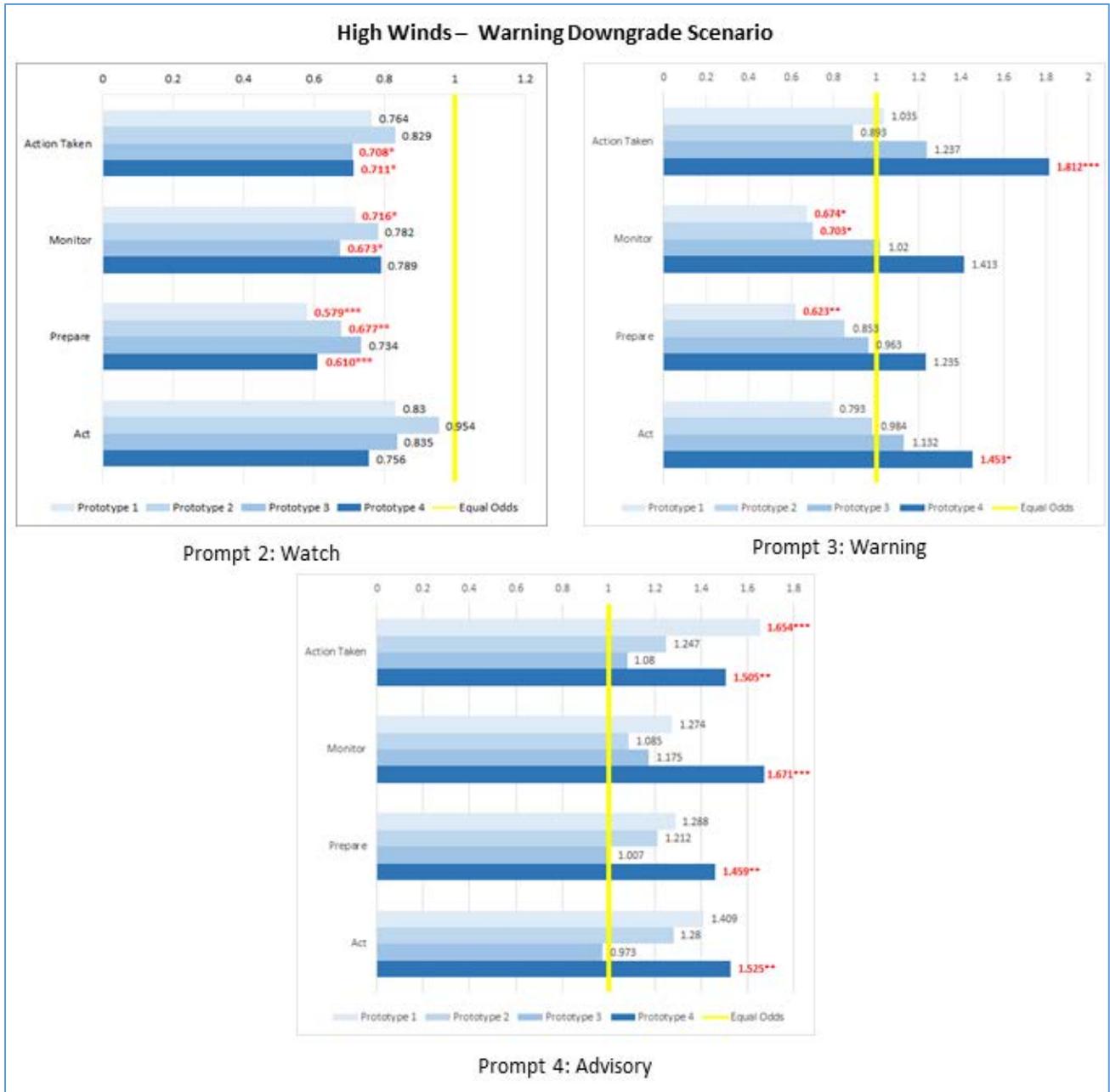


Figure 13. Graphical Depiction of Estimated Odds Ratios for Warning Downgrade Scenario: High Winds Survey

## 7.4.2 Advisory with an Upgrade Scenario

After a baseline prompt, the warning with a downgrade scenario started with a watch-level prompt, and then progressed to an advisory-level prompt followed by an upgrade to a warning. Table 30 presents the estimated odds ratios for the warning downgrade scenario; in the table, the “\*” symbol depicts statistical significance. Figure 14 provides a graphical depiction of the estimates in Table 30 and using red text and the “\*” again to depict statistical significance. The results of each protective response variable can be described as follows:

### Action Taken

- At the “Advisory level,” Prototypes 1, 2, and 4 performed better than the current system. Specifically, those who saw Prototypes 1, 2, and 4 were significantly more likely to take a more protective action in comparison to those who saw the current system.
- Prototype 4 consistently performed better than the current system at all levels.

### Likelihood of Monitoring

- At the “Watch level,” the current system outperformed all of the prototypes in terms of monitoring. Specifically, those who saw Prototypes 3 and 4 were significantly less likely to monitor.
- At the “Advisory level,” those who saw Prototypes 1, 2, and 4 performed better than the current system. However, only those who saw Prototype 1 were significantly more likely to monitor.

### Likelihood of Preparing

- At the “Watch level,” the current system outperformed all of the prototypes in terms of preparation. Specifically, those who saw Prototypes 3 and 4 were significantly less likely to prepare – in comparison to those who saw the current system.
- At the “Advisory level,” Prototypes 1, 2, and 4 outperformed the current system. Specifically, those who saw Prototype 1 and 4 were significantly more likely to prepare – in comparison to those who saw the current system.

### Likelihood of Acting

- Again, at the “Watch level,” the current system outperformed all of the prototypes in terms of eliciting action. Specifically, those who saw Prototype 3 and 4 were significantly less likely to act than those who saw the current system. **Could this be a positive result? Do we want people taking protective action at a “Watch level” headline?**
- At the “Advisory level,” those who saw Prototypes 1 and 2 were significantly more likely to act in comparison to those who saw the current system. However, the odds ratios produced by Prototype 4 were *extremely close to significance*.
- At the “Warning level,” those who saw Prototype 4 were significantly more likely to act in comparison to the those who saw the current system.

**Table 30. Estimated Odds Ratios for Advisory Upgrade Scenario: High Winds**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Watch</b>				
Prototype 1	1.009 (0.05)	0.770 (-1.28)	0.828 (-0.99)	0.801 (-1.16)
Prototype 2	1.217 (1.06)	0.781 (-1.22)	0.951 (-0.26)	0.966 (-0.18)
Prototype 3	1.092 (0.47)	0.650** (-1.95)	0.538*** (-3.21)	0.708* (-1.80)
Prototype 4	1.190 (0.94)	0.696* (-1.16)	0.674** (-2.07)	0.681** (-2.03)
<b>Prompt 3: Advisory</b>				
Prototype 1	1.566** (2.41)	1.499** (-1.96)	1.520** (2.28)	1.602** (2.53)
Prototype 2	1.701*** (2.86)	1.194 (0.94)	1.272 (1.33)	1.400 (1.83)
Prototype 3	0.831 (-1.01)	0.845 (-0.90)	0.773 (-1.43)	0.833 (-0.99)
Prototype 4	1.386* (1.76)	1.227 (1.09)	1.352* (1.66)	1.350 (1.64)
<b>Prompt 4: Warning</b>				
Prototype 1	1.122 (0.63)	0.712* (-1.68)	1.011 (0.06)	0.897 (-0.60)
Prototype 2	1.058 (0.31)	0.806 (-1.06)	0.845 (-0.92)	0.904 (-0.55)
Prototype 3	1.348 (1.63)	0.974 (-0.13)	1.008 (0.04)	1.106 (0.55)
Prototype 4	1.325 (1.54)	1.198 (0.96)	1.198 (0.96)	1.372** (1.67)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

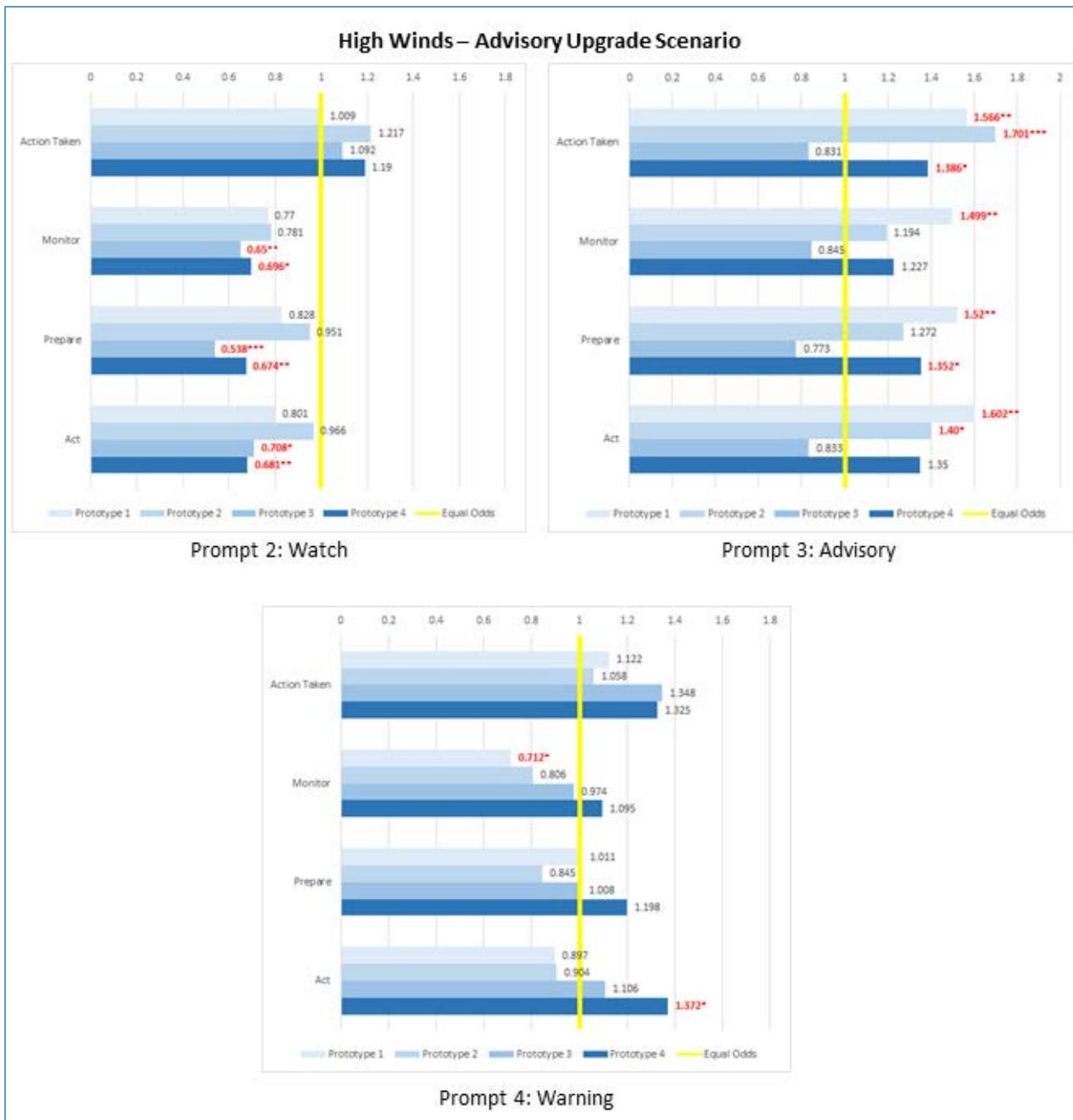


Figure 14. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: High Winds Survey

### 7.5 Summary and Conclusions

To offer a summary of the high wind survey results, Table 31 presents the percentages of estimates for each prototype that were significantly greater or significantly less than 1.0. Based on Table 31, Prototype 4 had the greater percentage of estimates larger than 1.0. However, Prototypes 1, 3, and 4 had an equal percentage of estimates less than 1.0. However, we need to further examine the specifics of these estimates less than 1.0.

**Table 31. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: High Wind Survey**

Prototype	All Estimates	
	> 1.0	< 1.0
Prototype 1	21%	21%
Prototype 2	8%	8%
Prototype 3	0%	21%
Prototype 4	38%	21%
Total Number of Estimates [a]	24	

[a] This is the total for each Prototype

Table 32 expands the summary in Table 31 by breaking the percentages down by prompt level (i.e., Watch, Advisory, Warning). In Table 32, we see that Prototype 1 and 4’s estimates that were significantly less than 1.0 occurred at the “Watch level.” In fact, all of Prototype 4’s estimates that were significantly less than 1.0 occurred at the “Watch level.” The greatest point of improvement over the current system occurred at the “Advisory level,” where Prototype’s 1, 2, and 4 all achieved estimates that were significantly greater than 1.0. At the “Warning level,” Prototype 4 is the only prototype to achieve an estimate significantly greater than 1.0 – Prototype 1 and 2 both had estimates that were significantly less than 1.0.

**Table 32. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: High Wind Survey**

Prototype	Watch		Advisory		Warning	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	13%	63%	0%	0%	38%
Prototype 2	0%	13%	25%	0%	0%	13%
Prototype 3	0%	50%	0%	0%	0%	0%
Prototype 4	0%	63%	63%	0%	25%	0%
Total Number of Estimates [a]	8		8		8	

[a] This is the total for each Prototype

Table 33 expands the summary in Tables 31 and 32 by breaking the percentages down by protective response variable (i.e., Action taken, Likelihood to Monitor, Likelihood to Prepare, and Likelihood to Act). These data reveal that all of the estimates that were significantly greater than 1.0 were concentrated on increasing action taken and likelihood of taking protective action. On the other hand, the estimates that were significantly less than 1.0 were concentrated on decreasing the likelihood of monitoring and preparing.

**Table 33. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: High Wind Survey**

Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	33%	0%	17%	50%	17%	33%	17%	0%
Prototype 2	17%	0%	0%	17%	0%	17%	17%	0%
Prototype 3	0%	17%	0%	33%	0%	17%	0%	17%
Prototype 4	50%	17%	17%	17%	33%	33%	50%	17%
Total Number of Estimates [a]	6		6		6		6	

[a] This is the total for each Prototype

Table 34, 35, and 36 further breakdown the percentages by looking at both protective response variable (i.e., Action taken, Likelihood to Monitor, Likelihood to Prepare, and Likelihood to Act) and prompt level (i.e., Watch level, Advisory level, Warning level). These tables offer additional information to better determine if individuals are taking the *most appropriate actions* at each prompt level. At the “Watch level,” all of the estimates were significantly less than 1.0. At the “Advisory level,” Prototypes 1 and 4 consistently perform better than the current system across all protective response variables. At the “Warning level,” Prototype 4 promotes action.

**Table 34. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Watch level, by Prototype and Protective Response Variable: High Wind Survey**

WATCH LEVEL								
Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	50%	0%	50%	0%	0%
Prototype 2	0%	0%	0%	0%	0%	50%	0%	0%
Prototype 3	0%	50%	0%	100%	0%	100%	0%	50%
Prototype 4	0%	50%	0%	50%	0%	50%	0%	50%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each Prototype

**Table 35. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Advisory level, by Prototype and Protective Response Variable: High Wind Survey**

ADVISORY LEVEL								
Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	100%	0%	50%	0%	50%	0%	50%	0%
Prototype 2	50%	0%	0%	0%	0%	0%	50%	0%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	100%	0%	50%	0%	100%	0%	50%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each Prototype

**Table 36. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Warning level, by Prototype and Protective Response Variable: High Wind Survey**

WARNING LEVEL								
Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	100%	0%	50%	0%	0%
Prototype 2	0%	0%	0%	50%	0%	0%	0%	0%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	50%	0%	0%	0%	0%	0%	100%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each Prototype

Based on this summary and the results presented in the two scenarios, some overall conclusions about the high wind hazard can be drawn.

- **The Current System “Watch level” headline (i.e., High Wind Watch) outperforms all of the Prototypes.** Specifically, the odds ratio values were generally below or close to equaling one in the “Watch, Advisory, and Warning levels” across all prototypes.
- **Prototype 1 performed consistently at the “Advisory level,” but does not work well at the “Warning level.”** Prototype 1 had several estimates significantly greater than 1.0 associated with the “Advisory level;” however, those estimates significantly greater than 1.0 did not translate into the “Warning level.” Perhaps, the use of the “Warning” headline creates action

during the “Advisory” phase – but does not encourage further action when the headline is repeated at the “Warning level.”

- **Prototype 3 consistently underperformed in comparison to the current system and other prototypes.** Specifically, Prototype 3 only achieved estimates that were significantly less than 1.0 for all of the response variables.
- **Prototype 4 consistently performs better than the other prototypes for high wind hazards, except at the “Watch level.”** Outside of the “Watch level,” all of the odds ratios associated with Prototype 4 are above 1.0. Further, there are 9 significant estimates that were greater than 1.0.
- **Current Knowledge Conclusion:** Overall, the respondents appear to be misunderstanding the “Wind Advisory” in both the Warning with a Downgrade and Advisory with an Upgrade conditions. Instead of an increase in forecast certainty, respondents perceived less risk, confidence, urgency, and probability when an “Advisory” headline was seen. In fact, their response to these variables was lower than their response to the “Watch” headline.

## 8.0 Education and Outreach Potential

As discussed in Section 2.2, participants were randomly assigned to either receive additional information about the prototype or not. This variable was manipulated for two reasons: (1) to evaluate the intuitiveness of the system (i.e., those individuals who did not receive additional information) and (2) to determine the value of educational outreach. Further, this provided a more realistic sample of individuals when evaluating the current system – as some individuals understand the difference between the watch, warning, advisory terminology and others do not. However, this single manipulation cannot be used extensively to argue for *or* against the value of education and outreach, but it does provide additional information to the NWS.

Figure 15 provides an example of the additional information given to participants *before* being asked about the prototype scenarios. This information was different for each prototype and for each hazard being surveyed. **Remember:** Half of the total sample saw additional information prior to seeing the prototype scenarios.

The National Weather Service is considering a change to a warning system that involves three high wind messages: **WIND NOTICE, WIND ALERT, and WIND WARNING**. Below you will find more information and a table that describes each message in more detail.

When conditions are favorable for the occurrence of high winds, a **WIND NOTICE** may be issued for your area. As forecasters become more certain, they will issue a **WIND ALERT** for sustained wind speeds ranging from 30 to 39 miles per hour – lasting for one hour or longer. This product may then be changed to a **WIND WARNING** if sustained wind speeds are forecast to be greater than 40 miles per hour for one hour or longer, or for winds gusting to 58 miles per hour for any duration.

Message:	Message Details:
Wind Notice	The <i>potential</i> for sustained wind speeds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration in the next 12 to 48 hours.
Wind Alert	Sustained wind speeds are forecast to range from 30 to 39 miles per hour for one hour or longer.
Wind Warning	Sustained wind speeds are forecast to be greater than 40 miles per hour for one hour or longer, or for winds gusting to 58 miles per hour for any duration.

Please take a look at the table above, as the next several questions will prompt you to make decisions using this weather warning system. When you are finished looking over the table, please continue to the next page. **Note:** You will not be able to return to this page.

Figure 15. Additional Information Given to Half of Participants

Similar to the odds ratios used to describe the differences between the prototypes in the previous sections, the odds ratios can tell us whether those who saw additional information (Figure 15) before the prototype were more or less likely to be in a higher response category. Table 37 presents the

estimated odds ratios for showing additional information before seeing the prototype in the excessive heat surveys, and Table 38 offers the estimated odds ratios for the high wind survey. In the table, the “\*” symbol depicts statistical significance. The results can be described as follows:

**Excessive Heat:**

- **Providing additional information may help respondents make better decisions at early-stages of a long-term weather event.** When individuals saw additional information *before* seeing a prototype, they were less likely to be in a higher response category during the early-stages of a hypothetical excessive heat scenario (Prompt 2 and Prompt 3). In other words, providing additional information may help respondents understand that hazardous weather will not be occurring for a few days. As a result, respondents were more likely to take more appropriate actions (i.e., Monitor or Prepare) during the early-stages of an excessive heat event. This pattern was most obvious among the Warm Regions survey; however, there was some indication in the Cold Region survey as well.
- **Providing additional information may not be as important for excessive heat events.** While there are some significant odds ratios (like those discussed in the previous section), a majority of the odds ratios are not significant. This in itself is somewhat of a result. Perhaps providing information is not as important for excessive heat events.

**Table 37. Estimated Odds Ratios for Additional Information in the Excessive Heat Warm and Cold Region Surveys**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2: Advisory</b>				
Warm Regions	0.731* (-1.76)	0.531** (-2.98)	0.655** (-2.10)	0.776 (-1.34)
Cold Regions	0.902 (-0.59)	1.014 (0.07)	0.963 (-0.20)	1.163 (0.83)
<b>Prompt 3: Advisory Cont.</b>				
Warm Regions	1.175 (0.96)	0.893 (-0.56)	0.950 (-0.27)	0.985 (-0.08)
Cold Regions	1.134 (0.77)	0.721* (-1.77)	1.028 (0.15)	1.104 (0.56)
<b>Prompt 4: Warning</b>				
Warm Regions	1.106 (0.58)	0.915 (-0.42)	0.975 (-0.13)	1.030 (0.16)
Cold Regions	1.145 (0.81)	0.907 (-0.51)	1.198 (1.00)	1.114 (0.60)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**High Winds:**

- **Providing additional information may help respondents make better decisions at the “Advisory” and “Warning” levels.** Unlike excessive heat, most of the odds ratios associated with the additional information variable for the high wind surveys are significant – especially at the

“Advisory” and “Warning” levels. What does this mean? Perhaps this hazard is not as well known as the other hazards. Therefore, providing additional information about the meteorological criteria (i.e., wind speeds) may, in fact, educate respondents and in turn encourage them to take further action. As a result, providing this additional information ahead of the prototype manipulation may be creating somewhat of an anchoring effect.

**Table 38. Estimated Odds Ratios for Additional Information in the High Wind Survey**

	(1) Action Taken	(2) Likelihood of Monitoring	(3) Likelihood of Preparing	(4) Likelihood of Acting
<b>Prompt 2:</b>				
AU: <i>Watch</i>	1.176 (1.38)	1.032 (0.25)	1.364*** (2.59)	1.214 (1.62)
WD: <i>Watch</i>	1.371** (2.57)	1.139 (1.00)	1.205 (1.54)	1.022 (0.18)
<b>Prompt 3:</b>				
AU: <i>Advisory</i>	1.281** (2.14)	1.256* (1.93)	1.285** (2.19)	1.231* (1.80)
WD: <i>Warning</i>	1.688*** (4.42)	1.248* (1.68)	1.707*** (4.42)	1.379*** (2.63)
<b>Prompt 4:</b>				
AU: <i>Warning</i>	1.285** (2.19)	1.284* (1.93)	1.511** (3.50)	1.477*** (3.32)
WD: <i>Advisory</i>	1.141 (1.11)	1.140 (1.09)	1.380*** (2.79)	1.330** (2.46)

Exponentiated coefficients; z statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

[a] AU = Advisory with an Upgrade condition; WD = Warning with a Downgrade condition.

**Summary:**

- **The importance of education and outreach may vary between hazards.** As we have seen from this modest analysis, the importance of providing additional information and/or education may vary across hazards. Can we dichotomize these differences based on short-term vs. long-term hazards? Perhaps the importance of education and outreach varies based on how well-known a hazard may be. Additional analyses are needed to provide definitive answers; however, this is a start.
- **Remember:** This was only a small-scale analysis, and further interest in the educational and outreach potential of various hazards would require additional inquiry.

## 9.0 Conclusions, Recommendations, and Next Steps

### 9.1 Conclusions

#### 9.1.1 Overall Results for Current Knowledge

**Conclusion #1: Respondents seem to be responding appropriately to the current excessive heat WWA headlines.** This conclusion can be drawn based on the means associated with behavior (i.e., overall action, monitoring, prepare, and protective action) increasing linearly across the conditions. Further, a similar trend is observed among the perception variables (i.e., risk, confidence, urgency, and probability). This conclusion is observed in both the excessive heat cold and warm region surveys.

**Conclusion #2: Respondents appear to misunderstand the “Wind Advisory” headline in the current system – for both the upgrade and downgrade scenarios.** Instead of an increase in all of the perception variables, respondents perceived less risk, confidence, urgency, and probability when an “Advisory” headline was seen. In fact, their response to these variables was lower than their response to the “Watch” headline.

#### 9.1.2 Overall Results by Prototype and Hazard

To offer a summary of the results from all surveys, Table 39 presents the percentages of estimates for each prototype that were significantly greater or significantly less than 1.0. Remember, estimates significantly greater than 1.0 indicate that the given prototype outperformed the current system and estimates significantly less than 1.0 indicate that the current system performed better.

**Conclusion #3: Prototypes 1, 2, and 4 performed the best overall in comparison to the current system.** However, Prototype 1 also had several estimates that were significantly less than 1.0 – this should be taken into consideration. It is important to keep in mind that these prototypes only outperformed the current system in roughly one out of five estimates (i.e., Prototype 1), one out of ten estimates (i.e., Prototype 2), and one out of every four estimates (i.e., Prototype 4). While these three prototypes outperformed the current system at times, it was not a staggering result.

**Conclusion #4: Prototype 3 performed poorly in comparison to the current system.** Prototype 3 only received two estimates that were significantly greater than 1.0 and six estimates that were less than 1.0. Again, this lack of performance was not overwhelming – but noteworthy.

**Table 39. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Excessive Heat and High Winds Surveys**

Prototype	Significantly Greater Than 1.0	Significantly Less Than 1.0
Prototype 1	17%	10%
Prototype 2	10%	4%
Prototype 3	4%	13%
Prototype 4	25%	10%
Total Number of Estimates [a]	48	

[a] This is the total for each Prototype

**Conclusion #5: Prototype performance varied by hazard; however, overall they agreed with the conclusions presented above.** Tables 40 and 41 provide a breakdown of the percentages of all estimates significantly greater and less than 1.0 for the excessive heat and high wind hazards. The excessive heat surveys from warm and cold regions did not completely agree. Prototypes 1, 2, and 4 outperformed the current system in the Warm Regions, whereas Prototypes 2 and 4 outperformed the current system in the Cold Regions. Again, this outperformance was not an overwhelming result. For the high wind hazard, Prototype 4 outperformed the current system and the other prototypes. While it also possessed estimates that were significantly less than 1.0, these values were isolated to the “Watch level.” More on this later.

**Table 40. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: Excessive Heat, Warm and Cold Regions**

Prototypes	Excessive Heat, Warm		Excessive Heat, Cold	
	Significantly Greater Than 1.0	Significantly Less Than 1.0	Significantly Greater Than 1.0	Significantly Less Than 1.0
Prototype 1	16%	0%	0%	0%
Prototype 2	16%	0%	8%	0%
Prototype 3	8%	0%	8%	8%
Prototype 4	16%	0%	8%	0%
Total Number of Estimates [a]	12	12	12	12

**Table 41. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype: High Winds**

Prototypes	High Winds	
	Significantly Greater Than 1.0	Significantly Less Than 1.0
Prototype 1	21%	21%
Prototype 2	8%	8%
Prototype 3	0%	21%
Prototype 4	38%	21%
Total Number of Estimates [a]	24	24

### 9.1.3 Overall Results by Prompt Level

Table 42 provides a breakdown by prompt level of the estimated odds ratios that were significantly greater than 1.0 and less than 1.0. Due to the excessive heat hazard not testing the “Watch” headline, these tables were not combined.

**Conclusion #6: The prototypes perform differently within each prompt level.** Although Prototypes 1, 2, and 4 performed best overall, this result varies by prompt level. For example, Prototype 1 and 4 perform best at the “Advisory level” for High Winds, but Prototypes 2 and 4 perform best when issuing an “Advisory” headline within Excessive Heat. This breakdown by prompt level (i.e., Table 42) may prove beneficial if the NWS desires to create a “Frankenstein” operational prototype given the results of the generalizable survey.

**Conclusion #7: The Current System “Watch” headline (i.e., High Wind Watch) outperforms all of the high wind prototypes at the “Watch level.”** This is evident in Table 42 under the “High Wind Estimates” portion of the table, where a high percentage of odds ratio estimates were significantly less than 1.0.

**Table 42. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Prompt Level: Excessive Heat and High Wind Surveys**

Prototype	High Wind Estimates						Excessive Heat Estimates [b]					
	Watch		Advisory		Warning		Watch		Advisory		Warning	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	13%	63%	0%	0%	38%	13%	0%	0%	0%	13%	0%
Prototype 2	0%	13%	25%	0%	0%	13%	25%	0%	0%	0%	13%	0%
Prototype 3	0%	50%	0%	0%	0%	0%	13%	13%	13%	0%	0%	0%
Prototype 4	0%	63%	63%	0%	25%	0%	25%	0%	0%	0%	13%	0%
Total Number of Estimates [a]	8		8		8		8		8		8	

[a] This is the total for each Prototype

[b] The hazards were separated because the Excessive Heat Prototypes did not test “Watch” headlines.

### 9.1.4 Overall Results by Protective Response Variable

Table 43 provides a breakdown by response variable of the estimated odds ratios that were significantly greater than 1.0 and less than 1.0.

**Conclusion #8: Prototypes 1 and 4 were both more effective at eliciting action in comparison to the current system.** For both the “Action Taken” and “Likelihood of Acting” response variables, Prototypes 1 and 4 performed the best.

**Conclusion #9: Prototypes 2 and 4 were both better at increasing the monitoring of weather forecast information in comparison to the current system.** For the “Likelihood of Monitoring” response variable, Prototypes 2 and 4 had a greater percentage of estimates that were significantly larger than 1.0. However, both of these prototypes did have a couple of estimates that were significantly less than 1.0.

**Conclusion #10: Prototype 4 was more effective at increasing preparation in comparison to the current system.** For the “Likelihood of Preparing” response variable, Prototype 4 had the greatest percentage of estimates that were significantly larger than 1.0. However, this prototype also had a fairly large percentage of estimates than were significantly less than 1.0. Upon further investigation, almost all of the estimates that were significantly lower than 1.0 occurred under the “Watch” headline, where all prototypes failed to outperform the current system.

**Table 43. Percentages of All Estimates Significantly Greater and Less than 1.0, by Prototype and Protective Response Variable: Excessive Heat and High Wind Surveys**

	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	17%	0%	25%	25%	8%	17%	8%	0%
Prototype 2	8%	0%	17%	8%	8%	8%	8%	0%
Prototype 3	0%	25%	8%	17%	8%	8%	0%	8%
Prototype 4	25%	8%	25%	8%	25%	17%	17%	8%
Total Number of Estimates [a]	12		12		12		12	

[a] This is the total for each Prototype

### 9.1.5 Overall Results by Protective Response Variable and Prompt Level

Tables 44, 45, and 46 further breakdown the percentages by looking at both protective response variable (i.e., Action taken, Likelihood to Monitor, Likelihood to Prepare, and Likelihood to Act) and prompt level (i.e., Watch level, Advisory level, Warning level). These tables offer additional information to better determine if individuals are taking the *most appropriate actions* at each prompt level. These tables only reflect the high wind surveys, due to the prompt level differences that exist within the excessive heat surveys.

**Conclusion #11: Prototype 4 performs well at both the “Advisory level” and “Warning level.”** In comparison to the other prototypes, Prototype 4 consistently performs well at both the “Advisory” and “Warning” level. Specifically, at the “Advisory level”, Prototype 4 performs well across all of the protective response variables. At the “Warning level,” Prototype 4 is effective at eliciting action.

**Table 44. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Watch level, by Prototype and Protective Response Variable: High Wind Survey**

WATCH LEVEL								
Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	50%	0%	50%	0%	0%
Prototype 2	0%	0%	0%	0%	0%	50%	0%	0%
Prototype 3	0%	50%	0%	100%	0%	100%	0%	50%
Prototype 4	0%	50%	0%	50%	0%	50%	0%	50%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each Prototype

[b] Due to the differences in the excessive heat prototypes, only the breakdown for high winds is shown.

**Table 45. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Advisory level, by Prototype and Protective Response Variable: High Wind Survey**

ADVISORY LEVEL								
Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	100%	0%	50%	0%	50%	0%	50%	0%
Prototype 2	50%	0%	0%	0%	0%	0%	50%	0%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	100%	0%	50%	0%	100%	0%	50%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each Prototype

[b] Due to the differences in the excessive heat prototypes, only the breakdown for high winds is shown.

**Table 46. Percentages of All Estimates Significantly Greater and Less than 1.0 at the Warning level, by Prototype and Protective Response Variable: High Wind Survey**

WARNING LEVEL								
Prototype	Action Taken		Likelihood of Monitoring		Likelihood of Preparing		Likelihood of Acting	
	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0	> 1.0	< 1.0
Prototype 1	0%	0%	0%	100%	0%	50%	0%	0%
Prototype 2	0%	0%	0%	50%	0%	0%	0%	0%
Prototype 3	0%	0%	0%	0%	0%	0%	0%	0%
Prototype 4	50%	0%	0%	0%	0%	0%	100%	0%
Total Number of Estimates [a]	2		2		2		2	

[a] This is the total for each Prototype

[b] Due to the differences in the excessive heat prototypes, only the breakdown for high winds is shown.

## 9.2 Recommendations

After examining the results and conclusions from the companion report authored by ERG and considering the conclusions described above, the following recommendations are offered:

- **Fixing the “problem” words (i.e., Watch and Advisory) can be a possible solution.**

When examining the overall results by prompt level, Prototype 2 appears to be more effective at the “Watch” level and the “Advisory” level – in comparison to the current system. The goal of

Prototype 2 was to evaluate a similar system to the current one; however, it allowed us to test alternative headlines for “Watch” and “Advisory.” Considering that previous Hazard Simplification projects have noted that emergency managers and broadcast meteorologists were interested in only making minor changes, this could be an solution that considers those needs. **After further examination of the results across different prompt levels, it appears that the transition from “Alert” to “Warning” does not provoke much behavior change. Therefore, replacing “Advisory” with “Alert” may only lead to individuals performing “Warning” level behaviors at the “Advisory” level. As a result, this change may fail to improve the spectrum of understanding that exists surrounding our current weather warning system. This should be strongly considered when thinking about this as a possible solution.**

- **Develop a new message sequence that combines Prototypes 2 and 4.**

As described in both reports, Prototypes 2 and 4 consistently performed better than the current system and other prototypes. However, when examining the overall results by prompt level, Prototype 2 appears to be more effective at the “Watch” level and the “Emergency” level and Prototype 4 consistently performs well at the “Advisory,” and “Warning” levels. To maximize the results of these two prototypes, it is suggested that a new prototype combine the two. Table 47 provides one option for a possible “Operational Prototype” when combining Prototype 2 and 4. **The message sequence in the combined column would, based on the data analyses, generate the greatest preparation and protective action response. However, this is only one option for combining the two prototypes.** Additional conversations and further discussion with NWS will be conducted to determine the best approaches to consider.

**Table 47. Combined Prototype 2 and 4 Based on Data Analysis Results**

Prompt Level	Prototype 2	Prototype 4	Combined
Watch	X Notice	Possible X Conditions	X Notice
Advisory	X Alert	Level Orange X Warning	Level Orange X Warning
Warning	X Warning	Level Red X Warning	Level Red X Warning
Emergency	X Emergency	Level Purple X Warning	X Emergency

**Additional Thoughts:**

- **Headlines matter.** Prototype 1 was specifically designed to evaluate whether individuals anchor to weather information or the weather-related headlines. Because Prototype 1 performs poorly across most of the hazards, this survey effort reveals the importance of weather headlines when communicating with a general public audience.
- **Any changes to the prototypes should take into account all hazards.** As discussed in the results, the success of the prototypes varied by hazard. Therefore, strong consideration should be given

to each hazard when deciding on a final “Operational Prototype.” Further, other hazards that were not considered during this survey process (i.e., Tropical hazards) should also be considered when deciding on a final “Operational Prototype.” Ask questions such as: Does this prototype make sense for all hazards? Are we staying consistent across all program areas? Will the tropical hazards fit into this “Operational Prototype?”

- **The NWS should continue thinking about the meteorological attributes that will drive each headline change.** The survey discussed in this report mapped meteorological criteria that is currently used by NWS policy to issue *watches, warnings, and advisories*. Therefore, considerable effort should be given to the meteorological attributes that would drive each headline change in a new or modified weather warning system. For example, would it be focused around impacts, confidence, or even a matrix system combining both impacts and confidence? This should be strongly considered as the NWS moves forward with additional testing.

## 9.3 Next Steps and Lessons Learned

### 9.3.1 Next Steps

Given these recommendations, several next steps are proposed for consideration as the NWS continues to evaluate alternatives to the current WWA system:

***Discuss the results of the generalizable survey with members of the weather community, partners, and stakeholders.***

- **Hazard Simplification Workshop 2.0:** Consider conducting another workshop similar to the [Hazard Simplification Workshop in 2015](#). Given the various options and recommendations for creating an “Operational Prototype,” NWS participants, emergency managers, broadcast meteorologists, social scientists, and other relevant partners could assist in finalizing an appropriate “Operational Prototype” that could be evaluated via additional operational testing in the Hazardous Weather Testbed. However, it will be *very important* to develop a core set of goals ahead of the workshop to ensure that a “Operational Prototype” is obtained at the end of the workshop.
- **Hazard Simplification Webinar:** Since the Hazard Simplification Workshop 2.0 would only allow a select number of participants and would ultimately require travel, webinar(s) in conjunction with the workshop may be considered to obtain feedback from a larger community perspective. This activity could act as a mini “listening tour” to better understand the partner’s/stakeholder’s perspective on the finalized “Operational Prototype.” For example, the NWS could team up with members of the NWA Societal Impacts Committee to co-host a NWA Webinar Wednesday by creating an interactive, online focus group with various members of the community. This could produce additional opportunities to obtain feedback from the weather enterprise, while collaborating with professional organizations in our community.

***Utilize the Hazardous Weather Testbed (HWT) to evaluate the operational viability of a finalized “Operational Prototype.”***

- **Testing operational feasibility of “Operational Prototype” in the HWT:** Consider conducting another operational feasibility study in collaboration with the HWT to test the “Operational Prototype” with NWS forecasters, emergency managers, and broadcast meteorologists using past events and real-world examples. The proposed “Operational Prototype” may seem appropriate on paper, but caveats and shortcomings of the newly proposed system may only arise through further operational testing.
- **Incorporate members of the general public into the HWT process:** Although the results of the generalizable survey allow us to understand the warning language that best resonates with the public, that data only used hypothetical situations. Therefore, it is recommended that members of the general public be included in the HWT process. To my knowledge, this has never been done before. However, if it is important to evaluate the “Operational Prototype” among NWS forecasters, emergency managers, and broadcast meteorologists using past events, then this process should also be conducted with members of the public. This exercise may reveal additional details about the proposed “Operational Prototype” that did not arise when members of the public completed the generalizable survey.
- **Evaluate the feasibility of the “Operational Prototype” in relation to the other NOAA/NWS initiatives:** The use of further testing within the HWT could also provide an opportunity to evaluate the Hazard Simplification “Operational Prototype” with other NOAA/NWS initiatives (e.g., FACETS, PHI, Hazard Services). All of these different projects are progressing independently; however, collaborating with the HWT would allow for feasibility testing of the “Operational Prototype” with these other initiatives. This process was extremely insightful during the previous Hazard Simplification Testbed evaluation; therefore, it is recommended that further testing be conducted that combines all of these initiatives.

***Offer remote and/or on-site internship or research opportunities for students to continue analyzing the Hazard Simplification survey data.***

- The Hazard Simplification survey data collected by myself and ERG contains a plethora of variables and demographic information that was not able to be completely investigated. Therefore, NWS should invest in internship and/or research opportunities for students and early career professionals. For example, the NWS may consider advertising on the [National Science Foundation \(NSF\) Graduate Research Internship Program \(GRIP\)](#) website. This dataset would also be optimal for further investigation by a Masters or Ph.D. student. This could promote further collaborations between the NWS and the academic sectors of the weather enterprise.

***Develop and implement an extensive public education campaign to inform the general public of any changes to the weather warning system.***

- **Conduct focus groups, interviews, and/or surveys to evaluate the audience and test messages.** If changes are made to the weather warning system, then extensive educational

research will need to be conducted. This could involve focus groups, interviews, and/or surveys to better understand your audience and to test any messages developed. Prior to implementing any changes to the weather warning system, this research will need to be conducted and evaluated to better understand the best way to convey and communicate these changes to the general public. Only then, can a major marketing effort occur.

- **Revise K-12 curriculum to emphasize any new changes to the weather warning system.** Since individuals learn about our weather warning system in school, it will be incredibly important to update the K-12 curriculum in schools across the United States. Further, K-12 students can be used as a vehicle to discuss the changes to the weather warning system with their families. This could include sending information home with students, assignments to be completed with the entire family, as well as projects such as creating a family emergency plan.

***Coordinate with all sectors of the weather enterprise and partners/stakeholders to assist with transition to new weather warning system.***

- **Develop a task force or advisory group to assist with weather warning system transition:** If any changes are made to the weather warning system, the NWS may consider developing a taskforce, advisory group, or subcommittee to assist with the transition. This task force/advisory group should be charged with stimulating ideas and activities on matters that pertain to the interests and transition of the weather warning system across all sectors of the weather enterprise and partners/stakeholders. This task force/advisory group should also promote consistency across the entirety of the weather enterprise, to ensure we are all working together toward a common goal. The task force/advisory group should consist of members drawn from the academic, private, emergency manager, and government sectors of our enterprise. Specifically, the government sectors should include representatives from other governmental partners (e.g., Department of Transportation, National Parks Service, and other entities that convey weather-related warnings).
- **Collaborate with professional organizations (e.g., American Meteorological Society, National Weather Association, etc.) and develop subcommittees to assist with weather warning system transition:** If a task force or advisory group is not preferred, the NWS could consider collaborating with several relevant committees within different professional organizations. Some relevant boards/committees include: [AMS Board on Enterprise Communication](#), [AMS Committee on Effective Communication of Weather and Climate Information](#), [NWA Societal Impacts Committee](#), etc. In addition to these professional organizations, NWS may consider reaching out to the [Alliance for Integrative Approaches to Extreme Environmental Events](#) – a newly formed entity that seeks to serve as an organizing mechanism among the various sectors and stakeholders in the hazards community.

### *9.3.2 Lessons Learned*

Considering the extent of the survey implementation process and the undertaking of surveying the general public, the following section documents the successes and challenges associated with the

entirety of this process. It is our hope that this information can be used by the NWS when collecting survey data in the future.

- **External validation must be conducted when using a scenario- and prompt-based methodology:** While an effective approach for collecting data surrounding hypothetical weather situations, this methodological approach requires external validation to ensure that participants are effectively progressing through time with each new prompt. This was especially challenging when surveying long-term hazards, as participants initially struggled with making decisions days in advance of the severe weather event. If considering this methodology in the future, (1) allot additional time and funding for external validation and (2) consider conducting cognitive interviews to walk through the scenarios in a one-on-one setting. This was extremely beneficial in the present study and provided direct feedback for improving the prompts.
- **Strongly consider the number of prototypes tested/evaluated in future research endeavors:** Although evaluating five prototypes provided extensive data, it ultimately restricts the number of participants that can be purchased with the budget provided and required that individuals each view two prototypes. While the report authored by ERG considered the sequence that individuals saw the prototypes, future studies should consider only showing participants *one* prototype to prevent cross-contamination. As a result, future research endeavors should strongly consider narrowing the number of prototypes tested.
- **Evaluating current knowledge of “Watch, Warning, and Advisory” using knowledge questions and behavioral response:** Previous research has shown that measuring current WWA knowledge is often difficult and done inconsistently. To overcome this concern, this research project utilized both current knowledge questions *and* the behavioral response to each of the WWA headlines. While further improvement and refinement is needed to evaluate the best ways to obtain current knowledge among members of the public, this was an improvement over simply asking individuals to report factual information. Future studies should continue looking for additional ways to evaluate current knowledge. NWS should consider using the perception questions that were included in this report (i.e., perceived risk, perceived confidence, perceived urgency, and probability of occurrence). These perception variables evaluate different aspects of each headline to provide additional information on their knowledge and/or willingness to react to certain WWA headlines.
- **Establish a timeline that considers document review from all hazard areas:** To ensure that the language included in the survey was representative of each hazard and NWS policy, each hazard program area reviewed the prototypes and language associated with their hazard survey prior to deployment. This was a much needed, yet intricate and lengthy process. Therefore, future studies involving survey efforts *across* hazard program areas should consider this review process when establishing a timeline for project completion.
- **Encourage the use of collaborative editing tools when crafting the questionnaire, survey instrument language, and working across hazard areas:** The use of cloud-based, editing tools (i.e., Google Documents) proved beneficial when crafting scenario- and prompt-based language across hazard areas. However, this was not used extensively throughout this process. As a result, I would advocate for exclusively using these online editing tools when editing scenario-

and prompt-based language or survey question wording. This will offer documentation of all the changes made, and allow everyone to decide on a finalized version.

## Appendix 1: Example Survey Instrument

# Hazard Simplification Survey High Wind Survey Instrument

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## Part I - Easy Demographics

**State:** Using the dropdown list, please select the state where your primary residence is located.  
[dropdown list of states]

**How\_long:** Approximately how long have you lived in that state?

- 1- Less than 1 year
- 2- 1 to 3 years
- 3- 3 to 5 years
- 4- 5 to 10 years
- 5- More than 10 years

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**adults:** Including yourself, how many adults age 18 and older live at your primary residence? [Verbatim]

**children:** How many children age 17 and younger live at your primary residence? [Verbatim]

**zipcode:** What is your current zipcode? (E.g., 30602). [Verbatim]

**home\_type:** What type of home is your primary residence?

- 1 - Apartment
- 2 - Single family home
- 3 - Duplex
- 4 - Mobile home
- 5 - Condo or townhouse
- 6 - Other (please specify) [Verbatim]

**home\_lot:** Which of the following categories best describes the location of your primary residence?

- 1 - Urban location in a densely populated area
- 2 - Suburban location in a neighborhood that is near a densely populated area

3 - Rural location in a sparsely populated area

**Hazard\_proximity:** If applicable, which of the following categories best describes the environment near your residence?

1 - River, stream, or small creek

2 - Lake or pond

3 - Ocean or coastal community

4 – Mountain

5 – Forest

6 - Not applicable

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## Part II - General Risk and Weather Questions

Now, we have a few questions that will assess your risk perception, attitudes, and experiences surrounding high winds. Here, “high winds” refers to situations where strong wind speeds are the primary threat, even if weather conditions are otherwise good. Using this information, please answer the following questions to the best of your knowledge.

**[W\_RP\_susceptibility]:** Using a scale from 0 to 10, where 0 means *not likely at all* and 10 means *extremely likely*, how do you rate the overall harm from high winds to:

- You

- Your home/apartment

- Your local community

**[W\_RP\_Severity]:** Using a scale from 0 to 10, where 0 means *not serious at all* and 10 means *extremely serious*, how do you rate the overall threat from high winds to:

- You

- Your home/apartment
- Your local community

-----Page Break-----

**[H\_RP\_Affect]:** How would you describe your feelings when you hear about an impending...

Very negative feelings	Rather negative feelings	Neither negative nor positive feelings	Rather positive feelings	Very positive feelings
------------------------	--------------------------	--	--------------------------	------------------------

...day without wind?

... breezy day?

... high wind day?

Thinking about high winds, please click on a circle between the pair of words that best describes your feelings.

- Stressed ..... Calm
- Displeased .....Pleased
- Sad .....Happy
- Depressed ....Elated

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**[W\_exp\_past]:** Have you or your family members, neighbors, friends, or associates ever experienced property damage, personal injury, or loss of life from high winds? *Please select all that apply.*

- 1 - No
- 2 - Yes, for you personally
- 3 - Yes, for family
- 4 - Yes, for neighbors
- 5 - Yes, for close friends or associates

-----Page Break-----

**[W\_exp\_fut]:** If you were to live in your neighborhood for the rest of your life, what is the probability that you or one of your neighbors will experience property damage, personal injury, or loss of life from high winds? Please indicate the probability as a *percent*. [Verbatim]

-----Page Break-----

**[W\_Adaptive\_behaviors]:** Using a scale from 0 to 10, where 0 means *disagree* and 10 means *agree*, how do you rate your agreement or disagreement with the following statements:

0 1 2 3 4 5 6 7 8 9 10 N/A.

My car handles high winds very well.

Driving in high winds make me nervous.

I have Homeowner's Insurance or Renter's Insurance in case high winds, fallen trees, or large branches damage my home.

I prepare for the possibility of a power outage that may be caused by high winds, fallen trees, or large branches.

High winds influence me to change my schedule.

My job requires me to work outside.

I avoid being outside during high winds, even if weather conditions are otherwise good.

I regularly trim the trees and branches in my yard.

I regularly have my trees inspected for wounds, decay, or structural defects.

I live near a wooded area with large trees.

I take proper precautions when required to work outdoors in high winds.

-----Page Break-----

**[W\_Att\_Info]:** Using a scale from 0 to 10, where 0 means *disagree* and 10 means *agree*, please rate your agreement or disagreement with the following.

Understanding the risks posed by high winds is:

Strongly Disagree

Strongly Agree

0 1 2 3 4 5 6 7 8 9 10

a. Wise

b. Useful

c. Valuable

d. Beneficial

-----Page Break-----

**[W\_GathCap]:** Using a scale from 0 to 10, where 0 means *disagree* and 10 means *agree*, please rate your agreement or disagreement with the following statements.

Strongly Disagree

Strongly Agree

0 1 2 3 4 5 6 7 8 9 10

a. I can't make sense of information about high winds.

b. When it comes to information about high winds, I don't know how to separate facts from fiction.

c. Most information about high winds is too technical for me to understand.

d. I can't understand information about high winds even if I make an effort.

**[H\_SubjNorms]:** Using a scale from 0 to 10, where 0 means *disagree* and 10 means *agree*, please rate your agreement or disagreement with the following statements.

Strongly Disagree

Strongly Agree

0 1 2 3 4 5 6 7 8 9 10

a. My friends expect me to know something about high winds.

b. Most people who are important to me think I should know something about high winds.

c. My family expects me to know something about high winds.

## Part III – High Wind Messaging Treatments

The next two sections will prompt you to make decisions using a given set of forecast scenarios and excessive heat messages. It is important that you are realistic and honest about how you might respond to the different scenarios, as your responses may be considered when making decisions about how to issue weather warning messages in the future.

**\*\*Participants will be randomly selected to see 2 of the five proposed weather warning system prototypes. Further, they will each be randomly selected to receive either the Warning Downgrade (WarnDown) or Advisory Upgrade (AdvUp) change in forecast condition.**

**\*\*Participants will be randomly selected to see no additional information or will be provided additional information (see below).**

This section will prompt you to answer questions based on a given warning system. Please pay attention to the time period in each scenario, as each new scenario will ask you to answer similar questions at different time points.

## Current Prototype:

The National Weather Service currently issues three types of messages: **WATCHES, WARNINGS, and ADVISORIES** depending on forecast certainty and threat to life and property. Below you will find more information and a table that describes the National Weather Service’s current warning system for high winds in more detail.

When conditions are favorable for the occurrence of high winds, a **HIGH WIND WATCH** may be issued for your area. As forecasters become more certain, they will issue a **WIND ADVISORY** for sustained winds ranging from 30 to 39 miles per hour – lasting for one hour or longer. This product may then be changed to a **HIGH WIND WARNING** if sustained winds are forecast to be greater than 40 miles per hour for one hour or longer, or for winds gusting to 58 miles per hour for any duration.

Name of Warning	Details
High Wind Watch	The <i>potential</i> for sustained wind speeds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration in the next 12 to 48 hours.
Wind Advisory	Sustained wind speeds are forecast to range from 30 to 39 miles per hour for one hour or longer.
High Wind Warning	Sustained wind speeds are forecast to be greater than 40 miles per hour for one hour or longer, or for winds gusting to 58 miles per hour for any duration.

Please take a look at the table above, as the next several questions will prompt you to make decisions using this weather warning system. When you are finished looking over the table, please continue to the next page. **Note:** You will not be able to return to this page.

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- Wind Messaging Treatments\_Curr\_WarnDown:

- **W\_Curr\_WD\_Base: Forecast Scenario:** Imagine you are home on a Tuesday in March. You learn that the National Weather Service is forecasting the potential for high winds on Wednesday with sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
  - *W\_Curr\_WD\_Base\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - **Nothing:** I would continue my current activities.
    - **Monitor:** I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc.
    - **Prepare:** I would start preparing by bringing in loose items, securing outdoor furniture, etc.
    - **Take some action:** I would cancel, move, or postpone outdoor activities; I would allow more time for driving.
    - **Take protective action:** I would go indoors and stay away from windows, even if weather conditions are otherwise good; I would limit driving with high profile vehicles.
  - *W\_Curr\_WD\_Base\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_Curr\_WD\_Base\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_Curr\_WD\_Base\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
- **W\_Curr\_WD\_Watch: Forecast Scenario:** Suppose it is still Tuesday and the National Weather Service has issued a **HIGH WIND WATCH** for Wednesday with the potential for sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
  - *W\_Curr\_WD\_Watch\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
  - *W\_Curr\_WD\_Watch\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_Curr\_WD\_Watch\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_Curr\_WD\_Watch\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
- **W\_Curr\_WD\_Warn: Forecast Scenario:** Now, it is Wednesday morning and the National Weather Service has issued a **HIGH WIND WARNING** through Wednesday evening for sustained winds greater than 40 miles per hour lasting one hour or longer, or winds gusting to 58 miles per hour for any duration.
  - *W\_Curr\_WD\_Warn\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday morning?
  - *W\_Curr\_WD\_Warn\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).

- *W\_Curr\_WD\_Warn\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
      - *W\_Curr\_WD\_Warn\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
    - **W\_Curr\_WD\_Adv: Forecast Scenario:** Now, imagine that it is Wednesday afternoon, and you receive the following information: “The National Weather Service has changed their forecast to a **WIND ADVISORY** through Wednesday evening, now expecting sustained winds ranging from 30 to 39 miles per hour lasting for one hour or longer.”
      - *W\_Curr\_WD\_Adv\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday afternoon?
      - *W\_Curr\_WD\_Adv\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
      - *W\_Curr\_WD\_Adv\_2* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
      - *W\_Curr\_WD\_Adv\_3* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
- Wind Messaging Treatments\_Current\_AdvUp:
  - **W\_Curr\_AU\_Base: Forecast Scenario:** Imagine you are home on a Tuesday in March. You learn that the National Weather Service is forecasting the potential for high winds on Wednesday with sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_Curr\_AU\_Base\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - *W\_Curr\_AU\_Base\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_Curr\_AU\_Base\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_Curr\_AU\_Base\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  - **W\_Curr\_AU\_Watch: Forecast Scenario:** Suppose it is still Tuesday and the National Weather Service has issued a **HIGH WIND WATCH** for Wednesday with the potential for sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_Curr\_AU\_Watch\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - *W\_Curr\_AU\_Watch\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_Curr\_AU\_Watch\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).

- *W\_Curr\_AU\_Watch\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
- **W\_Curr\_AU\_Adv: Forecast Scenario:** Now, it is Wednesday morning and the National Weather Service has issued a **WIND ADVISORY** through Wednesday evening for sustained winds ranging from 30 to 39 miles per hour lasting for one hour or longer.
  - *W\_Curr\_AU\_Adv\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday morning?
  - *W\_Curr\_AU\_Adv\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_Curr\_AU\_Adv\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_Curr\_AU\_Adv\_4* – Based on the forecast scenario above, what is the probability that excessive heat will actually occur?
- **W\_Curr\_AU\_Warn: Forecast Scenario:** Now, imagine that it is Wednesday afternoon, and you receive the following information: “The National Weather Service has changed their forecast to a **HIGH WIND WARNING** through Wednesday evening, now expecting sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.”
  - *W\_Curr\_AU\_Warn\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday afternoon?
  - *W\_Curr\_AU\_Warn\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_Curr\_AU\_Warn\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_Curr\_AU\_Warn\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?

## Prototype 1:

The National Weather Service is considering a change to a warning system that involves only two high wind messages: **WIND OUTLOOK** and **WIND WARNING**. Below you will find more information and a table that describes these messages in more detail.

When conditions are favorable for the occurrence of high winds, a **WIND OUTLOOK** may be issued for your area. As forecasters become more certain, they will issue a **WIND WARNING**. Please read the forecast details for wind speed specifics, as sustained winds and/or wind gusts are forecast to meet or exceed 30 miles per hour.

Name of Warning	Details
Wind Outlook	The <i>potential</i> for sustained wind speeds and/or wind gusts to meet or exceed 30 miles per hour in the next 12 to 48 hours.
Wind Warning	Sustained wind speeds and/or wind gusts are forecast to meet or exceed 30 miles per hour. Please read the forecast, as wind speeds and timing can vary.

Please take a look at the table above, as the next several questions will prompt you to make decisions using this weather warning system. When you are finished looking over the table, please continue to the next page. **Note:** You will not be able to return to this page.

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- Wind Messaging Treatments\_P1\_WarnDown:
  - **W\_P1\_WD\_Base: Forecast Scenario:** Imagine you are home on a Tuesday in March. You learn that the National Weather Service is forecasting the potential for high winds on Wednesday with sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_P1\_WD\_Base\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
      - **Nothing:** I would continue my current activities.
      - **Monitor:** I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc.
      - **Prepare:** I would start preparing by bringing in loose items, securing outdoor furniture, etc.

- **Take some action:** I would cancel, move, or postpone outdoor activities; I would allow more time for driving.
  - **Take protective action:** I would go indoors and stay away from windows, even if weather conditions are otherwise good; I would limit driving with high profile vehicles.
- *W\_P1\_WD\_Base\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P1\_WD\_Base\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P1\_WD\_Base\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
- **W\_P1\_WD\_Watch: Forecast Scenario:** Suppose it is still Tuesday and the National Weather Service has issued a **WIND OUTLOOK** for Wednesday with the potential for sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
  - *W\_P1\_WD\_Watch\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
  - *W\_P1\_WD\_Watch\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P1\_WD\_Watch\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P1\_WD\_Watch\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
- **W\_P1\_WD\_Warn: Forecast Scenario:** Now, it is Wednesday morning and the National Weather Service has issued a **WIND WARNING** through Wednesday evening for sustained winds greater than 40 miles per hour lasting one hour or longer, or winds gusting to 58 miles per hour for any duration.
  - *W\_P1\_WD\_Warn\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday morning?
  - *W\_P1\_WD\_Warn\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P1\_WD\_Warn\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P1\_WD\_Warn\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
- **W\_P1\_WD\_Adv: Forecast Scenario:** Now, imagine that it is Wednesday afternoon, and you receive the following information: “The National Weather Service has changed their forecast to a **WIND WARNING** through Wednesday evening, now expecting sustained winds ranging from 30 to 39 miles per hour lasting for one hour or longer.”
  - *W\_P1\_WD\_Adv\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday afternoon?

- *W\_P1\_WD\_Adv\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P1\_WD\_Adv\_2* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P1\_WD\_Adv\_3* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
- Wind Messaging Treatments\_P1\_AdvUp:
  - **W\_P1\_AU\_Base: Forecast Scenario:** Imagine you are home on a Tuesday in March. You learn that the National Weather Service is forecasting the potential for high winds on Wednesday with sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_P1\_AU\_Base\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - *W\_P1\_AU\_Base\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P1\_AU\_Base\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P1\_AU\_Base\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  - **W\_P1\_AU\_Watch: Forecast Scenario:** Suppose it is still Tuesday and the National Weather Service has issued a **WIND OUTLOOK** for Wednesday with the potential for sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_P1\_AU\_Watch\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - *W\_P1\_AU\_Watch\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P1\_AU\_Watch\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P1\_AU\_Watch\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  - **W\_P1\_AU\_Adv: Forecast Scenario:** Now, it is Wednesday morning and the National Weather Service has issued a **WIND WARNING** through Wednesday evening for sustained winds ranging from 30 to 39 miles per hour lasting for one hour or longer.
    - *W\_P1\_AU\_Adv\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday morning?
    - *W\_P1\_AU\_Adv\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).

- *W\_P1\_AU\_Adv\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P1\_AU\_Adv\_4* – Based on the forecast scenario above, what is the probability that excessive heat will actually occur?
- **W\_P1\_AU\_Warn: Forecast Scenario:** Now, imagine that it is Wednesday afternoon, and you receive the following information: “The National Weather Service has changed their forecast to a **WIND WARNING** through Wednesday evening, now expecting sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.”
  - *W\_P1\_AU\_Warn\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday afternoon?
  - *W\_P1\_AU\_Warn\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P1\_AU\_Warn\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P1\_AU\_Warn\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?

## Prototype 2:

The National Weather Service is considering a change to a warning system that involves three high wind messages: **WIND NOTICE**, **WIND ALERT**, and **WIND WARNING**. Below you will find more information and a table that describes each message in more detail.

When conditions are favorable for the occurrence of high winds, a **WIND NOTICE** may be issued for your area. As forecasters become more certain, they will issue a **WIND ALERT** for sustained winds ranging from 30 to 39 miles per hour – lasting for one hour or longer. This product may then be changed to a **WIND WARNING** if sustained winds are forecast to be greater than 40 miles per hour for one hour or longer, or for winds gusting to 58 miles per hour for any duration.

Name of Warning	Details
Wind Notice	The <i>potential</i> for sustained wind speeds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration in the next 12 to 48 hours.
Wind Alert	Sustained wind speeds are forecast to range from 30 to 39 miles per hour for one hour or longer.
Wind Warning	Sustained wind speeds are forecast to be greater than 40 miles per hour for one hour or longer, or for winds gusting to 58 miles per hour for any duration.

Please take a look at the table above, as the next several questions will prompt you to make decisions using this weather warning system. When you are finished looking over the table, please continue to the next page. **Note:** You will not be able to return to this page.

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- Wind Messaging Treatments\_P2\_WarnDown:
  - **W\_P2\_WD\_Base: Forecast Scenario:** Imagine you are home on a Tuesday in March. You learn that the National Weather Service is forecasting the potential for high winds on Wednesday with sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.



- **W\_P2\_WD\_Adv: Forecast Scenario:** Now, imagine that it is Wednesday afternoon, and you receive the following information: “The National Weather Service has changed their forecast to a **WIND ALERT** through Wednesday evening, now expecting sustained winds ranging from 30 to 39 miles per hour lasting for one hour or longer.”
  - *W\_P2\_WD\_Adv\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday afternoon?
  - *W\_P2\_WD\_Adv\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P2\_WD\_Adv\_2* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P2\_WD\_Adv\_3* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  
- Wind Messaging Treatments\_P2\_AdvUp:
  - **W\_P2\_AU\_Base: Forecast Scenario:** Imagine you are home on a Tuesday in March. You learn that the National Weather Service is forecasting the potential for high winds on Wednesday with sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_P2\_AU\_Base\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - *W\_P2\_AU\_Base\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P2\_AU\_Base\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P2\_AU\_Base\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  - **W\_P2\_AU\_Watch: Forecast Scenario:** Suppose it is still Tuesday and the National Weather Service has issued a **WIND NOTICE** for Wednesday with the potential for sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_P2\_AU\_Watch\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - *W\_P2\_AU\_Watch\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P2\_AU\_Watch\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P2\_AU\_Watch\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  - **W\_P2\_AU\_Adv: Forecast Scenario:** Now, it is Wednesday morning and the National Weather Service has issued a **WIND ALERT** through Wednesday evening for sustained winds ranging from 30 to 39 miles per hour lasting for one hour or longer.

- *W\_P2\_AU\_Adv\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday morning?
  - *W\_P2\_AU\_Adv\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P2\_AU\_Adv\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P2\_AU\_Adv\_4* – Based on the forecast scenario above, what is the probability that excessive heat will actually occur?
- **W\_P2\_AU\_Warn: Forecast Scenario:** Now, imagine that it is Wednesday afternoon, and you receive the following information: “The National Weather Service has changed their forecast to a **WIND WARNING** through Wednesday evening, now expecting sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.”
- *W\_P2\_AU\_Warn\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday afternoon?
  - *W\_P2\_AU\_Warn\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P2\_AU\_Warn\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P2\_AU\_Warn\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?

### Prototype 3:

The National Weather Service is considering a change to a warning system that involves three high wind messages: **POSSIBLE WIND EVENT, MODERATE WIND WARNING, and SEVERE WIND WARNING**. Below you will find more information and a table that describes each message in more detail.

When conditions are favorable for the occurrence of high winds, a **POSSIBLE WIND EVENT** may be issued for your area. As forecasters become more certain, they will issue a **MODERATE WIND WARNING** for sustained winds ranging from 30 to 39 miles per hour – lasting for one hour or longer. This product may then be changed to a **SEVERE WIND WARNING** if sustained winds are forecast to be greater than 40 miles per hour for one hour or longer, or for winds gusting to 58 miles per hour for any duration.

Name of Warning	Details
Possible Wind Event	The <i><b>potential</b></i> for sustained wind speeds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration in the next 12 to 48 hours.
Moderate Wind Warning	Sustained wind speeds are forecast to range from 30 to 39 miles per hour for one hour or longer.
Severe Wind Warning	Sustained wind speeds are forecast to be greater than 40 miles per hour for one hour or longer, or for winds gusting to 58 miles per hour for any duration.

Please take a look at the table above, as the next several questions will prompt you to make decisions using this weather warning system. When you are finished looking over the table, please continue to the next page. **Note:** You will not be able to return to this page.

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- Wind Messaging Treatments\_P3\_WarnDown:
  - **W\_P3\_WD\_Base: Forecast Scenario:** Imagine you are home on a Tuesday in March. You learn that the National Weather Service is forecasting the potential for high winds on Wednesday with sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.



- **W\_P3\_WD\_Adv: Forecast Scenario:** Now, imagine that it is Wednesday afternoon, and you receive the following information: “The National Weather Service has changed their forecast to a **MODERATE WIND WARNING** through Wednesday evening, now expecting sustained winds ranging from 30 to 39 miles per hour lasting for one hour or longer.”
  - *W\_P3\_WD\_Adv\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday afternoon?
  - *W\_P3\_WD\_Adv\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P3\_WD\_Adv\_2* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P3\_WD\_Adv\_3* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  
- Wind Messaging Treatments\_P3\_AdvUp:
  - **W\_P3\_AU\_Base: Forecast Scenario:** Imagine you are home on a Tuesday in March. You learn that the National Weather Service is forecasting the potential for high winds on Wednesday with sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_P3\_AU\_Base\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - *W\_P3\_AU\_Base\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P3\_AU\_Base\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P3\_AU\_Base\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  - **W\_P3\_AU\_Watch: Forecast Scenario:** Suppose it is still Tuesday and the National Weather Service has issued a **POSSIBLE WIND EVENT** for Wednesday with the potential for sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_P3\_AU\_Watch\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - *W\_P3\_AU\_Watch\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P3\_AU\_Watch\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P3\_AU\_Watch\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  - **W\_P3\_AU\_Adv: Forecast Scenario:** Now, it is Wednesday morning and the National Weather Service has issued a **MODERATE WIND WARNING** through Wednesday evening for sustained winds ranging from 30 to 39 miles per hour lasting for one hour or longer.

- *W\_P3\_AU\_Adv\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday morning?
  - *W\_P3\_AU\_Adv\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P3\_AU\_Adv\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P3\_AU\_Adv\_4* – Based on the forecast scenario above, what is the probability that excessive heat will actually occur?
- **W\_P3\_AU\_Warn: Forecast Scenario:** Now, imagine that it is Wednesday afternoon, and you receive the following information: “The National Weather Service has changed their forecast to a **SEVERE WIND WARNING** through Wednesday evening, now expecting sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.”
- *W\_P3\_AU\_Warn\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday afternoon?
  - *W\_P3\_AU\_Warn\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P3\_AU\_Warn\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P3\_AU\_Warn\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?

### Prototype 4:

The National Weather Service is considering a change to a warning system that involves three high wind messages: **POSSIBLE HIGH WINDS, LEVEL ORANGE WIND WARNING, and LEVEL RED WIND WARNING**. Below you will find more information and a table that describes each message in more detail.

When conditions are favorable for the occurrence of high winds, a **POSSIBLE HIGH WINDS** may be issued for your area. As forecasters become more certain, they will issue a **LEVEL ORANGE WIND WARNING** for sustained winds ranging from 30 to 39 miles per hour – lasting for one hour or longer. This product may then be changed to a **LEVEL RED WIND WARNING** if sustained winds are forecast to be greater than 40 miles per hour for one hour or longer, or for winds gusting to 58 miles per hour for any duration.

Name of Warning	Details
Possible High Winds	The <i>potential</i> for sustained wind speeds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration in the next 12 to 48 hours.
Level Orange Wind Warning	Sustained wind speeds are forecast to range from 30 to 39 miles per hour for one hour or longer.
Level Red Wind Warning	Sustained wind speeds are forecast to be greater than 40 miles per hour for one hour or longer, or for winds gusting to 58 miles per hour for any duration.

Please take a look at the table above, as the next several questions will prompt you to make decisions using this weather warning system. When you are finished looking over the table, please continue to the next page. **Note:** You will not be able to return to this page.

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- Wind Messaging Treatments\_P4\_WarnDown:
  - **W\_P4\_WD\_Base: Forecast Scenario:** Imagine you are home on a Tuesday in March. You learn that the National Weather Service is forecasting the potential for high winds on Wednesday with sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.

- *W\_P4\_WD\_Base\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
      - **Nothing:** I would continue my current activities.
      - **Monitor:** I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc.
      - **Prepare:** I would start preparing by bringing in loose items, securing outdoor furniture, etc.
      - **Take some action:** I would cancel, move, or postpone outdoor activities; I would allow more time for driving.
      - **Take protective action:** I would go indoors and stay away from windows, even if weather conditions are otherwise good; I would limit driving with high profile vehicles.
    - *W\_P4\_WD\_Base\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P4\_WD\_Base\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P4\_WD\_Base\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  - **W\_P4\_WD\_Watch: Forecast Scenario:** Suppose it is still Tuesday and the National Weather Service has issued a **POSSIBLE HIGH WINDS** for Wednesday with the potential for sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_P4\_WD\_Watch\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - *W\_P4\_WD\_Watch\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P4\_WD\_Watch\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P4\_WD\_Watch\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  - **W\_P4\_WD\_Warn: Forecast Scenario:** Now, it is Wednesday morning and the National Weather Service has issued a **LEVEL RED WIND WARNING** through Wednesday evening for sustained winds greater than 40 miles per hour lasting one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_P4\_WD\_Warn\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday morning?
    - *W\_P4\_WD\_Warn\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P4\_WD\_Warn\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P4\_WD\_Warn\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?

- **W\_P4\_WD\_Adv: Forecast Scenario:** Now, imagine that it is Wednesday afternoon, and you receive the following information: “The National Weather Service has changed their forecast to a **LEVEL ORANGE WIND WARNING** through Wednesday evening, now expecting sustained winds ranging from 30 to 39 miles per hour lasting for one hour or longer.”
  - *W\_P4\_WD\_Adv\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday afternoon?
  - *W\_P4\_WD\_Adv\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P4\_WD\_Adv\_2* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P4\_WD\_Adv\_3* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  
- Wind Messaging Treatments\_P4\_AdvUp:
  - **W\_P4\_AU\_Base: Forecast Scenario:** Imagine you are home on a Tuesday in March. You learn that the National Weather Service is forecasting the potential for high winds on Wednesday with sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_P4\_AU\_Base\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - *W\_P4\_AU\_Base\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P4\_AU\_Base\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P4\_AU\_Base\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  - **W\_P4\_AU\_Watch: Forecast Scenario:** Suppose it is still Tuesday and the National Weather Service has issued a **POSSIBLE HIGH WINDS** for Wednesday with the potential for sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.
    - *W\_P4\_AU\_Watch\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Tuesday?
    - *W\_P4\_AU\_Watch\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
    - *W\_P4\_AU\_Watch\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
    - *W\_P4\_AU\_Watch\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?
  - **W\_P4\_AU\_Adv: Forecast Scenario:** Now, it is Wednesday morning and the National Weather Service has issued a **LEVEL ORANGE WIND WARNING** through Wednesday

evening for sustained winds ranging from 30 to 39 miles per hour lasting for one hour or longer.

- *W\_P4\_AU\_Adv\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday morning?
  - *W\_P4\_AU\_Adv\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P4\_AU\_Adv\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P4\_AU\_Adv\_4* – Based on the forecast scenario above, what is the probability that excessive heat will actually occur?
- **W\_P4\_AU\_Warn: Forecast Scenario:** Now, imagine that it is Wednesday afternoon, and you receive the following information: “The National Weather Service has changed their forecast to a **LEVEL RED WIND WARNING** through Wednesday evening, now expecting sustained winds greater than 40 miles per hour for one hour or longer, or winds gusting to 58 miles per hour for any duration.”
- *W\_P4\_AU\_Warn\_1* – Based on the forecast scenario, which of the following most accurately describes what you would do on Wednesday afternoon?
  - *W\_P4\_AU\_Warn\_2* – Using a scale from 1 to 5, where 1 means *very unlikely* and 5 means *very likely*, how likely are you to do the following based on the forecast scenario above? (Monitor, Prepare, Take Protective Action).
  - *W\_P4\_AU\_Warn\_3* – Based on the forecast scenario above, please rate the following using a scale from 0 to 10, where 0 means no (risk/confidence/urgency) and 10 means extreme (risk/confidence/urgency).
  - *W\_P4\_AU\_Warn\_4* – Based on the forecast scenario above, what is the probability that high winds will actually occur?

## Part IV - Sources

**Adapted from a [Pew News Media Survey](#)**

**[News\_Level]** How closely do you follow ...

Very closely    Somewhat closely    Not very closely    Not at all closely    No Answer

a.) Your local weather

b.) The weather where your friends or family live

b.) National Weather

**[NEWS\_DEVICE]** Thinking about the weather, how often do you get weather information... [RANDOMIZE a-b]

Often    Sometimes    Hardly Ever    Never    No Answer

- a.) On a desktop or laptop computer
- b.) On a mobile device (such as a smartphone or tablet)

If [NEWS\_Device] a = often, sometimes, hardly ever and [NEWS\_Device] b = often, sometimes, hardly ever then ask:

**[NewsDigPref]** Do you prefer to get your weather information

- a.) on a desktop or laptop
- b.) on a mobile device (such as a smartphone or tablet)

**[NEWS\_PLATFORM]** And how often do you... [randomize options]

Often   Sometimes   Hardly Ever   Never   No Answer

- a.) Read weather in print?
- b.) Listen to weather on the radio?
- c.) Watch local television weather?
- d.) Watch national evening network television weather?
- e.) Watch cable television weather (such as The Weather Channel, WeatherNation, or AccuWeather)?
- f.) Get weather from a social networking site (such as Facebook or Twitter)?
- g.) Get weather from a website or application?

**[Randomize order of PLATFORM\_DAILY/WIND]**

**[PLATFORM\_Daily]** Which of the following would you say you prefer for getting *daily* weather information? (choose one)

Reading weather in a print newspaper

Listening to weather on the radio

Watching weather on television

Getting weather from a social networking site (such as Facebook or Twitter)

Getting weather from a website or app

**[PLATFORM\_Wind]** Which of the following would you say you prefer for getting *high wind* information? (choose one)

Reading weather in a print newspaper

Listening to weather on the radio

Watching weather on television

Getting weather from a social networking site (such as Facebook or Twitter)

Getting weather from a website or app

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**[H\_conf\_info]** Thinking about the past 12 months, how much conflicting or contradictory information ***about high winds*** have you heard from each of the following sources?

- Online news (such as New York Times website, CNN.com)
- Social media (such as Facebook, Youtube, Twitter, or blogs)
- Weather websites (such as weather.com, weather.gov, accuweather.com, wunderground.com)
- Local Television Weather
- Cable Television Weather (such as The Weather Channel, WeatherNation, or AccuWeather)
- Print newspapers or magazines
- Family, friends, or co-workers
- Weather Phone Apps
- Other sources

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**[H\_conf\_actions]** Thinking about the past 12 months, how much conflicting or contradictory information ***about what actions to take during high winds*** have you heard from each of the following sources?

- Online news (such as New York Times website, CNN.com)
- Social media (such as Facebook, Youtube, Twitter, or blogs)
- Weather websites (such as weather.com, weather.gov, accuweather.com, wunderground.com)
- Local Television Weather
- Cable Television Weather (such as The Weather Channel, WeatherNation, or AccuWeather)
- Print newspapers or magazines
- Family, friends, or co-workers
- Weather Phone Apps
- Other sources

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## Part V – Demographics

**age:** What is your age?

Under 18 years

18 to 24 years

25 to 34 years

35 to 44 years

45 to 54 years

55 to 64 years

Age 65 or older

**edu:** What is the highest level of education you have completed?

1 – Elementary, junior high or some high school

2 - High school graduate/GED

3 - Some college/vocational school

4 - College graduate

5 - Some graduate work

6 - Master's degree

7 - Doctorate (of any type)

8 - Other degree [Verbatim]

**gend:** Are you male or female?

1 - Female

2 – Male

3 – Prefer Not to Answer

4 – Other [Verbatim]

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**hisp:** Are you, yourself, of Hispanic or Latinx origin or descent, such as Mexican, Puerto Rican, Cuban, South American, Central American, or other Spanish background?

0 - No, I am not of Hispanic or Latino origin or descent.

1 - Yes, I am of Hispanic or Latino origin or descent.

**race:** Which of the following best describes your race?

1 - White

2 - Black or African American

3 - American Indian or Alaska Native

4 - Asian

5 - Native Hawaiian or Pacific Islander

6 – Other (please explain) [Verbatim]

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**Income:** Thinking specifically about the past 12 months, what was your annual household income from all sources?

1 - Less than \$24,999

2 - \$25,000 – \$49,999

3 - \$50,000 – \$99,999

4 - \$100,000 – \$199,999

5 - \$200,000 or more

## Appendix 2: Excessive Heat – Warm Regions Demographic Information

### **Demographic Information:**

<b>Variable</b>	<b>N</b>	<b>%</b>
<i>Gender:</i>		
Female	208	76.2
Male	63	23.1
<i>Annual Household Income:</i>		
Less than \$24,999	71	25.8
\$25,000 - \$49,999	96	34.9
\$50,000 – \$99,999	77	28.0
\$100,000 - \$199,999	26	9.5
\$200,000+	5	1.8
<i>Race:</i>		
Caucasian American	224	81.5
Black or African American	33	12.0
American Indian or Alaska Native	3	1.1
Asian	14	5.1
Native Hawaiian or Pacific Islander	0	0
Other (or not reported)	1	0.4
<i>Hispanic Origin:</i>		
Yes	24	8.7
No	251	91.3
<i>Educational Background:</i>		
Elementary, junior high, or some high school.	12	2.5
High School Graduate/GED	63	26
Some College/vocational school	80	32.9
College graduate	74	26.7
Some graduate work	17	1.4
Master's Degree	21	7.6
Doctorate (of any type) or Professional Degree	4	2.9
Other Degree	3	1.1
<i>Age Breakdown:</i>		
18-24 years old	22	8.0
25-34 years old	46	16.7
35-44 years old	46	16.7
45-54 years old	38	13.8
55-64 years old	63	22.9
65+ years old	60	21.8
<i>Primary Residence:</i>		
Apartment	44	16.0
Single family home	180	65.5
Duplex	4	1.5

Mobile home	35	12.7
Condo or townhouse	12	4.4
Other	0	0.0
<i>Location of Primary Residence:</i>		
Urban location	65	23.7
Suburban location	133	48.5
Rural location	76	27.7
<i>Environment Near Residence:</i>		
River, stream, or creek	59	21.5
Lake or pond	52	18.9
Ocean or coastal community	30	10.9
Mountain	32	11.6
Desert	16	5.8
Not Applicable (or not reported)	86	31.3
<i>Number of Adults (18+) in Household:</i>		
One	70x1	25.4
Two	153x2	55.6
Three	39x3	14.2
Four	9x4	3.3
Five	3x5	1.1
Eleven	1	0.4
<i>Number of Children (&lt;17) in Household:</i>		
Zero	180	65.5
One	40	14.5
Two	28	10.2
Three	22	8.0
Four	3	1.1
Five	1	0.4
Seven	1	0.4
<i>Past Experiences with Heat:</i>		
No	221	80.4
Yes, for you personally	31	11.3
Yes, for family	19	6.9
Yes, for neighbors	13	4.7
Yes, for close friends/associates	13	4.7
<b>Note:</b> The past experiences with heat question allowed participants to select more than one option.		

### ***Weather Information Habits:***

<b>Variable</b>	<b>N</b>	<b>%</b>
<i>How closely do you follow your local weather?</i>		
Not at all closely	4	1.5
Not very closely	16	5.9
Somewhat closely	83	30.6
Very closely	166	62.0
<i>How closely do you follow the weather of friends/fam?</i>		
Not at all closely	25	9.4
Not very closely	49	18.4
Somewhat closely	107	40.2
Very closely	85	32.0
<i>How closely do you follow national weather?</i>		
Not at all closely	18	6.7
Not very closely	64	23.7
Somewhat closely	98	36.3
Very closely	90	33.3
<i>How often do you get weather info from a computer?</i>		
Never	22	8.1
Hardly Ever	24	8.9
Sometimes	99	36.5
Often	126	45.8
<i>How often do you get weather info from a mobile device?</i>		
Never	38	15.2
Hardly Ever	20	8.0
Sometimes	60	24.0
Often	132	52.8
<i>Which do you prefer? Computer or mobile device?</i>		
Computer	125	55.3
Mobile Device	101	44.7
<i>How often do you read weather in print?</i>		
Never	75	28.7
Hardly Ever	64	24.5
Sometimes	63	24.1
Often	59	22.6
<i>How often do you listen to weather on the radio?</i>		
Never	45	17.0
Hardly Ever	59	22.3
Sometimes	89	33.6
Often	72	27.2

<i>How often do you watch local television weather?</i>		
Never	23	8.5
Hardly Ever	21	7.7
Sometimes	58	21.3
Often	170	62.5
<i>How often do you watch national evening weather?</i>		
Never	37	13.9
Hardly Ever	36	13.5
Sometimes	82	30.7
Often	112	41.9
<i>How often do you watch cable television weather?</i>		
Never	38	14.3
Hardly Ever	44	16.5
Sometimes	87	32.7
Often	97	36.5
<i>How often do you get weather from social media?</i>		
Never	93	35.8
Hardly Ever	45	17.3
Sometimes	70	26.9
Often	52	20.0
<i>How often do you get weather from a website or app?</i>		
Never	32	11.9
Hardly Ever	30	11.2
Sometimes	74	27.6
Often	132	49.3
<i>Which do you prefer for getting daily weather info?</i>		
Print	4	1.5
Radio	11	4.0
Television	143	52.4
Social Media	11	4.0
Website or app	104	38.1
<i>Which do you prefer for getting excessive heat info?</i>		
Print	5	1.9
Radio	12	4.5
Television	147	55.5
Social Media	15	5.7
Website or app	86	32.5

### **Theoretical Risk Variables:**

<b>Variable</b>	<b>Mean</b>	<b>Standard Deviation</b>
<i>Perceived Susceptibility:</i>		
You	6.87	2.79
Your home/apartment	5.89	2.88
Your local community	6.50	2.65
<i>Perceived Severity:</i>		
You	6.84	2.82
Your home/apartment	5.88	2.93
Your local community	6.39	2.75
<i>Affect:</i>		
70-80 degree day?	3.94	1.00
80-90 degree day?	2.51	1.23
Multiple days above 95 degrees?	1.83	1.30
<i>Possibility of Experiencing Heat Impacts in Future:</i>		
	42.96%	27.53
<i>Adaptive Behaviors:</i>		
I use A/C during excessive heat.	8.97	1.97
I don't use A/C during excessive heat.	2.80	2.76
I am aware of resources offered by my community for staying cool	6.61	3.08
I don't feel safe leaving my house to stay cool during excessive heat.	5.05	3.26
My job requires me to work outside.	3.24	3.22
I take proper precautions when required to work outdoors in excessive heat.	8.40	1.91
I avoid being outside during excessive heat	8.32	2.42
I usually stay inside during excessive heat.	8.55	2.18
I make an effort to stay hydrated.	9.06	1.43
Excessive heat influences me to change my schedule.	6.64	2.94
<i>Gathering Capacity:</i>		
I can't make sense of information about excessive heat.	3.11	2.65
When it comes to information about excessive heat, I can't separate facts from fiction.	3.73	2.92
Most information about excessive heat is too technical for me to understand.	3.34	2.78
I can't understand information about excessive heat even if I make an effort.	3.04	2.74
<i>Subjective Norms:</i>		
My friends expect me to know something about excessive heat.	6.14	2.91

Most people who are important to me think I should know something about excessive heat.	6.45	2.86
My family expects me to know something about excessive heat.	6.68	2.81

## Appendix 3: Excessive Heat – Cold Regions Demographic Information

### **Demographic Information:**

Variable	N	%
<i>Gender:</i>		
Female	192	68.8
Male	83	30.1
<i>Annual Household Income:</i>		
Less than \$24,999	80	29.0
\$25,000 - \$49,999	94	34.1
\$50,000 – \$99,999	81	29.3
\$100,000 - \$199,999	19	6.9
\$200,000+	2	0.7
<i>Race:</i>		
Caucasian American	240	86.6
Black or African American	26	9.4
American Indian or Alaska Native	0	0
Asian	9	3.2
Native Hawaiian or Pacific Islander	0	0
Other (or not reported)	4	1.4
<i>Hispanic Origin:</i>		
Yes	18	6.5
No	259	93.5
<i>Educational Background:</i>		
Elementary, junior high, or some high school.	7	2.5
High School Graduate/GED	72	26
Some College/vocational school	91	32.9
College graduate	74	26.7
Some graduate work	4	1.4
Master’s Degree	21	7.6
Doctorate (of any type) or Professional Degree	8	2.9
<i>Age Breakdown:</i>		
18-24 years old	20	7.2
25-34 years old	47	17.0
35-44 years old	33	11.9
45-54 years old	41	14.8
55-64 years old	61	22.0
65+ years old	75	27.1
<i>Primary Residence:</i>		
Apartment	53	19.1
Single family home	189	68.2
Duplex	10	3.6
Mobile home	10	3.6

Condo or townhouse	10	3.6
Other	5	1.8
<i>Location of Primary Residence:</i>		
Urban location	73	26.4
Suburban location	129	46.7
Rural location	74	26.8
<i>Environment Near Residence:</i>		
River, stream, or creek	77	27.6
Lake or pond	35	12.5
Ocean or coastal community	18	6.5
Mountain	30	10.8
Desert	2	0.7
Not Applicable (or not reported)	117	41.9
<i>Number of Adults (18+) in Household:</i>		
One	80	28.7
Two	135	48.4
Three	44	15.8
Four	12	4.3
Five	4	1.4
Six	1	0.4
<i>Number of Children (&lt;17) in Household:</i>		
Zero	209	75.5
One	39	14.1
Two	20	7.2
Three	7	2.5
Four	2	0.7
<i>Past Experiences with Heat:</i>		
No	232	83.2
Yes, for you personally	30	10.8
Yes, for family	14	5.0
Yes, for neighbors	11	3.9
Yes, for close friends/associates	12	4.3
<b>Note:</b> The past experiences with heat question allowed participants to select more than one option.		

### **Weather Information Habits:**

<b>Variable</b>	<b>N</b>	<b>%</b>
<i>How closely do you follow your local weather?</i>		
Not at all closely	5	1.8
Not very closely	18	6.6
Somewhat closely	89	32.5
Very closely	162	59.1
<i>How closely do you follow the weather of friends/fam?</i>		
Not at all closely	28	10.5
Not very closely	59	22.1
Somewhat closely	101	37.8
Very closely	79	29.6
<i>How closely do you follow national weather?</i>		
Not at all closely	25	9.1
Not very closely	65	23.7
Somewhat closely	118	43.1
Very closely	66	24.1
<i>How often do you get weather info from a computer?</i>		
Never	24	8.9
Hardly Ever	35	13.0
Sometimes	91	33.8
Often	119	44.2
<i>How often do you get weather info from a mobile device?</i>		
Never	71	28.3
Hardly Ever	13	5.2
Sometimes	58	23.1
Often	109	43.4
<i>Which do you prefer? Computer or mobile device?</i>		
Computer	96	48.5
Mobile Device	102	51.5
<i>How often do you read weather in print?</i>		
Never	89	34.1
Hardly Ever	60	23.0
Sometimes	53	20.3
Often	59	22.6
<i>How often do you listen to weather on the radio?</i>		
Never	57	21.5
Hardly Ever	58	21.9
Sometimes	86	32.5
Often	64	24.2

<i>How often do you watch local television weather?</i>		
Never	20	7.5
Hardly Ever	28	10.5
Sometimes	61	22.8
Often	158	59.2
<i>How often do you watch national evening weather?</i>		
Never	41	15.4
Hardly Ever	47	17.6
Sometimes	73	27.3
Often	106	39.7
<i>How often do you watch cable television weather?</i>		
Never	48	18.5
Hardly Ever	41	15.8
Sometimes	78	30.0
Often	93	35.8
<i>How often do you get weather from social media?</i>		
Never	113	43.3
Hardly Ever	49	18.8
Sometimes	53	20.3
Often	46	17.6
<i>How often do you get weather from a website or app?</i>		
Never	40	15.2
Hardly Ever	24	9.1
Sometimes	62	23.5
Often	138	52.3
<i>Which do you prefer for getting daily weather info?</i>		
Print	8	2.9
Radio	17	6.2
Television	138	50.2
Social Media	9	3.3
Website or app	103	37.5
<i>Which do you prefer for getting excessive heat info?</i>		
Print	8	3.0
Radio	19	7.0
Television	144	53.1
Social Media	11	4.1
Website or app	89	32.8

### **Theoretical Risk Variables:**

<b>Variable</b>	<b>Mean</b>	<b>Standard Deviation</b>
<i>Perceived Susceptibility:</i>		
You	6.45	2.891
Your home/apartment	5.57	2.976
Your local community	6.14	2.870
<i>Perceived Severity:</i>		
You	6.14	2.986
Your home/apartment	5.28	2.966
Your local community	5.58	2.870
<i>Affect:</i>		
60-70 degree day?	4.34	0.910
80-90 degree day?	3.12	1.115
Multiple days above 95 degrees?	2.12	1.236
<i>Possibility of Experiencing Heat Impacts in Future:</i>		
	34.43%	26.169
<i>Adaptive Behaviors:</i>		
I use A/C during excessive heat.	8.73	2.20
I don't use A/C during excessive heat.	3.16	2.99
I am aware of resources offered by my community for staying cool	6.17	3.19
I don't feel safe leaving my house to stay cool during excessive heat.	4.65	3.18
My job requires me to work outside.	2.97	3.06
I take proper precautions when required to work outdoors in excessive heat.	8.27	2.09
I avoid being outside during excessive heat	8.02	2.38
I usually stay inside during excessive heat.	8.26	2.21
I make an effort to stay hydrated.	8.85	1.73
Excessive heat influences me to change my schedule.	7.01	2.81
<i>Gathering Capacity:</i>		
I can't make sense of information about excessive heat.	3.06	2.65
When it comes to information about excessive heat, I can't separate facts from fiction.	3.65	2.83
Most information about excessive heat is too technical for me to understand.	3.32	2.86
I can't understand information about excessive heat even if I make an effort.	2.91	2.71
<i>Subjective Norms:</i>		
My friends expect me to know something about excessive heat.	5.81	3.04

Most people who are important to me think I should know something about excessive heat.	6.31	2.96
My family expects me to know something about excessive heat.	6.21	3.08

## Appendix 4: High Wind Demographic Information

### **Demographic Information:**

Variable	N	%
<i>Gender:</i>		
Female	735	67.3
Male	349	32.4
<i>Annual Household Income:</i>		
Less than \$24,999	219	20.3
\$25,000 - \$49,999	346	32.1
\$50,000 – \$99,999	368	24.1
\$100,000 - \$199,999	114	10.6
\$200,000+	31	2.9
<i>Race:</i>		
Caucasian American	898	83.8
Black or African American	78	7.3
American Indian or Alaska Native	9	0.8
Asian	55	5.1
Native Hawaiian or Pacific Islander	2	0.2
Other (or not reported)	30	2.8
<i>Hispanic Origin:</i>		
Yes	92	8.6
No	984	91.4
<i>Educational Background:</i>		
Elementary, junior high, or some high school.	15	1.4
High School Graduate/GED	190	17.7
Some College/vocational school	321	29.9
College graduate	346	32.2
Some graduate work	33	3.1
Master’s Degree	138	12.8
Doctorate (of any type) or Professional Degree	29	2.7
Other Degree	3	0.3
<i>Age Breakdown:</i>		
18-24 years old	112	10.4
25-34 years old	205	19.0
35-44 years old	189	17.5
45-54 years old	165	15.3
55-64 years old	217	20.1
65+ years old	190	17.6
<i>Primary Residence:</i>		
Apartment	200	18.5
Single family home	727	67.4
Duplex	28	2.6

Mobile home	42	3.9
Condo or townhouse	72	6.7
Other	10	0.9
<i>Location of Primary Residence:</i>		
Urban location	249	23.3
Suburban location	536	50.2
Rural location	283	26.5
<i>Environment Near Residence:</i>		
River, stream, or creek	193	17.9
Lake or pond	151	14.0
Ocean or coastal community	77	7.1
Mountain	95	8.8
Forest/Wooded Area	207	19.2
Not Applicable (or not reported)	356	33.0
<i>Number of Adults (18+) in Household:</i>		
One	295	27.4
Two	530	49.2
Three	166	15.4
Four	68	6.3
Five	13	1.2
Six	4	0.4
Seven	1	0.1
<i>Number of Children (<math>\leq 17</math>) in Household:</i>		
Zero	749	69.6
One	165	15.3
Two	104	9.7
Three	43	4.0
Four	8	0.7
Five	4	0.4
Six	1	0.1
Nine	1	0.1
<i>Past Experiences with Wind:</i>		
No	475	44.0
Yes, for you personally	295	27.3
Yes, for family	250	23.2
Yes, for neighbors	289	26.8
Yes, for close friends/associates	184	17.1
<b>Note:</b> The past experiences with wind question allowed participants to select more than one option.		

### ***Weather Information Habits:***

<b>Variable</b>	<b>N</b>	<b>%</b>
<i>How closely do you follow your local weather?</i>		
Not at all closely	21	1.9
Not very closely	71	6.6
Somewhat closely	394	36.6
Very closely	591	54.9
<i>How closely do you follow the weather of friends/fam?</i>		
Not at all closely	92	8.7
Not very closely	233	22.0
Somewhat closely	486	45.9
Very closely	247	23.3
<i>How closely do you follow national weather?</i>		
Not at all closely	95	8.9
Not very closely	296	27.6
Somewhat closely	454	42.3
Very closely	228	21.2
<i>How often do you get weather info from a computer?</i>		
Never	76	7.1
Hardly Ever	164	15.3
Sometimes	388	36.3
Often	441	41.3
<i>How often do you get weather info from a mobile device?</i>		
Never	150	14.5
Hardly Ever	78	7.6
Sometimes	259	25.1
Often	546	52.9
<i>Which do you prefer? Computer or mobile device?</i>		
Computer	321	36.4
Mobile Device	561	63.6
<i>How often do you read weather in print?</i>		
Never	363	34.7
Hardly Ever	273	26.1
Sometimes	260	24.9
Often	150	14.3
<i>How often do you listen to weather on the radio?</i>		
Never	192	18.1
Hardly Ever	272	25.7
Sometimes	380	35.9
Often	214	20.2

<i>How often do you watch local television weather?</i>		
Never	98	9.2
Hardly Ever	131	12.3
Sometimes	283	26.6
Often	550	51.8
<i>How often do you watch national evening weather?</i>		
Never	184	17.5
Hardly Ever	199	18.9
Sometimes	317	30.1
Often	353	33.5
<i>How often do you watch cable television weather?</i>		
Never	186	17.6
Hardly Ever	231	21.9
Sometimes	325	30.7
Often	315	29.8
<i>How often do you get weather from social media?</i>		
Never	381	36.7
Hardly Ever	193	18.6
Sometimes	272	26.2
Often	191	18.4
<i>How often do you get weather from a website or app?</i>		
Never	106	10.1
Hardly Ever	102	9.7
Sometimes	320	30.4
Often	523	49.8
<i>Which do you prefer for getting daily weather info?</i>		
Print	16	1.5
Radio	69	6.4
Television	458	42.6
Social Media	41	3.8
Website or app	492	45.7
<i>Which do you prefer for getting high wind info?</i>		
Print	14	1.3
Radio	80	7.6
Television	485	46.2
Social Media	49	4.7
Website or app	421	40.1

### **Theoretical Risk Variables:**

<b>Variable</b>	<b>Mean</b>	<b>Standard Deviation</b>
<i>Perceived Susceptibility:</i>		
You	4.92	2.74
Your home/apartment	5.73	2.67
Your local community	6.10	2.59
<i>Perceived Severity:</i>		
You	4.97	2.72
Your home/apartment	5.62	2.64
Your local community	5.95	2.64
<i>Affect:</i>		
Day without wind?	3.81	0.95
Breezy day?	3.66	0.85
High wind day?	2.28	1.02
<i>Possibility of Experiencing Wind Impacts in Future:</i>		
	48.58%	27.46
<i>Adaptive Behaviors:</i>		
My car handles high winds very well.	6.19	2.30
Driving in high winds makes me nervous.	7.09	2.52
I have Homeowner's Insurance or Renter's Insurance in case high winds damage my home.	7.24	3.19
I prepare for power outages.	6.56	2.76
My job requires me to work outside.	2.94	2.92
I take proper precautions when required to work outdoors in high winds	6.61	2.62
I avoid being outside during high winds.	6.02	3.08
I regularly trim the trees in my backyard.	4.23	3.02
I regularly have my trees checked for wounds, decay, or structural damage.	5.40	2.90
High winds influence me to change my schedule.	6.80	2.68
I live near a wooded area with trees.	5.43	3.31
<i>Gathering Capacity:</i>		
I can't make sense of information about high winds.	3.39	2.47
When it comes to information about high winds, I can't separate facts from fiction.	3.75	2.61
Most information about high winds is too technical for me to understand.	3.54	2.55
I can't understand information about high winds even if I make an effort.	3.13	2.47

<i>Subjective Norms:</i>		
My friends expect me to know something about excessive heat.	4.93	2.91
Most people who are important to me think I should know something about high winds.	5.28	2.85
My family expects me to know something about high winds.	5.43	2.87

## Appendix 5: Excessive Heat Prototype Summaries

The following tables provide means for the variables collected for each prompt. This information can provide more behavioral and perceptual information associated with all of the prototypes. For example, these means can be compared to the Current System data found in each hazard specific chapter. While this information is not associated with statistical testing, it can provide a rough estimate of how individuals understand the headlines within each prototype.

### Prototype 1:

<b>P1</b>				
<b>Warm Climate</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.68	2.77	3.08	3.49
Monitor	3.92	4.07	4.16	4.37
Prepare	3.76	3.82	3.93	4.05
Prot. Action	3.76	3.75	3.99	4.26
Risk	7.23	7.40	7.82	8.14
Confidence	7.73	7.88	8.21	8.55
Urgency	7.45	7.72	7.97	8.31
Probability	73.15	75.54	77.96	80.96
<b>Cold Climate</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.63	2.66	3.06	3.45
Monitor	3.91	3.86	3.98	4.16
Prepare	3.62	3.58	3.79	3.90
Prot. Action	3.63	3.49	3.80	4.06
Risk	6.90	6.80	7.17	7.56
Confidence	7.29	7.35	7.97	8.10
Urgency	6.81	6.53	7.27	7.50
Probability	66.53	66.49	70.94	76.74

## Prototype 2:

<b>P2</b>				
<b>Warm Climate</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	3.08	3.19	3.26	3.74
Monitor	4.13	4.21	4.27	4.43
Prepare	4.16	4.12	4.20	4.37
Prot. Action	4.10	4.10	4.17	4.34
Risk	7.65	7.76	8.09	8.28
Confidence	7.99	8.33	8.64	8.71
Urgency	7.64	7.84	8.21	8.48
Probability	75.81	77.34	81.36	83.22
<b>Cold Climate</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.26	2.44	2.87	3.21
Monitor	4.06	4.08	4.06	4.18
Prepare	3.70	3.73	3.87	3.87
Prot. Action	3.50	3.51	3.72	3.96
Risk	6.81	7.00	7.29	7.46
Confidence	7.66	7.69	7.91	8.06
Urgency	6.77	6.83	7.35	7.71
Probability	69.51	72.17	77.71	78.98

### Prototype 3:

<b>P3</b>				
<b>Warm Climate</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.60	2.90	3.01	3.26
Monitor	3.79	3.84	3.94	4.06
Prepare	3.59	3.67	3.74	3.91
Prot. Action	3.64	3.75	3.77	4.01
Risk	6.79	7.12	7.39	7.57
Confidence	7.48	7.73	7.89	8.14
Urgency	6.83	7.10	7.28	7.68
Probability	72.43	75.74	78.15	81.07
<b>Cold Climate</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.57	2.50	2.89	3.54
Monitor	3.97	3.98	4.20	4.27
Prepare	3.60	3.64	3.98	4.06
Prot. Action	3.64	3.60	3.98	4.14
Risk	6.74	6.71	7.29	7.68
Confidence	7.23	7.18	7.77	8.13
Urgency	6.44	6.73	7.31	7.84
Probability	70.54	71.68	78.83	80.96

## Prototype 4:

<b>P4</b>				
<b>Warm Climate</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.89	2.84	3.07	3.56
Monitor	3.92	4.02	4.06	4.27
Prepare	3.87	3.86	3.94	4.09
Prot. Action	3.92	3.89	4.02	4.31
Risk	7.28	7.45	7.61	8.08
Confidence	7.72	7.76	8.14	8.42
Urgency	7.36	7.47	7.72	8.31
Probability	75.31	76.63	79.66	83.24
<b>Cold Climate</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.50	2.66	2.99	3.39
Monitor	3.81	3.97	4.00	4.17
Prepare	3.64	3.69	3.79	4.04
Prot. Action	3.53	3.67	3.72	4.08
Risk	6.55	6.57	6.84	7.41
Confidence	7.09	7.36	7.77	8.20
Urgency	6.39	6.79	7.11	7.63
Probability	66.25	69.52	74.08	79.96

## Appendix 6: High Wind Prototype Summaries

The following tables provide means for the variables collected for each prompt. This information can provide more behavioral and perceptual information associated with all of the prototypes. For example, these means can be compared to the Current System data found in each hazard specific chapter. While this information is not associated with statistical testing, it can provide a rough estimate of how individuals understand the headlines within each prototype.

### Prototype 1:

<b>P1</b>				
<b>Warning with a Downgrade:</b>				
	<b>Base</b>	<b>Watch</b>	<b>Warning</b>	<b>Advisory</b>
Overall Action	2.87	2.79	3.37	3.08
Monitor	3.79	3.71	3.93	3.61
Prepare	3.61	3.43	3.65	3.21
Some Action	3.47	3.30	3.61	3.15
Prot. Action	3.21	3.11	3.56	3.16
Risk	6.02	5.91	6.69	5.82
Confidence	6.96	6.77	7.55	7.05
Urgency	6.34	6.22	7.08	6.15
Probability	60.76	59.67	70.88	63.90
<b>Advisory with an Upgrade:</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.70	2.72	2.97	3.50
Monitor	3.87	3.85	3.74	3.98
Prepare	3.53	3.47	3.37	3.70
Some Action	3.31	3.25	3.15	3.43
Prot. Action	3.04	3.01	3.08	3.43
Risk	5.93	6.32	5.85	6.45
Confidence	6.94	7.28	6.97	7.10
Urgency	6.25	6.52	6.11	6.55
Probability	58.95	56.35	63.51	66.13

## Prototype 2:

<b>P2</b>				
<b>Warning with a Downgrade:</b>				
	<b>Base</b>	<b>Watch</b>	<b>Warning</b>	<b>Advisory</b>
Overall Action	2.77	2.78	3.20	2.87
Monitor	3.95	3.89	4.05	3.64
Prepare	3.72	3.58	3.84	3.26
Some Action	3.58	3.45	3.67	3.11
Prot. Action	3.19	3.11	3.66	3.09
Risk	6.22	6.12	6.95	5.89
Confidence	6.82	6.90	7.49	6.95
Urgency	6.45	6.32	7.13	5.99
Probability	59.68	58.88	70.04	61.70
<b>Advisory with an Upgrade:</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.72	2.82	3.04	3.35
Monitor	3.80	3.80	3.61	3.96
Prepare	3.56	3.58	3.35	3.71
Some Action	3.44	3.42	3.14	3.61
Prot. Action	3.13	3.19	3.06	3.53
Risk	6.06	6.29	5.90	6.73
Confidence	6.99	7.03	6.85	7.28
Urgency	6.47	6.65	6.26	7.16
Probability	60.65	61.67	63.32	68.98

### Prototype 3:

<b>P3</b>				
<b>Warning with a Downgrade:</b>				
	<b>Base</b>	<b>Watch</b>	<b>Warning</b>	<b>Advisory</b>
Overall Action	2.92	2.81	3.48	2.87
Monitor	3.99	3.87	4.22	3.69
Prepare	3.77	3.65	3.99	3.20
Some Action	3.61	3.42	3.90	3.18
Prot. Action	3.11	3.28	3.88	3.10
Risk	6.24	6.12	7.10	5.78
Confidence	6.98	6.79	7.65	6.63
Urgency	6.57	6.31	7.50	5.98
Probability	60.46	57.53	71.08	59.32
<b>Advisory with an Upgrade:</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.70	2.75	2.66	3.51
Monitor	3.80	3.72	3.44	4.02
Prepare	3.65	3.37	3.10	3.79
Some Action	3.45	3.17	2.85	3.69
Prot. Action	3.11	3.01	2.75	3.60
Risk	6.16	5.95	5.34	6.87
Confidence	6.90	6.72	6.51	7.44
Urgency	6.30	6.08	5.40	7.13
Probability	59.25	55.40	55.92	70.04

## Prototype 4:

<b>P4</b>				
<b>Warning with a Downgrade:</b>				
	<b>Base</b>	<b>Watch</b>	<b>Warning</b>	<b>Advisory</b>
Overall Action	2.62	2.66	3.53	2.95
Monitor	3.75	3.74	4.16	3.69
Prepare	3.60	3.48	3.94	3.29
Some Action	3.41	3.32	3.78	3.18
Prot. Action	3.10	3.01	3.77	3.14
Risk	5.81	5.78	7.02	5.79
Confidence	6.69	6.57	7.58	6.93
Urgency	6.05	5.89	7.30	6.01
Probability	57.33	56.61	73.35	62.48
<b>Advisory with an Upgrade:</b>				
	<b>Base</b>	<b>Watch</b>	<b>Advisory</b>	<b>Warning</b>
Overall Action	2.80	2.89	3.03	3.61
Monitor	3.82	3.81	3.71	4.07
Prepare	3.55	3.50	3.42	3.85
Some Action	3.40	3.29	3.20	3.78
Prot. Action	3.17	3.10	3.14	3.76
Risk	5.88	5.92	5.91	7.03
Confidence	6.69	6.67	6.77	7.52
Urgency	6.20	6.08	6.06	7.23
Probability	58.20	57.15	63.07	72.01

## Appendix 7: Excessive Heat (Cold Regions) – Ordinal Logistic Regression Models

Excessive Heat - Cold, Advisory Upgrade, Prompt 2 - Advisory

	(1) v2_1	(2) v2_2_1	(3) v2_2_2	(4) v2_2_3
main				
v1_1	6.387*** (16.95)			
proto1	0.701 (-1.32)	0.941 (-0.22)	1.233 (0.75)	0.748 (-1.05)
proto2	0.664 (-1.51)	1.234 (0.72)	1.649* (1.73)	0.997 (-0.01)
proto3	0.519** (-2.44)	0.976 (-0.09)	1.385 (1.14)	1.008 (0.03)
proto4	0.863 (-0.56)	1.402 (1.19)	1.739* (1.94)	1.566 (1.63)
RP_SusSev	1.008 (1.14)	1.005 (0.76)	1.002 (0.34)	1.003 (0.43)
RP_Aff1	0.964 (-0.81)	0.992 (-0.17)	1.050 (1.01)	1.066 (1.38)
RP_Aff2	1.003 (0.12)	0.992 (-0.31)	0.985 (-0.58)	0.983 (-0.66)
AdptBeh	1.009* (1.67)	1.007 (1.14)	1.009 (1.51)	1.009 (1.54)
exppast1	0.957 (-0.18)	0.851 (-0.59)	0.917 (-0.33)	1.077 (0.30)
AttInfo	0.994 (-0.48)	1.016 (1.09)	1.024* (1.67)	1.010 (0.69)
GathCap1	0.984 (-1.47)	0.987 (-1.13)	0.998 (-0.16)	1.010 (0.88)
SubjNorm1	1.004 (0.34)	1.008 (0.66)	1.014 (1.10)	1.017 (1.42)
age	0.892* (-1.90)	0.944 (-0.92)	0.935 (-1.05)	0.991 (-0.14)
Childinhome	1.153 (0.66)	0.773 (-1.09)	0.949 (-0.22)	1.156 (0.63)
female	0.893 (-0.58)	1.332 (1.42)	0.966 (-0.17)	0.975 (-0.13)
college	1.224 (1.12)	0.796 (-1.17)	0.972 (-0.15)	0.824 (-1.03)
white	1.126 (0.44)	1.127 (0.40)	1.401 (1.23)	0.817 (-0.76)
Info	0.902 (-0.59)	1.014 (0.07)	0.963 (-0.20)	1.163 (0.83)
v1_2_1		8.577***		

		(16.65)		
v1_2_2			10.01*** (18.18)	
v1_2_3				7.340*** (17.84)
<hr/>				
/				
cut1	4.944* (1.87)	37.71*** (3.91)	216.4*** (5.85)	90.89*** (4.99)
cut2	67.02*** (4.82)	171.9*** (5.50)	1330.4*** (7.69)	459.0*** (6.67)
cut3	588.6*** (7.07)	2476.6*** (8.05)	21944.3*** (10.11)	6210.3*** (9.11)
cut4	1828.6*** (8.14)	28270.8*** (10.04)	264226.5*** (11.93)	37274.6*** (10.63)
<hr/>				
<i>N</i>	542	540	540	538
pseudo $R^2$	0.315	0.354	0.394	0.349
Chi-Squared	523.0	520.4	634.8	568.5
<hr/>				

Exponentiated coefficients; *z* statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Excessive Heat - Cold, Advisory Upgrade, Prompt 3 – Advisory Cont.

	(1) v3_1	(2) v3_2_1	(3) v3_2_2	(4) v3_2_3
main				
v1_1	2.598*** (12.12)			
proto1	1.139 (0.52)	0.933 (-0.25)	1.289 (0.95)	1.029 (0.11)
proto2	1.050 (0.19)	0.772 (-0.92)	1.421 (1.28)	1.032 (0.12)
proto3	0.743 (-1.17)	1.253 (0.78)	1.626* (1.75)	1.223 (0.74)
proto4	1.044 (0.17)	1.040 (0.14)	1.256 (0.85)	0.926 (-0.29)
RP_SusSev	1.006 (0.97)	1.006 (0.79)	1.008 (1.13)	1.010 (1.55)
RP_Aff1	0.928* (-1.72)	0.992 (-0.17)	1.044 (0.93)	1.062 (1.37)
RP_Aff2	0.975 (-1.11)	0.970 (-1.22)	0.981 (-0.77)	0.978 (-0.92)
AdptBeh	1.013*** (2.69)	0.999 (-0.13)	1.007 (1.23)	1.006 (1.11)
exppast1	0.684* (-1.66)	0.722 (-1.17)	0.677 (-1.54)	0.900 (-0.43)
AttInfo	1.026** (2.11)	1.035*** (2.59)	1.053*** (3.91)	1.027** (1.96)
GathCap1	0.979** (-2.11)	0.987 (-1.13)	0.987 (-1.19)	0.981* (-1.71)
SubjNorm1	1.005 (0.43)	1.030** (2.37)	1.033*** (2.68)	1.018 (1.49)
age	0.889** (-2.07)	0.947 (-0.88)	0.914 (-1.47)	0.885** (-1.97)
Childinhome	1.014 (0.07)	0.849 (-0.71)	1.062 (0.27)	0.907 (-0.44)
female	1.180 (0.92)	0.767 (-1.30)	0.976 (-0.12)	0.972 (-0.15)
college	1.725*** (3.14)	0.873 (-0.70)	0.921 (-0.45)	1.048 (0.26)
white	1.490 (1.59)	0.716 (-1.15)	0.989 (-0.04)	0.910 (-0.35)
Info	1.134 (0.77)	0.721* (-1.77)	1.028 (0.15)	1.104 (0.56)
v1_2_1		5.139*** (14.59)		
v1_2_2			3.977*** (14.46)	

v1_2_3				4.048*** (15.29)
/				
cut1	2.329 (1.06)	3.562 (1.44)	30.83*** (4.02)	10.34*** (2.75)
cut2	10.46*** (2.92)	14.31*** (3.03)	104.8*** (5.47)	33.94*** (4.15)
cut3	55.34*** (4.95)	161.5*** (5.65)	906.4*** (7.77)	295.7*** (6.53)
cut4	198.3*** (6.42)	1092.4*** (7.58)	5386.9*** (9.48)	1815.9*** (8.37)
<i>N</i>	543	542	539	536
pseudo $R^2$	0.165	0.279	0.258	0.249
Chi-Squared	284.3	395.0	391.8	383.0

Exponentiated coefficients;  $z$  statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Excessive Heat - Cold, Advisory Upgrade, Prompt 4 - Warning

	(1) v4_1	(2) v4_2_1	(3) v4_2_2	(4) v4_2_3
main				
v1_1	1.872*** (8.52)			
proto1	0.841 (-0.69)	1.031 (0.11)	1.082 (0.29)	1.128 (0.45)
proto2	0.667 (-1.57)	0.908 (-0.34)	0.972 (-0.10)	0.864 (-0.54)
proto3	0.871 (-0.53)	1.058 (0.19)	1.282 (0.91)	0.911 (-0.33)
proto4	0.801 (-0.87)	1.257 (0.77)	1.529 (1.53)	1.174 (0.58)
RP_SusSev	1.011* (1.66)	1.019** (2.56)	1.023*** (3.30)	1.023*** (3.16)
RP_Aff1	0.926* (-1.79)	0.958 (-0.89)	0.992 (-0.18)	1.036 (0.79)
RP_Aff2	0.975 (-1.11)	0.954* (-1.82)	0.999 (-0.06)	0.951** (-2.02)
AdptBeh	1.004 (0.89)	0.998 (-0.32)	1.007 (1.24)	1.004 (0.72)
exppast1	0.698 (-1.55)	0.898 (-0.38)	0.739 (-1.16)	0.843 (-0.66)
AttInfo	1.027** (2.17)	1.033** (2.39)	1.041*** (3.12)	1.056*** (4.09)
GathCap1	0.981* (-1.81)	0.968*** (-2.78)	0.970*** (-2.73)	0.958*** (-3.68)
SubjNorm1	1.022* (1.94)	1.026** (2.03)	1.024** (1.97)	1.046*** (3.57)
age	0.946 (-0.95)	0.893* (-1.76)	0.936 (-1.10)	0.933 (-1.11)
Childinhome	0.926 (-0.37)	0.540*** (-2.60)	0.946 (-0.24)	0.799 (-0.98)
female	1.091 (0.48)	1.080 (0.38)	1.121 (0.59)	1.198 (0.93)
college	1.409** (1.97)	0.864 (-0.74)	0.949 (-0.28)	0.709* (-1.83)
white	1.145 (0.54)	1.152 (0.49)	0.967 (-0.12)	0.987 (-0.05)
Info	1.145 (0.81)	0.907 (-0.51)	1.198 (1.00)	1.114 (0.60)
v1_2_1		3.688*** (12.64)		
v1_2_2			2.837*** (12.01)	

v1_2_3				2.272*** (10.43)
/				
cut1	0.800 (-0.28)	1.754 (0.63)	12.72*** (2.99)	4.617* (1.79)
cut2	2.271 (1.03)	5.711* (1.95)	27.49*** (3.89)	12.63*** (2.98)
cut3	7.144** (2.47)	36.29*** (3.95)	152.7*** (5.80)	61.64*** (4.77)
cut4	15.02*** (3.38)	184.1*** (5.65)	633.7*** (7.28)	253.8*** (6.31)
<i>N</i>	542	541	540	538
pseudo $R^2$	0.098	0.233	0.197	0.174
Chi-Squared	162.4	309.8	288.9	245.3

Exponentiated coefficients;  $z$  statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## Appendix 8: Excessive Heat (Warm Regions) – Ordinal Logistic Regression Models

Excessive Heat - Warm, Advisory Upgrade, Prompt 2 - Advisory

	(1) v2_1	(2) v2_2_1	(3) v2_2_2	(4) v2_2_3
main				
v1_1	6.476*** (18.19)			
proto1	1.344 (1.10)	2.262** (2.54)	1.195 (0.58)	1.122 (0.40)
proto2	1.403 (1.26)	2.324*** (2.67)	1.076 (0.24)	1.373 (1.10)
proto3	1.730** (2.04)	1.541 (1.40)	1.230 (0.69)	1.141 (0.46)
proto4	1.080 (0.29)	2.382*** (2.72)	1.104 (0.33)	1.061 (0.21)
RP_SusSev	1.008 (1.28)	1.004 (0.51)	1.007 (0.85)	1.000 (-0.02)
RP_Aff1	0.978 (-0.55)	1.029 (0.59)	1.034 (0.75)	1.117** (2.53)
RP_Aff2	0.947** (-2.14)	0.961 (-1.38)	0.963 (-1.42)	0.964 (-1.43)
AdptBeh	1.003 (0.64)	0.999 (-0.11)	1.002 (0.32)	1.014** (2.53)
exppast1	1.094 (0.38)	0.719 (-1.13)	1.126 (0.45)	0.833 (-0.70)
AttInfo	1.001 (0.08)	1.065*** (3.41)	1.029 (1.57)	1.043** (2.53)
GathCap1	1.002 (0.15)	0.958*** (-3.08)	0.986 (-1.06)	0.966*** (-2.67)
SubjNorm1	1.011 (0.95)	1.034** (2.24)	1.027* (1.94)	1.014 (1.05)
age	0.983 (-0.29)	0.940 (-0.80)	1.062 (0.82)	0.845** (-2.44)
Childinhome	0.815 (-1.03)	0.791 (-0.99)	0.784 (-1.09)	0.649** (-2.03)
female	0.591** (-2.52)	1.859*** (2.65)	1.419 (1.57)	1.254 (1.05)
college	0.774 (-1.45)	0.653** (-2.03)	0.761 (-1.36)	0.882 (-0.67)
white	0.797 (-0.94)	0.550** (-2.03)	0.566** (-2.06)	0.759 (-1.02)
Info	0.731* (-1.76)	0.531*** (-2.98)	0.655** (-2.10)	0.776 (-1.34)
v1_2_1		14.19***		

		(16.98)		
v1_2_2			13.71*** (17.97)	
v1_2_3				7.486*** (17.11)
<hr/>				
/				
cut1	5.719* (1.96)	97.13*** (4.55)	148.8*** (4.95)	53.34*** (4.23)
cut2	56.62*** (4.41)	1210.8*** (6.82)	1750.4*** (7.26)	247.0*** (5.86)
cut3	518.0*** (6.68)	34279.2*** (9.39)	24483.7*** (9.37)	3135.8*** (8.19)
cut4	2376.6*** (8.15)	546743.0*** (11.23)	425294.5*** (11.32)	38851.2*** (10.16)
<hr/>				
<i>N</i>	537	536	536	534
pseudo <i>R</i> <sup>2</sup>	0.338	0.471	0.451	0.372
Chi-Squared	578.1	670.0	685.1	564.2
<hr/>				

Exponentiated coefficients; *z* statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Excessive Heat - Warm, Advisory Upgrade, Prompt 3 – Advisory Cont.

	(1) v3_1	(2) v3_2_1	(3) v3_2_2	(4) v3_2_3
main				
v1_1	2.794*** (13.93)			
proto1	0.980 (-0.08)	1.550 (1.39)	0.763 (-0.91)	1.159 (0.50)
proto2	0.807 (-0.82)	1.395 (1.08)	0.709 (-1.15)	1.128 (0.41)
proto3	0.878 (-0.50)	1.127 (0.40)	0.758 (-0.93)	0.825 (-0.67)
proto4	0.676 (-1.54)	1.254 (0.75)	0.663 (-1.41)	0.931 (-0.25)
RP_SusSev	1.005 (0.82)	0.991 (-1.14)	1.016** (2.00)	1.000 (-0.02)
RP_Aff1	0.944 (-1.54)	1.054 (1.17)	1.069 (1.50)	1.040 (0.92)
RP_Aff2	0.961* (-1.76)	0.945** (-2.06)	0.919*** (-3.30)	0.936*** (-2.59)
AdptBeh	1.008* (1.72)	0.997 (-0.49)	1.011* (1.84)	1.017*** (3.03)
exppast1	0.839 (-0.77)	0.926 (-0.27)	1.414 (1.34)	0.930 (-0.28)
AttInfo	1.053*** (3.29)	1.104*** (5.49)	1.062*** (3.43)	1.085*** (4.93)
GathCap1	0.993 (-0.59)	0.975* (-1.90)	0.981 (-1.45)	0.975** (-1.99)
SubjNorm1	0.982 (-1.62)	1.027* (1.86)	1.000 (0.03)	1.007 (0.54)
age	1.044 (0.74)	0.999 (-0.01)	1.028 (0.39)	0.917 (-1.26)
Childinhome	0.931 (-0.38)	1.144 (0.59)	1.078 (0.34)	1.080 (0.37)
female	0.618** (-2.42)	1.834*** (2.68)	1.373 (1.47)	1.232 (0.98)
college	0.893 (-0.67)	1.054 (0.26)	1.089 (0.44)	1.255 (1.19)
white	0.907 (-0.43)	0.818 (-0.73)	1.244 (0.87)	0.835 (-0.69)
Info	1.175 (0.96)	0.893 (-0.56)	0.950 (-0.27)	0.985 (-0.08)
v1_2_1		7.583*** (15.62)		
v1_2_2			6.362*** (15.95)	

v1_2_3				4.423*** (14.87)
/				
cut1	3.127 (1.40)	145.6*** (5.10)	131.1*** (5.13)	57.07*** (4.41)
cut2	15.24*** (3.30)	923.6*** (6.84)	884.3*** (7.05)	194.7*** (5.75)
cut3	71.15*** (5.11)	12740.1*** (8.94)	7317.7*** (8.93)	1745.5*** (7.84)
cut4	201.6*** (6.29)	159120.4*** (10.79)	81618.0*** (10.74)	11847.9*** (9.47)
<i>N</i>	537	533	533	532
pseudo $R^2$	0.174	0.385	0.351	0.292
Chi-Squared	296.4	519.5	506.8	418.4

Exponentiated coefficients; *z* statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Excessive Heat - Warm, Advisory Upgrade, Prompt 4 - Warning

	(1) v4_1	(2) v4_2_1	(3) v4_2_2	(4) v4_2_3
main				
v1_1	2.016*** (10.33)			
proto1	1.086 (0.32)	2.013** (2.15)	1.124 (0.41)	1.268 (0.80)
proto2	1.234 (0.79)	2.140** (2.35)	1.453 (1.30)	1.126 (0.41)
proto3	0.758 (-1.09)	1.272 (0.78)	1.202 (0.65)	0.832 (-0.64)
proto4	1.008 (0.03)	2.268** (2.53)	1.348 (1.06)	1.161 (0.52)
RP_SusSev	0.992 (-1.17)	0.988 (-1.36)	1.005 (0.71)	0.997 (-0.44)
RP_Aff1	0.908** (-2.54)	1.011 (0.23)	1.048 (1.10)	1.059 (1.33)
RP_Aff2	0.986 (-0.62)	0.943** (-2.01)	0.952** (-2.01)	0.959* (-1.65)
AdptBeh	1.014*** (2.99)	0.992 (-1.05)	1.009 (1.53)	1.014** (2.38)
exppast1	0.728 (-1.35)	0.838 (-0.58)	1.227 (0.81)	0.775 (-0.96)
AttInfo	1.065*** (3.92)	1.135*** (6.86)	1.081*** (4.42)	1.076*** (4.51)
GathCap1	0.988 (-1.07)	0.969*** (-2.18)	0.971** (-2.25)	0.953*** (-3.70)
SubjNorm1	0.975** (-2.27)	1.064*** (3.74)	1.012 (0.88)	1.040*** (2.85)
age	1.036 (0.59)	1.038 (0.48)	0.955 (-0.67)	1.008 (0.12)
Childinhome	0.963 (-0.20)	1.019 (0.08)	0.965 (-0.17)	1.013 (0.06)
female	0.786 (-1.19)	1.989*** (2.91)	1.562** (2.12)	1.874*** (2.90)
college	1.145 (0.79)	0.835 (-0.84)	0.812 (-1.10)	0.998 (-0.01)
white	1.134 (0.54)	0.804 (-0.77)	0.974 (-0.10)	0.785 (-0.93)
Info	1.106 (0.58)	0.915 (-0.42)	0.975 (-0.13)	1.030 (0.16)
v1_2_1		5.689*** (13.81)		
v1_2_2			3.688*** (13.23)	

v1_2_3				2.245*** (9.79)
/				
cut1	1.812 (0.74)	141.7*** (4.90)	49.49*** (4.30)	9.377** (2.49)
cut2	6.083** (2.23)	733.7*** (6.43)	161.4*** (5.60)	27.14*** (3.71)
cut3	19.97*** (3.66)	8103.4*** (8.28)	1070.3*** (7.48)	161.3*** (5.58)
cut4	45.58*** (4.65)	67219.2*** (9.84)	7606.5*** (9.22)	668.6*** (6.98)
<i>N</i>	534	535	534	533
pseudo $R^2$	0.115	0.372	0.262	0.184
Chi-Squared	186.4	459.2	357.1	230.9

Exponentiated coefficients;  $z$  statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## Appendix 8: High Winds (Advisory with an Upgrade) – Ordinal Logistic Regression Models

High Winds, Advisory Upgrade, Prompt 2 - Watch

	(1)	(2)	(3)	(4)
	v2_1	v2_2_1	v2_2_2	v2_2_4
main				
v1_1	4.851*** (21.09)			
proto1	1.009 (0.05)	0.770 (-1.28)	0.828 (-0.99)	0.801 (-1.16)
proto2	1.217 (1.06)	0.781 (-1.22)	0.951 (-0.26)	0.966 (-0.18)
proto3	1.092 (0.47)	0.650** (-2.12)	0.538*** (-3.21)	0.708* (-1.80)
proto4	1.190 (0.94)	0.696* (-1.76)	0.674** (-2.07)	0.681** (-2.03)
RP_SusSev	0.993 (-1.55)	1.011** (2.02)	1.000 (0.06)	1.000 (0.10)
RP_Aff1	0.990 (-0.26)	1.012 (0.28)	0.996 (-0.11)	1.045 (1.12)
RP_Aff2	1.008 (0.44)	1.021 (1.09)	1.017 (0.94)	1.010 (0.57)
AdptBeh	1.004 (1.00)	1.001 (0.34)	1.004 (1.19)	1.003 (0.74)
exppast1	0.682*** (-2.92)	0.946 (-0.39)	0.930 (-0.55)	0.986 (-0.11)
AttInfo	0.997 (-0.31)	1.025** (2.31)	1.019* (1.86)	1.018* (1.73)
GathCap1	1.004 (0.57)	0.997 (-0.32)	1.007 (0.91)	1.028*** (3.33)
SubjNorm1	1.025*** (2.92)	1.006 (0.60)	1.033*** (3.57)	1.032*** (3.46)
age	1.013 (0.32)	1.016 (0.37)	1.008 (0.19)	1.020 (0.48)
childinhome	1.000 (0.00)	1.162 (1.02)	1.138 (0.93)	1.038 (0.27)
female	1.048 (0.36)	1.052 (0.36)	1.335** (2.18)	1.015 (0.12)
college	0.845 (-1.41)	0.790* (-1.81)	0.927 (-0.62)	0.820 (-1.60)
white	0.829 (-1.08)	0.850 (-0.89)	1.081 (0.46)	0.588*** (-3.06)
Info	1.176 (1.38)	1.032 (0.25)	1.364*** (2.59)	1.214 (1.62)
v1_2_1		9.472***		

		(24.36)		
v1_2_2			5.197***	
			(22.46)	
v1_2_4				5.520***
				(23.63)
<hr/>				
/				
cut1	3.534**	59.09***	39.00***	45.81***
	(2.15)	(6.30)	(6.08)	(6.21)
cut2	69.82***	429.9***	174.5***	268.5***
	(7.04)	(9.34)	(8.53)	(9.00)
cut3	396.7***	7074.3***	1896.5***	2457.1***
	(9.73)	(13.07)	(12.01)	(12.13)
cut4	2679.4***	92902.1***	16724.7***	17832.3***
	(12.42)	(15.95)	(14.79)	(14.53)
<hr/>				
<i>N</i>	1042	1055	1050	1046
pseudo <i>R</i> <sup>2</sup>	0.203	0.355	0.272	0.304
Chi-Squared	620.7	1056.8	852.3	1012.7

Exponentiated coefficients; *z* statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

High Winds, Advisory Upgrade, Prompt 3 - Advisory

	(1) v3_1	(2) v3_2_1	(3) v3_2_2	(4) v3_2_4
main				
v1_1	2.694*** (15.83)			
proto1	1.566** (2.41)	1.499** (2.12)	1.520** (2.28)	1.602** (2.53)
proto2	1.701*** (2.86)	1.194 (0.94)	1.272 (1.33)	1.400* (1.83)
proto3	0.831 (-1.01)	0.845 (-0.90)	0.773 (-1.43)	0.833 (-0.99)
proto4	1.386* (1.77)	1.227 (1.09)	1.352* (1.66)	1.350 (1.64)
RP_SusSev	0.997 (-0.67)	1.012** (2.48)	1.003 (0.74)	1.004 (0.84)
RP_Aff1	1.040 (1.06)	1.044 (1.13)	1.032 (0.86)	1.022 (0.57)
RP_Aff2	0.989 (-0.67)	1.026 (1.47)	1.033* (1.91)	1.010 (0.57)
AdptBeh	1.006 (1.62)	1.002 (0.47)	0.999 (-0.33)	1.001 (0.42)
exppast1	0.776** (-1.97)	0.974 (-0.20)	0.826 (-1.51)	0.889 (-0.91)
AttInfo	1.017* (1.70)	1.025** (2.57)	1.021** (2.22)	1.012 (1.25)
GathCap1	1.014* (1.83)	1.000 (-0.04)	1.016** (2.04)	1.022*** (2.74)
SubjNorm1	1.008 (0.92)	1.007 (0.81)	1.032*** (3.68)	1.041*** (4.57)
age	0.944 (-1.47)	0.948 (-1.33)	0.954 (-1.24)	0.878*** (-3.33)
childinhome	1.156 (1.09)	1.027 (0.20)	1.164 (1.14)	1.109 (0.77)
female	1.306** (2.10)	1.566*** (3.45)	1.536*** (3.40)	1.471*** (3.02)
college	0.767** (-2.24)	0.948 (-0.45)	1.047 (0.39)	0.772** (-2.16)
white	0.989 (-0.06)	0.892 (-0.69)	0.814 (-1.27)	0.698** (-2.17)
Info	1.281** (2.14)	1.256* (1.93)	1.285** (2.19)	1.231* (1.80)
v1_2_1		4.065*** (19.67)		
v1_2_2			2.808*** (17.35)	

v1_2_4				2.811*** (18.05)
/				
cut1	3.405** (2.12)	52.55*** (6.81)	26.22*** (5.80)	11.82*** (4.40)
cut2	54.09*** (6.78)	264.4*** (9.54)	91.70*** (8.01)	48.50*** (6.88)
cut3	198.9*** (8.87)	1544.6*** (12.23)	523.0*** (10.82)	279.2*** (9.75)
cut4	874.9*** (11.13)	8570.0*** (14.54)	2452.5*** (13.07)	1006.5*** (11.66)
<i>N</i>	1042	1054	1053	1046
pseudo $R^2$	0.118	0.209	0.155	0.185
Chi-Squared	362.8	660.8	505.5	615.8

Exponentiated coefficients;  $z$  statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

High Winds, Advisory Upgrade, Prompt 4 - Warning

	(1) v4_1	(2) v4_2_1	(3) v4_2_2	(4) v4_2_4
main				
v1_1	2.476*** (14.73)			
proto1	1.122 (0.63)	0.712* (-1.68)	1.011 (0.06)	0.897 (-0.60)
proto2	1.058 (0.31)	0.806 (-1.06)	0.845 (-0.92)	0.904 (-0.55)
proto3	1.348 (1.63)	0.974 (-0.13)	1.008 (0.04)	1.106 (0.55)
proto4	1.325 (1.54)	1.095 (0.43)	1.198 (0.96)	1.372* (1.67)
RP_SusSev	1.004 (0.96)	1.017*** (3.14)	1.013*** (2.70)	1.009* (1.80)
RP_Aff1	0.971 (-0.82)	1.045 (1.05)	0.975 (-0.66)	0.986 (-0.37)
RP_Aff2	0.963** (-2.20)	1.015 (0.76)	0.997 (-0.19)	0.974 (-1.50)
AdptBeh	1.000 (0.13)	0.992* (-1.94)	0.996 (-1.03)	0.997 (-0.90)
exppast1	0.834 (-1.43)	0.886 (-0.86)	0.890 (-0.90)	1.009 (0.07)
AttInfo	1.028*** (2.88)	1.054*** (4.94)	1.051*** (5.08)	1.064*** (6.17)
GathCap1	1.000 (-0.00)	0.982** (-1.98)	1.002 (0.19)	1.001 (0.09)
SubjNorm1	1.015* (1.76)	0.994 (-0.58)	1.017* (1.82)	1.029*** (3.21)
age	0.915** (-2.24)	0.943 (-1.34)	0.971 (-0.73)	0.939 (-1.57)
childinhome	0.981 (-0.14)	1.204 (1.23)	1.222 (1.47)	1.170 (1.14)
female	1.277* (1.95)	1.187 (1.21)	1.274* (1.88)	1.184 (1.33)
college	0.810* (-1.81)	1.038 (0.28)	1.214 (1.61)	0.980 (-0.16)
white	0.786 (-1.43)	0.941 (-0.33)	0.917 (-0.52)	0.686** (-2.22)
Info	1.285*** (2.19)	1.284* (1.93)	1.511*** (3.50)	1.477*** (3.32)
v1_2_1		5.700*** (21.04)		
v1_2_2			2.642*** (16.15)	

v1_2_4				2.586 <sup>***</sup> (16.37)
/				
cut1	0.798 (-0.40)	43.45 <sup>***</sup> (5.87)	12.79 <sup>***</sup> (4.38)	7.560 <sup>***</sup> (3.48)
cut2	5.310 <sup>***</sup> (2.91)	176.0 <sup>***</sup> (8.02)	34.02 <sup>***</sup> (6.07)	23.88 <sup>***</sup> (5.47)
cut3	20.91 <sup>***</sup> (5.26)	1247.7 <sup>***</sup> (10.78)	131.9 <sup>***</sup> (8.27)	114.9 <sup>***</sup> (8.07)
cut4	59.94 <sup>***</sup> (7.03)	10166.1 <sup>***</sup> (13.39)	694.9 <sup>***</sup> (10.78)	518.8 <sup>***</sup> (10.36)
<i>N</i>	1043	1051	1053	1049
pseudo <i>R</i> <sup>2</sup>	0.099	0.284	0.151	0.164
Chi-Squared	316.4	791.5	460.6	520.6

Exponentiated coefficients; *z* statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## Appendix 9: High Winds (Warning with a Downgrade) – Ordinal Logistic Regression Models

High Winds, Warning Downgrade, Prompt 2 - Watch

	(1)	(2)	(3)	(4)
	v2_1	v2_2_1	v2_2_2	v2_2_4
main				
v1_1	5.548*** (21.70)			
proto1	0.764 (-1.42)	0.716* (-1.65)	0.579*** (-2.87)	0.830 (-1.00)
proto2	0.829 (-0.98)	0.782 (-1.21)	0.677** (-2.04)	0.954 (-0.25)
proto3	0.708* (-1.79)	0.673* (-1.95)	0.734 (-1.63)	0.835 (-0.96)
proto4	0.711* (-1.79)	0.789 (-1.16)	0.610*** (-2.62)	0.756 (-1.49)
RP_SusSev	0.999 (-0.11)	1.007 (1.24)	1.005 (1.08)	0.999 (-0.19)
RP_Aff1	0.982 (-0.47)	0.994 (-0.15)	1.047 (1.20)	1.056 (1.42)
RP_Aff2	0.975 (-1.41)	1.003 (0.15)	0.976 (-1.39)	0.997 (-0.18)
AdptBeh	1.003 (0.72)	1.001 (0.22)	0.999 (-0.23)	1.000 (0.08)
exppast1	1.009 (0.07)	0.990 (-0.07)	0.922 (-0.63)	0.952 (-0.38)
AttInfo	1.032*** (3.06)	1.039*** (3.51)	1.026** (2.51)	1.015 (1.51)
GathCap1	0.996 (-0.52)	0.986 (-1.64)	1.004 (0.49)	1.003 (0.37)
SubjNorm1	1.015* (1.67)	1.020** (2.04)	1.011 (1.26)	1.013 (1.45)
age	0.948 (-1.30)	1.086* (1.92)	1.010 (0.25)	0.997 (-0.07)
childinhome	0.883 (-0.88)	0.976 (-0.16)	0.837 (-1.27)	0.860 (-1.06)
female	0.865 (-1.09)	0.940 (-0.44)	0.941 (-0.47)	0.826 (-1.47)
college	1.067 (0.53)	0.973 (-0.21)	1.136 (1.06)	0.938 (-0.53)
white	0.522*** (-3.66)	0.650** (-2.31)	0.720* (-1.90)	0.677** (-2.27)
Info	1.371** (2.57)	1.139 (1.00)	1.205 (1.54)	1.022 (0.18)
v1_2_1		8.869***		

		(23.38)		
v1_2_2			5.099***	
			(22.10)	
v1_2_4				5.714***
				(23.89)
<hr/>				
/				
cut1	4.200**	43.63***	12.51***	19.41***
	(2.45)	(5.90)	(4.39)	(5.09)
cut2	101.8***	437.2***	82.80***	121.8***
	(7.64)	(9.45)	(7.64)	(8.16)
cut3	726.2***	6629.6***	679.0***	1000.8***
	(10.62)	(13.10)	(10.93)	(11.40)
cut4	3565.6***	75694.5***	5416.8***	7606.6***
	(12.78)	(15.82)	(13.81)	(14.08)
<hr/>				
<i>N</i>	1019	1034	1034	1032
pseudo <i>R</i> <sup>2</sup>	0.232	0.348	0.257	0.291
Chi-Squared	691.7	1014.8	796.5	954.6
<hr/>				

Exponentiated coefficients; *z* statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

High Winds, Warning Downgrade, Prompt 3 - Warning

	(1) v3_1	(2) v3_2_1	(3) v3_2_2	(4) v3_2_4
main				
v1_1	2.437*** (14.44)			
proto1	1.035 (0.19)	0.674* (-1.96)	0.623** (-2.56)	0.793 (-1.25)
proto2	0.893 (-0.62)	0.703* (-1.70)	0.853 (-0.84)	0.984 (-0.09)
proto3	1.237 (1.17)	1.020 (0.10)	0.963 (-0.20)	1.132 (0.65)
proto4	1.812*** (3.20)	1.413 (1.64)	1.235 (1.11)	1.453* (1.95)
RP_SusSev	1.002 (0.33)	1.004 (0.77)	1.006 (1.26)	1.015*** (2.87)
RP_Aff1	0.927** (-2.12)	1.057 (1.31)	1.017 (0.44)	1.003 (0.09)
RP_Aff2	0.955*** (-2.67)	0.963** (-1.98)	0.976 (-1.40)	0.945*** (-3.17)
AdptBeh	1.004 (1.31)	0.998 (-0.45)	0.997 (-0.69)	0.998 (-0.44)
exppast1	0.997 (-0.02)	0.888 (-0.85)	0.983 (-0.13)	1.025 (0.19)
AttInfo	1.042*** (4.08)	1.067*** (6.13)	1.047*** (4.58)	1.074*** (7.13)
GathCap1	0.987* (-1.81)	0.975*** (-2.94)	0.995 (-0.59)	0.988 (-1.51)
SubjNorm1	1.000 (-0.04)	1.004 (0.36)	1.001 (0.12)	1.005 (0.57)
age	0.886*** (-3.06)	0.985 (-0.35)	0.924* (-1.94)	0.900** (-2.55)
childinhome	0.998 (-0.02)	0.986 (-0.09)	1.164 (1.09)	0.798 (-1.59)
female	1.116 (0.86)	1.126 (0.84)	0.896 (-0.83)	1.085 (0.62)
college	1.307** (2.28)	1.150 (1.06)	1.141 (1.10)	1.076 (0.60)
white	0.811 (-1.24)	0.752 (-1.51)	1.054 (0.32)	0.700** (-2.02)
Info	1.688*** (4.42)	1.248* (1.68)	1.707*** (4.42)	1.379*** (2.63)
v1_2_1		5.157*** (19.59)		
v1_2_2			2.962*** (17.13)	

v1_2_4				2.993*** (18.12)
/				
cut1	0.646 (-0.77)	16.55*** (4.41)	6.806*** (3.39)	5.781*** (3.05)
cut2	4.712*** (2.72)	90.77*** (7.14)	17.36*** (5.07)	20.22*** (5.24)
cut3	21.55*** (5.34)	653.1*** (10.01)	77.46*** (7.61)	101.8*** (7.93)
cut4	67.29*** (7.26)	5902.8*** (12.85)	509.0*** (10.57)	622.9*** (10.72)
<i>N</i>	1018	1035	1036	1033
pseudo $R^2$	0.104	0.279	0.163	0.196
Chi-Squared	322.9	744.2	472.8	592.8

Exponentiated coefficients;  $z$  statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

High Winds, Warning Downgrade, Prompt 4 - Advisory

	(1) v4_1	(2) v4_2_1	(3) v4_2_2	(4) v4_2_4
main				
v1_1	1.919*** (11.02)			
proto1	1.654*** (2.71)	1.274 (1.31)	1.288 (1.41)	1.409* (1.90)
proto2	1.247 (1.20)	1.085 (0.43)	1.212 (1.07)	1.280 (1.37)
proto3	1.080 (0.42)	1.175 (0.87)	1.007 (0.04)	0.973 (-0.15)
proto4	1.505** (2.20)	1.671*** (2.72)	1.459** (2.09)	1.525** (2.33)
RP_SusSev	1.008* (1.66)	1.007 (1.45)	1.009* (1.85)	1.013*** (2.84)
RP_Aff1	1.045 (1.22)	0.979 (-0.57)	0.962 (-1.06)	1.022 (0.59)
RP_Aff2	0.982 (-1.08)	0.991 (-0.50)	1.014 (0.82)	1.000 (0.01)
AdptBeh	0.999 (-0.21)	0.995 (-1.48)	1.000 (0.05)	1.000 (0.09)
exppast1	0.833 (-1.44)	1.154 (1.12)	1.095 (0.74)	1.153 (1.15)
AttInfo	1.024** (2.37)	1.028*** (2.73)	1.028*** (2.88)	1.032*** (3.33)
GathCap1	1.006 (0.78)	1.016** (2.12)	1.021*** (2.82)	1.023*** (3.05)
SubjNorm1	0.997 (-0.29)	1.019** (2.08)	1.017* (1.92)	1.014 (1.60)
age	0.945 (-1.44)	0.927* (-1.87)	0.884*** (-3.20)	0.872*** (-3.49)
childinhome	0.892 (-0.83)	0.831 (-1.32)	0.849 (-1.23)	0.733** (-2.31)
female	1.300** (2.01)	1.303** (2.03)	0.983 (-0.14)	1.198 (1.43)
college	0.929 (-0.62)	1.051 (0.41)	1.056 (0.48)	0.880 (-1.11)
white	0.756 (-1.64)	1.009 (0.05)	0.933 (-0.43)	0.756* (-1.73)
Info	1.141 (1.11)	1.140 (1.09)	1.380*** (2.79)	1.330** (2.46)
v1_2_1		4.377*** (19.63)		
v1_2_2			2.371*** (14.84)	

v1_2_4				2.487*** (16.44)
/				
cut1	1.027 (0.05)	19.15*** (5.06)	9.881*** (4.23)	13.25*** (4.65)
cut2	19.80*** (5.20)	118.9*** (8.17)	29.95*** (6.26)	49.90*** (7.01)
cut3	60.07*** (7.06)	712.2*** (10.94)	136.9*** (8.88)	240.7*** (9.62)
cut4	169.8*** (8.76)	4528.9*** (13.53)	586.6*** (11.23)	1099.3*** (11.93)
<i>N</i>	1018	1035	1033	1032
pseudo $R^2$	0.062	0.213	0.113	0.151
Chi-Squared	180.4	658.3	368.1	494.3

Exponentiated coefficients;  $z$  statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$