National Weather Service Hazard Simplification:

Public Survey

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.

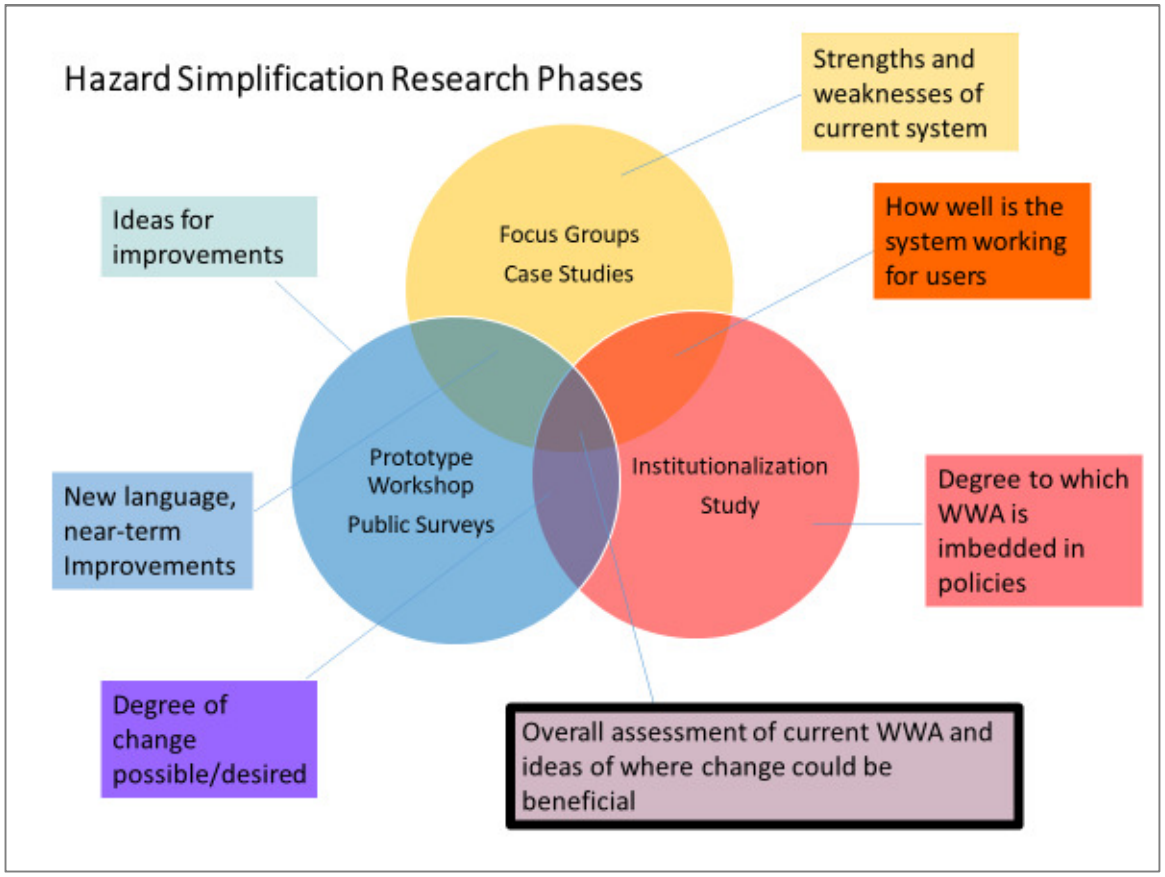

Figure ES-1. Hazard Simplification Project Research Phases

ERG implemented a set of seven public surveys in February and March of 2018 covering six distinct weather hazards:[1]

- Winter weather – mild regions

[1] 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	• VA, NC, KY, TN, SC, GA, AL, MS, AR, MO, NE, OK • Adults aged 20+ • No state with more than 200 responses	2/5/18 – 2/7/18; 2/15/18 – 2/16/18	1,410
Winter weather – cold climates	• ME, NH, VT, MA, RI, CT, NY, PA, MI, WI, MN, CO, WY, MT, ID • Adults aged 20+ • No state with more than 150 responses	2/2/18 – 2/5/18; 2/15/18 – 2/16/18	1,298
Thunderstorms	• All U.S. States and Washington DC • Adults aged 20+ • No more than 65% as women • No state with more than 100 responses	2/20/18 – 2/22/18	1,501
Tornadoes	• AL, AR, GA, IA, IL, IN, KS, KY, LA, MO, MN, MS, NC, NE, OK, SC, TN, TX • Adults aged 20+ • No more than 65% as women • No state with more than 80 responses	2/20/18 – 2/22/18	700
Coastal flooding	• ME, NH, MA, RI, CT, NY, NJ, MD, DE, VA, NC, SC, GA, FL, AL, MS, LA, TX • Must live within 10 miles of the coast • Adults aged 20+ • No more than 65% as women • No state with more than 60 responses	3/2/18 – 3/12/18	690
Flash flooding	• TX, MS, AR, AL, TN, KY, MO, IA, IL, MI, IN, OH, PA, NY, NJ, CT, MA, NC, VA, MD, WV, WI • Adults aged 20+ • No more than 65% as women • No state with more than 60 responses	3/2/18 – 3/7/18	841
Areal flooding	• 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 • Adults aged 20+ • No more than 65% as women • No state with more than 80 responses	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.[2]

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.

[2] 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
Winter Weather, Mild	Winter Storm Warning	43.1%	Winter Weather 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%

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:[3] 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

[3] 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.[4] 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.[5] 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

Prototype	Significantly Greater Than 1.0 (Outperformed the Current System)	Significantly Less Than 1.0 (Unperformed the Current System)
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.

[4] By design, odds ratios are never less than zero.

[5] 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.[6] 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.

[6] 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.

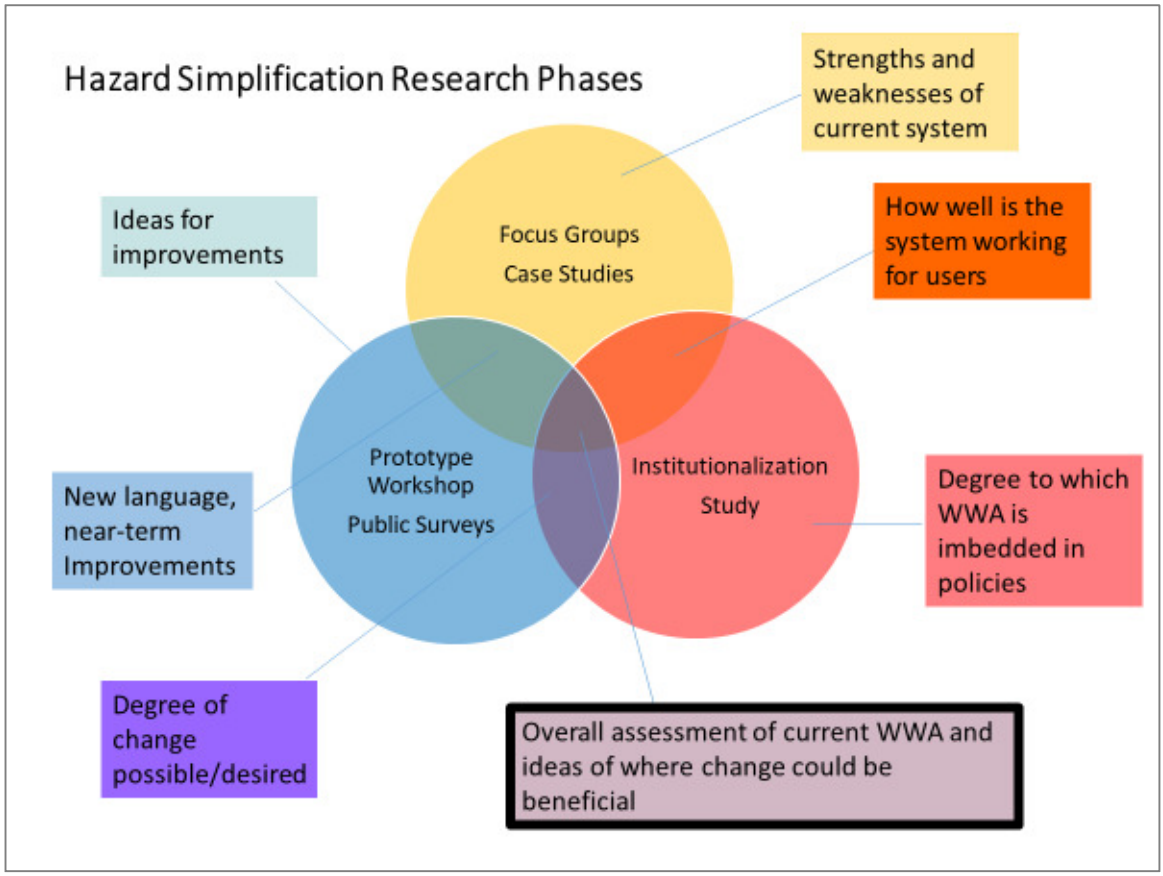

Figure 1. Hazard Simplification Project Research Phases

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:[7]

- 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.[8] 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

[7] 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.

[8] 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:[9]

- 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.

[9] 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	• VA, NC, KY, TN, SC, GA, AL, MS, AR, MO, NE, OK • Adults aged 20+ • No state with more than 200 responses	2/5/18 – 2/7/18; 2/15/18 – 2/16/18 [a]	1,400 [a]	1,410
Winter weather – cold climates	• ME, NH, VT, MA, RI, CT, NY, PA, MI, WI, MN, CO, WY, MT, ID • Adults aged 20+ • No state with more than 150 responses	2/2/18 – 2/5/18; 2/15/18 – 2/16/18 [b]	1,300 [b]	1,298
Thunderstorms	• All U.S. States and Washington DC • Adults aged 20+ • No more than 65% as women • No state with more than 100 responses	2/20/18 – 2/22/18	1,500	1,501
Tornadoes	• AL, AR, GA, IA, IL, IN, KS, KY, LA, MO, MN, MS, NC, NE, OK, SC, TN, TX • Adults aged 20+ • No more than 65% as women [c] • No state with more than 80 responses	2/20/18 – 2/22/18	700	700
Coastal flooding	• ME, NH, MA, RI, CT, NY, NJ, MD, DE, VA, NC, SC, GA, FL, AL, MS, LA, TX • Must live within 10 miles of the coast • Adults aged 20+ • No more than 65% as women [c] • No state with more than 60 responses	3/2/18 – 3/12/18	700	690
Flash flooding	• TX, MS, AR, AL, TN, KY, MO, IA, IL, MI, IN, OH, PA, NY, NJ, CT, MA, NC, VA, MD, WV, WI • Adults aged 20+ • No more than 65% as women [c] • No state with more than 60 responses	3/2/18 – 3/7/18	800	841

Weather Hazard	Survey Parameters	Dates	Targeted Sample	Collected Sample
Areal flooding	• 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 • Adults aged 20+ • No more than 65% as women [c] • No state with more than 80 responses	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.[10] 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.[11] 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.

[10] 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.
[11] 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.[12] 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.

[12] 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	
TOTALS	7,400	7,400	-

[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[13] (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

[13] 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.[14] 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).[15]

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.[16] 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*

[14] 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.

[15] https://www.stata.com/manuals13/u20.pdf#u20.21Obtainingrobustvarianceestimates.

[16] By design, odds ratios are never less than zero.

through fourth prompts[17] 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.[18]

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:[19]

- *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

[17] The first prompt was the baseline prompt and was used as a control variable in the models for the subsequent prompts.
[18] 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.
[19] 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).

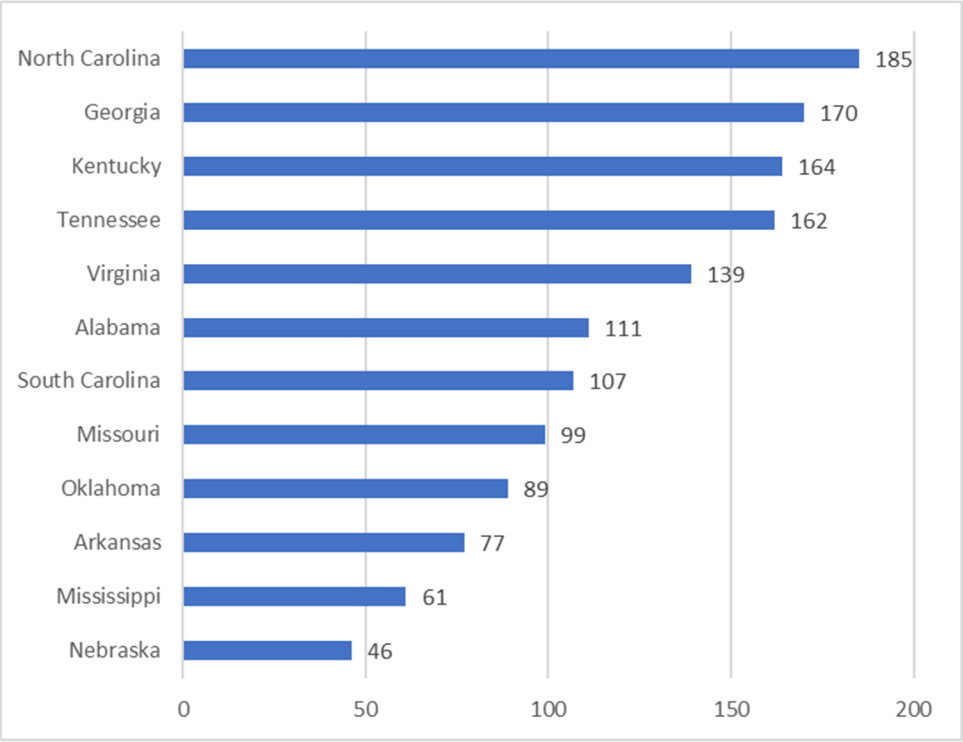

Figure 2. Numbers of Respondents from States Included in the Winter Weather Mild Survey

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
Age		**Race**	
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%	**Income**	
65+	14.8%	Less than $24,999	30.5%
Gender		$25,000 - $49,999	30.8%
Female	58.2%	$50,000 - $99,999	28.0%
Male	41.8%	$100,000 - $199,999	9.2%
Education		More than $200,000	1.5%
Less than college degree	64.5%	**Home Location**	
College degree	21.8%	Urban	16.7%
Post-undergraduate work/degree	13.8%	Suburban	45.7%
Hispanic origin		Rural	37.5%
Yes	4.5%		
No	95.5%	**Average number of adults in home**	**2.23**
		Average number of children in home	**0.80**

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[20] (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

[20] 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 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
Prompt 2: Watch				
Prototype 1	0.901	1.036	1.036	0.994
	(-0.46)	(0.16)	(0.16)	(-0.03)
Prototype 2	0.791	0.998	1.191	0.864
	(-0.99)	(-0.01)	(0.78)	(-0.63)
Prototype 3	0.792	1.119	1.246	1.027
	(-1.02)	(0.48)	(0.94)	(0.12)
Prototype 4	0.874	0.864	1.085	0.719
	(-0.61)	(-0.62)	(0.36)	(-1.48)
Prompt 3: Warning				
Prototype 1	0.613**	0.858	0.847	1.322
	(-2.11)	(-0.61)	(-0.68)	(1.18)
Prototype 2	0.586**	1.345	0.723	1.315
	(-2.24)	(1.16)	(-1.41)	(1.26)
Prototype 3	0.639*	1.349	0.951	1.571*
	(-1.84)	(1.08)	(-0.21)	(1.90)
Prototype 4	0.844	2.176***	1.260	1.752**
	(-0.69)	(2.71)	(0.99)	(2.45)
Prompt 4: Advisory				
Prototype 1	1.073	0.882	1.154	1.533*
	(0.27)	(-0.51)	(0.61)	(1.80)
Prototype 2	0.725	1.485	1.321	1.763**
	(-1.32)	(1.55)	(1.20)	(2.42)
Prototype 3	0.645*	0.740	0.809	0.840
	(-1.74)	(-1.12)	(-0.90)	(-0.76)
Prototype 4	0.995	1.228	1.184	1.059
	(-0.02)	(0.80)	(0.75)	(0.26)

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

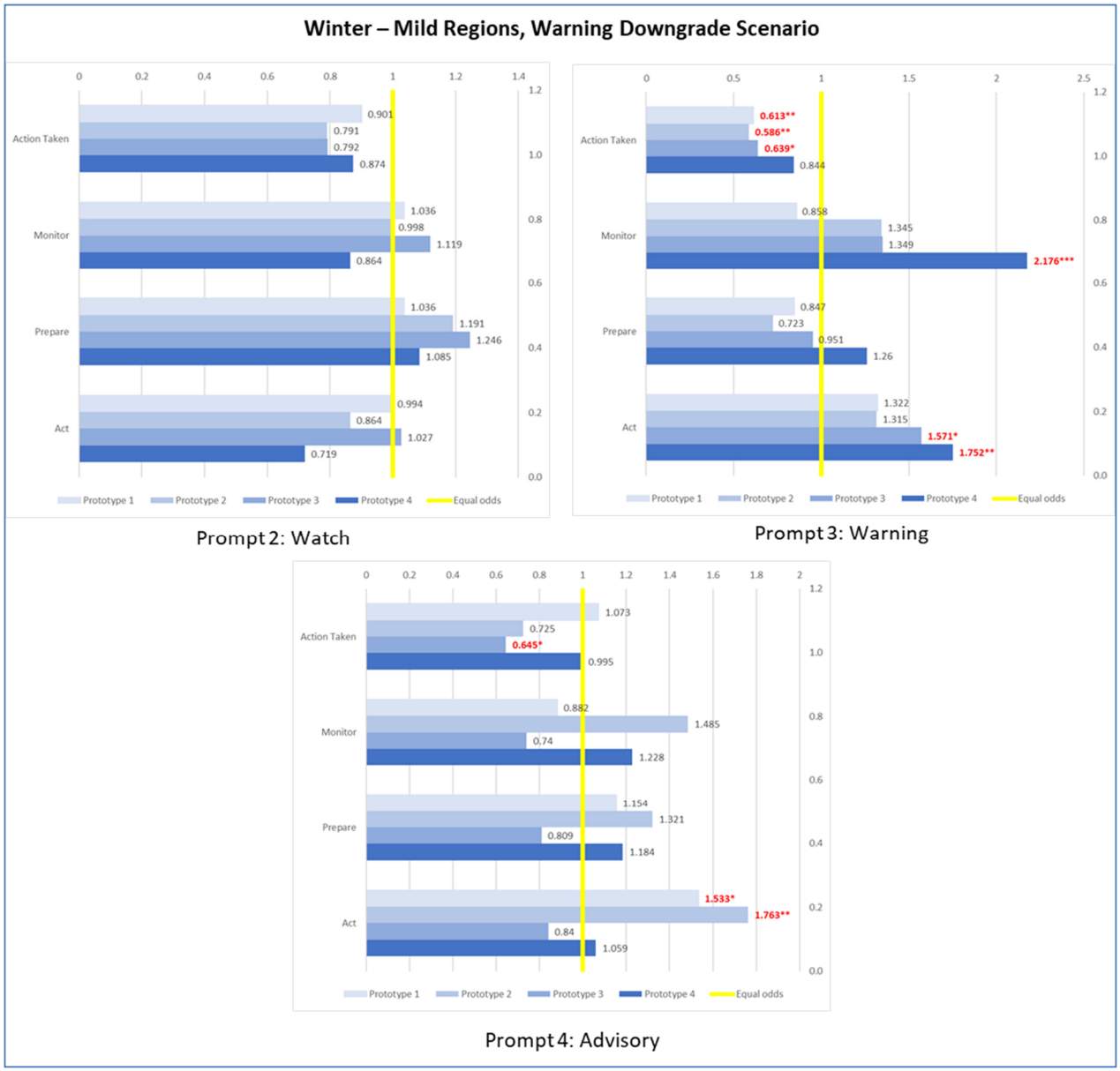

Figure 3. Graphical Depiction of Estimated Odds Ratios for Warning Downgrade Scenario: Winter Weather Mild Regions Survey

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

Exponentiated coefficients; z statistics in parentheses

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

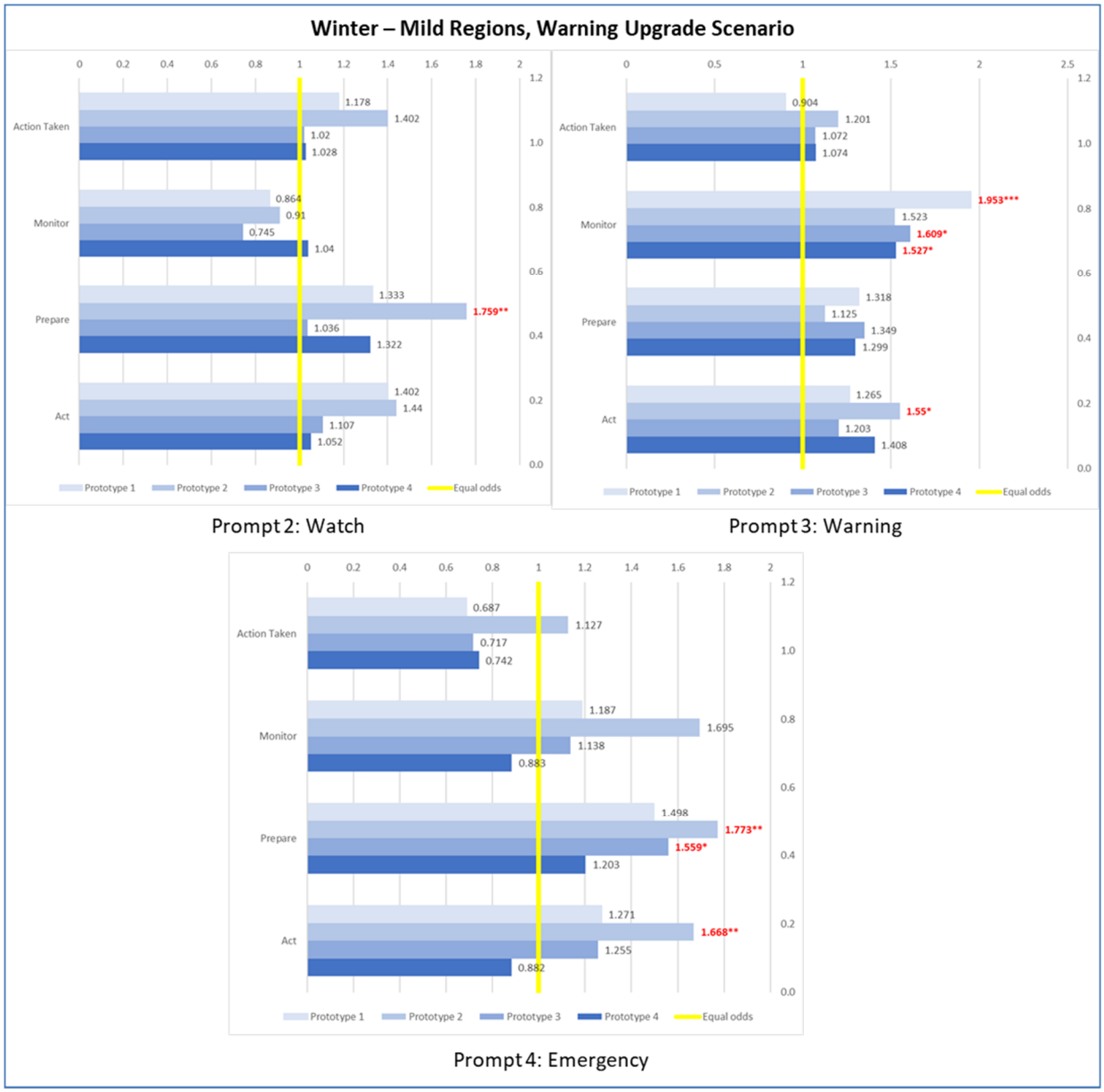

Figure 4. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Winter Weather Mild Regions Survey

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

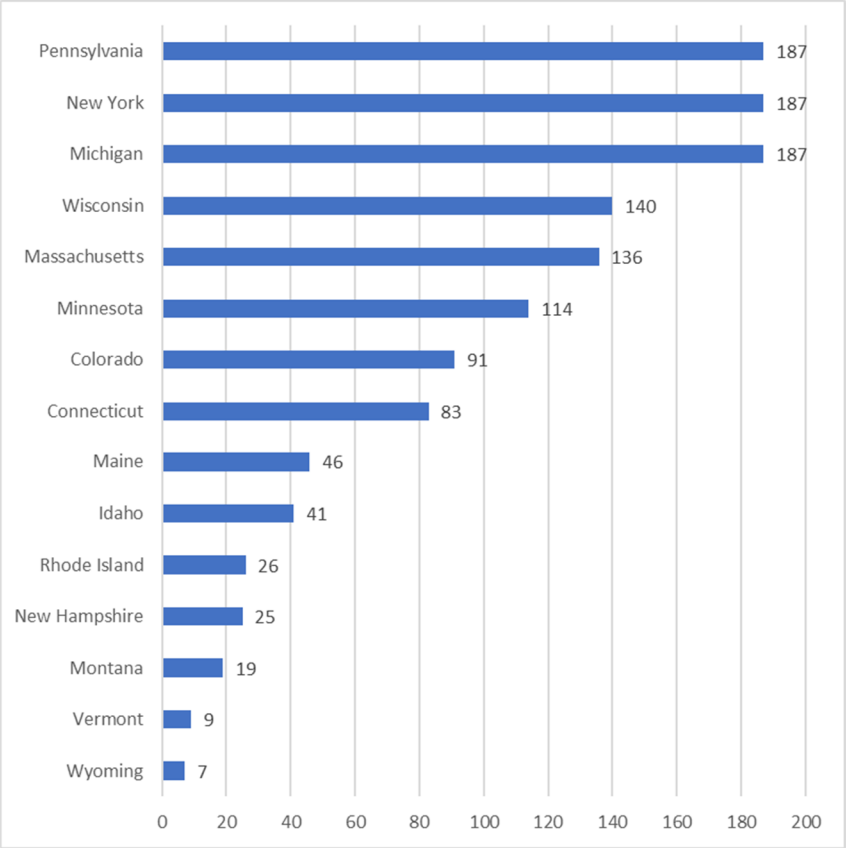

Figure 6. Numbers of Respondents from States Included in the Winter Weather Cold Survey

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
Age		**Race**	
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%	**Income**	
65+	20.4%	Less than $24,999	23%
Gender		$25,000 - $49,999	31%
Female	55.4%	$50,000 - $99,999	32%
Male	44.6%	$100,000 - $199,999	11%
Education		More than $200,000	3%
Less than college degree	54.5%	**Home Location**	
College degree	27.3%	Urban	23.9%
Post-undergraduate work/degree	18.2%	Suburban	47.1%
Hispanic origin		Rural	29.0%
Yes	6.4%		
No	93.6%	**Average number of adults in home**	**2.08**
		Average number of children in home	**0.51**

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[21] (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

[21] 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.[22]

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.

[22] 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
Prompt 2: Watch				
Prototype 1	0.469***	0.766	0.699	0.895
	(-3.47)	(-1.12)	(-1.49)	(-0.47)
Prototype 2	0.663*	0.763	0.917	0.810
	(-1.86)	(-1.24)	(-0.41)	(-0.97)
Prototype 3	0.643**	1.129	0.849	0.816
	(-1.96)	(0.48)	(-0.68)	(-0.86)
Prototype 4	0.546***	0.832	0.814	0.840
	(-2.72)	(-0.85)	(-0.86)	(-0.71)
Prompt 3: Warning				
Prototype 1	0.882	1.130	0.833	0.804
	(-0.57)	(0.44)	(-0.76)	(-0.89)
Prototype 2	1.009	0.826	0.684	0.838
	(0.04)	(-0.68)	(-1.64)	(-0.74)
Prototype 3	1.412	1.393	1.275	1.161
	(1.48)	(1.07)	(0.88)	(0.61)
Prototype 4	1.265	1.451	1.515*	1.222
	(1.08)	(1.27)	(1.78)	(0.84)
Prompt 4: Advisory				
Prototype 1	1.381	0.869	1.557*	0.962
	(1.52)	(-0.56)	(1.91)	(-0.17)
Prototype 2	1.182	0.699	1.073	1.184
	(0.74)	(-1.48)	(0.30)	(0.73)
Prototype 3	1.207	0.608*	1.092	0.644*
	(0.82)	(-1.87)	(0.38)	(-1.90)
Prototype 4	1.242	1.021	1.349	1.079
	(1.00)	(0.08)	(1.31)	(0.35)

Exponentiated coefficients; z statistics in parentheses
$^{*}\ p < 0.10,\ ^{**}\ p < 0.05,\ ^{***}\ p < 0.01$

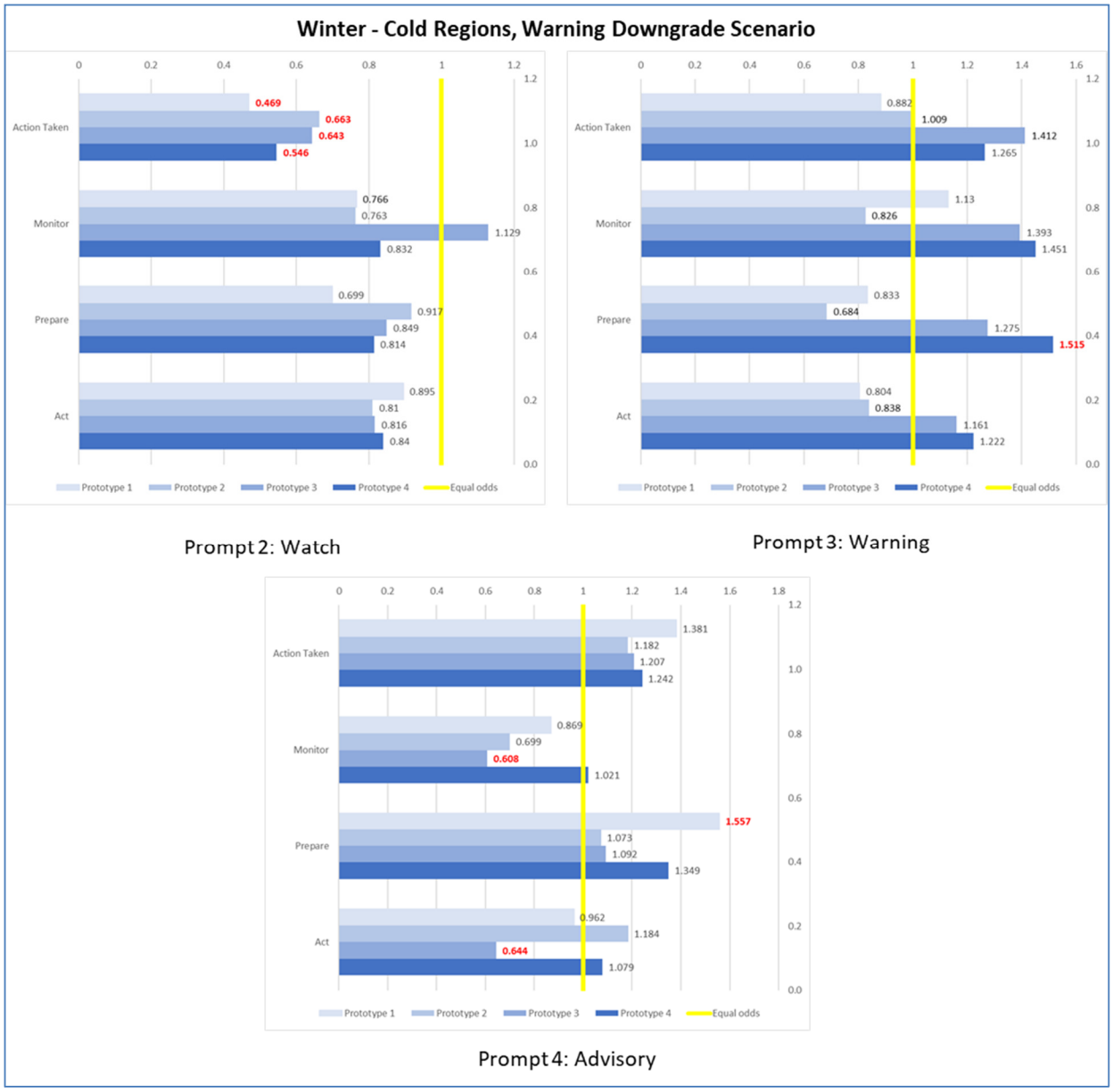

Figure 7. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Winter Weather Cold Regions Survey

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

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

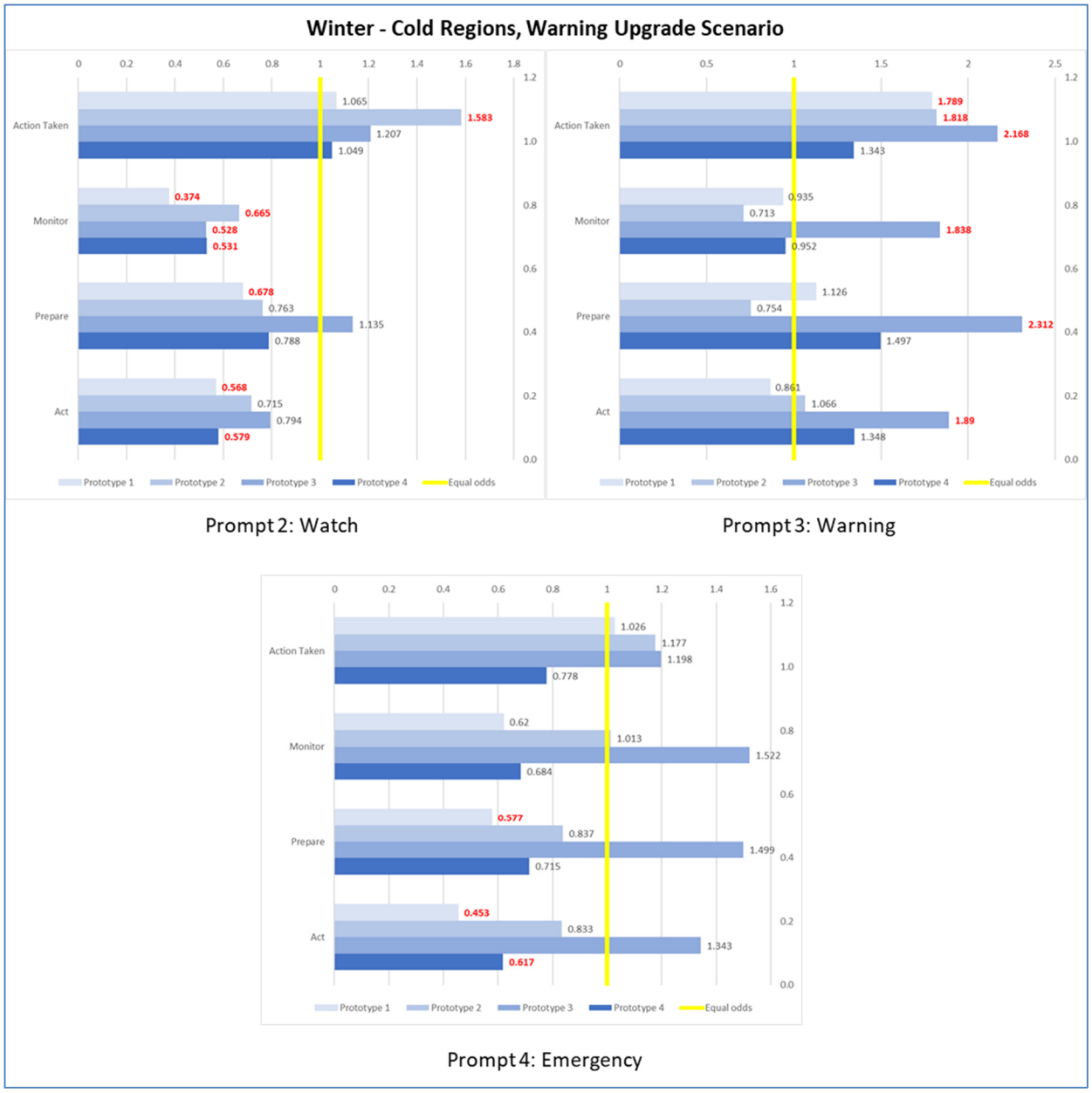

Figure 8. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Winter Weather Cold Regions Survey

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

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

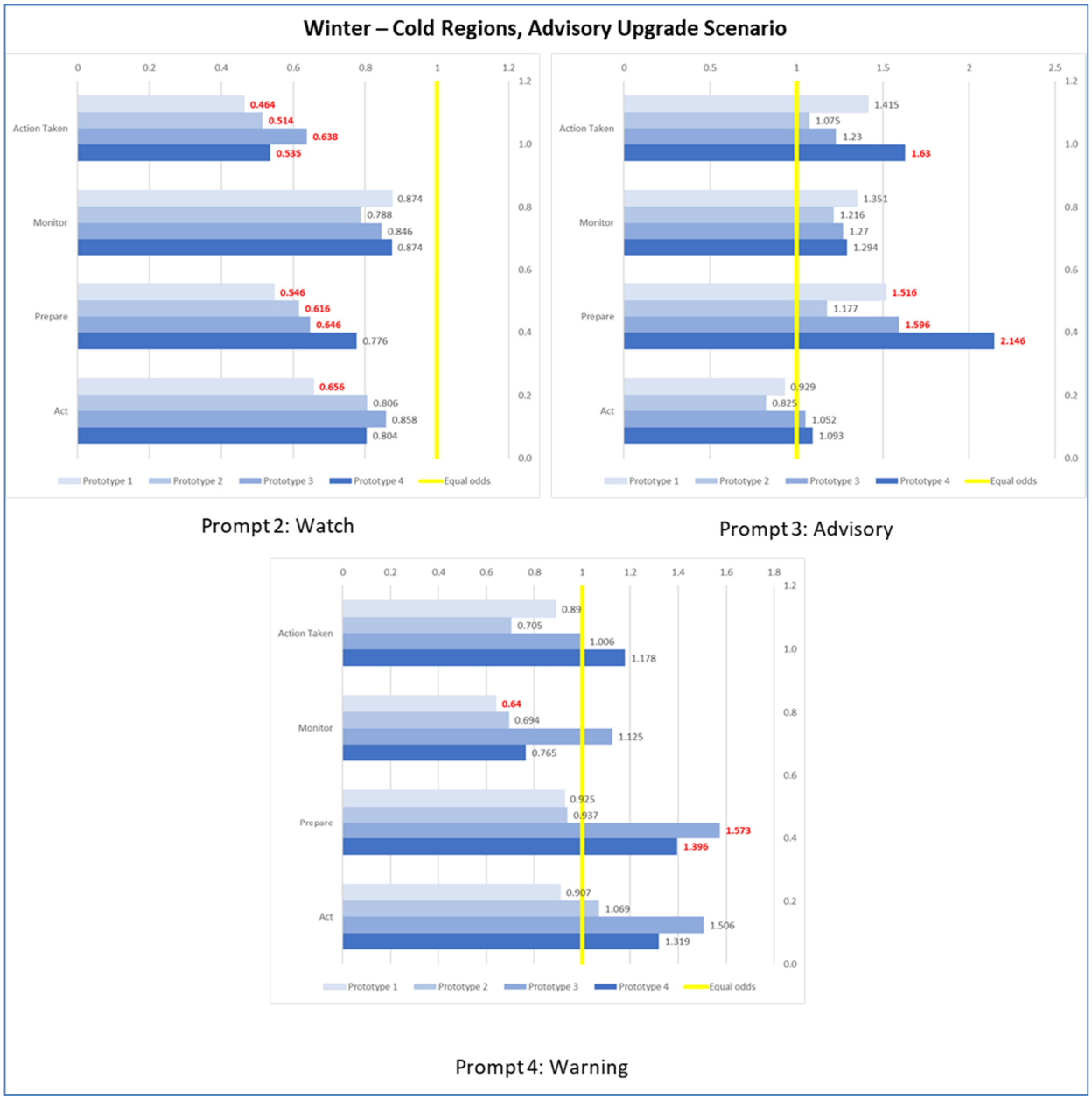

Figure 9. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: Winter Weather Cold Regions Survey

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
Age		**Race**	
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%	**Income**	
65+	17.2%	Less than $24,999	23.4%
Gender		$25,000 - $49,999	29.2%
Female	46.2%	$50,000 - $99,999	30.9%
Male	53.8%	$100,000 - $199,999	14.3%
Education		More than $200,000	2.3%
Less than college degree	52.3%	**Home Location**	
College degree	30.8%	Urban	24.2%
Post-undergraduate work/degree	16.9%	Suburban	49.0%
Hispanic origin		Rural	26.8%
Yes	9.7%		
No	90.3%	**Average number of adults in home**	**2.15**
		Average number of children in home	**0.62**

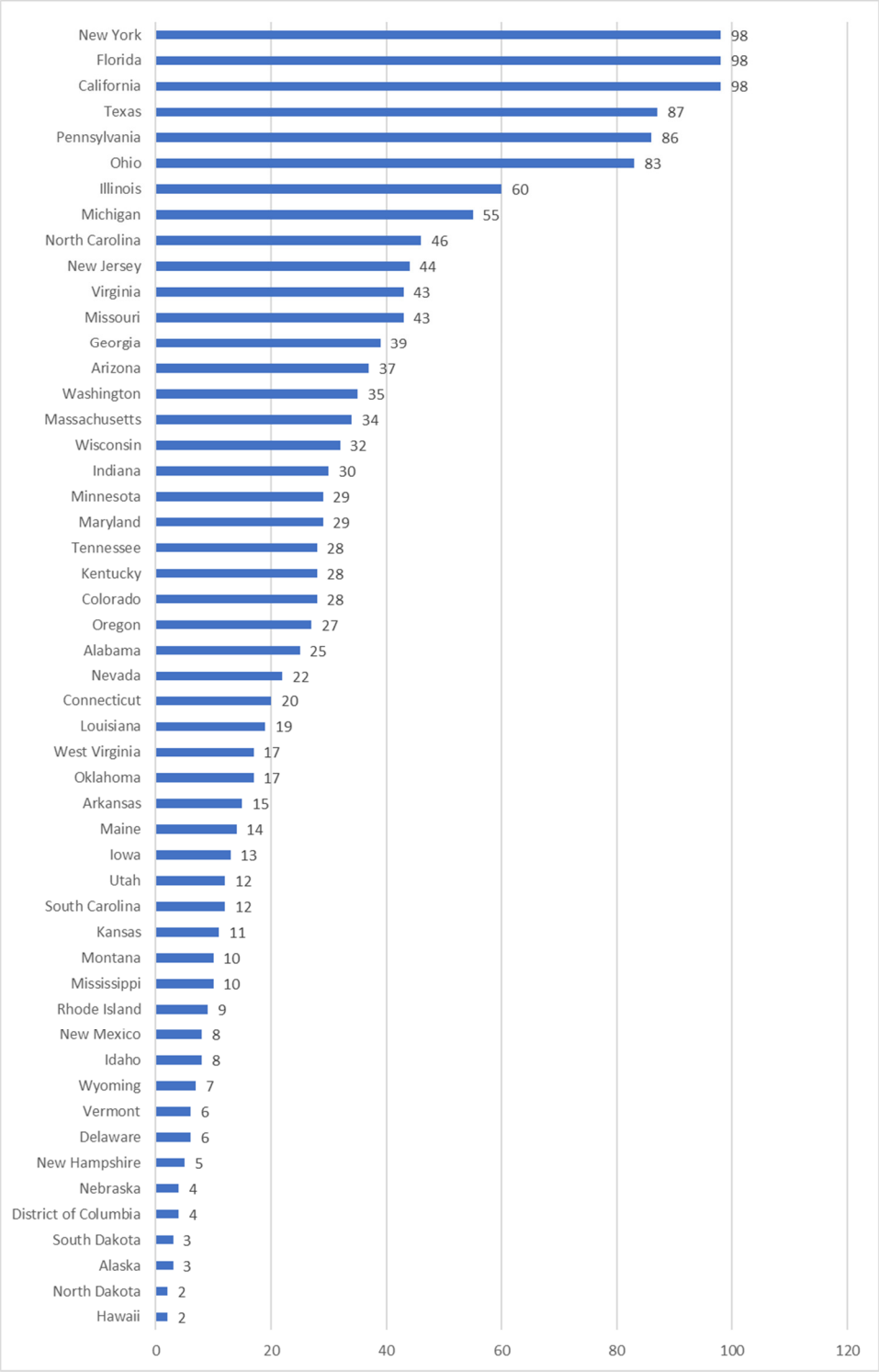

Figure 10. Numbers of Respondents from States Included in the Thunderstorms Survey

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[23] (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.

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

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

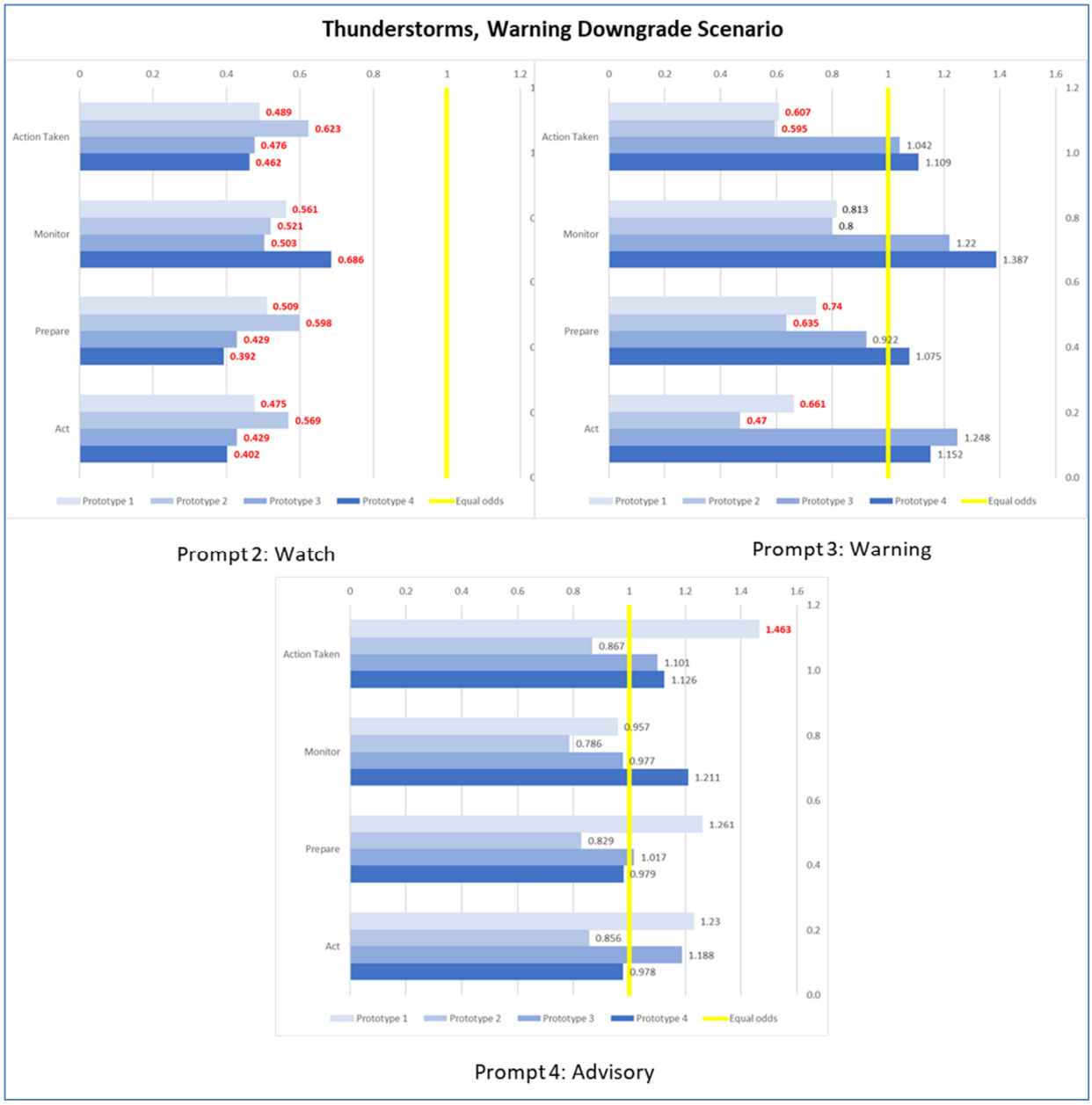

Figure 11. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Thunderstorms Survey

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.[24] 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.

[24] 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
Prompt 2: Watch				
Prototype 1	1.033	0.775	1.053	1.173
	(0.18)	(-1.20)	(0.28)	(0.88)
Prototype 2	1.656***	1.158	1.922***	1.641***
	(2.73)	(0.73)	(3.35)	(2.60)
Prototype 3	0.969	1.126	0.984	1.140
	(-0.18)	(0.58)	(-0.09)	(0.73)
Prompt 3: Warning				
Prototype 1	0.490***	0.498***	0.481***	0.491***
	(-3.63)	(-2.75)	(-3.40)	(-3.47)
Prototype 2	0.450***	0.624*	0.588**	0.539***
	(-4.08)	(-1.83)	(-2.40)	(-2.85)
Prototype 3	0.683*	0.755	0.715	0.801
	(-1.92)	(-1.05)	(-1.47)	(-0.98)
Prompt 4: Emergency				
Prototype 1	0.569***	0.550**	0.496***	0.508***
	(-2.76)	(-1.99)	(-2.85)	(-2.82)
Prototype 2	0.791	0.799	0.851	0.877
	(-1.15)	(-0.76)	(-0.65)	(-0.53)
Prototype 3	1.039	1.207	0.937	1.000
	(0.18)	(0.61)	(-0.26)	(-0.00)

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

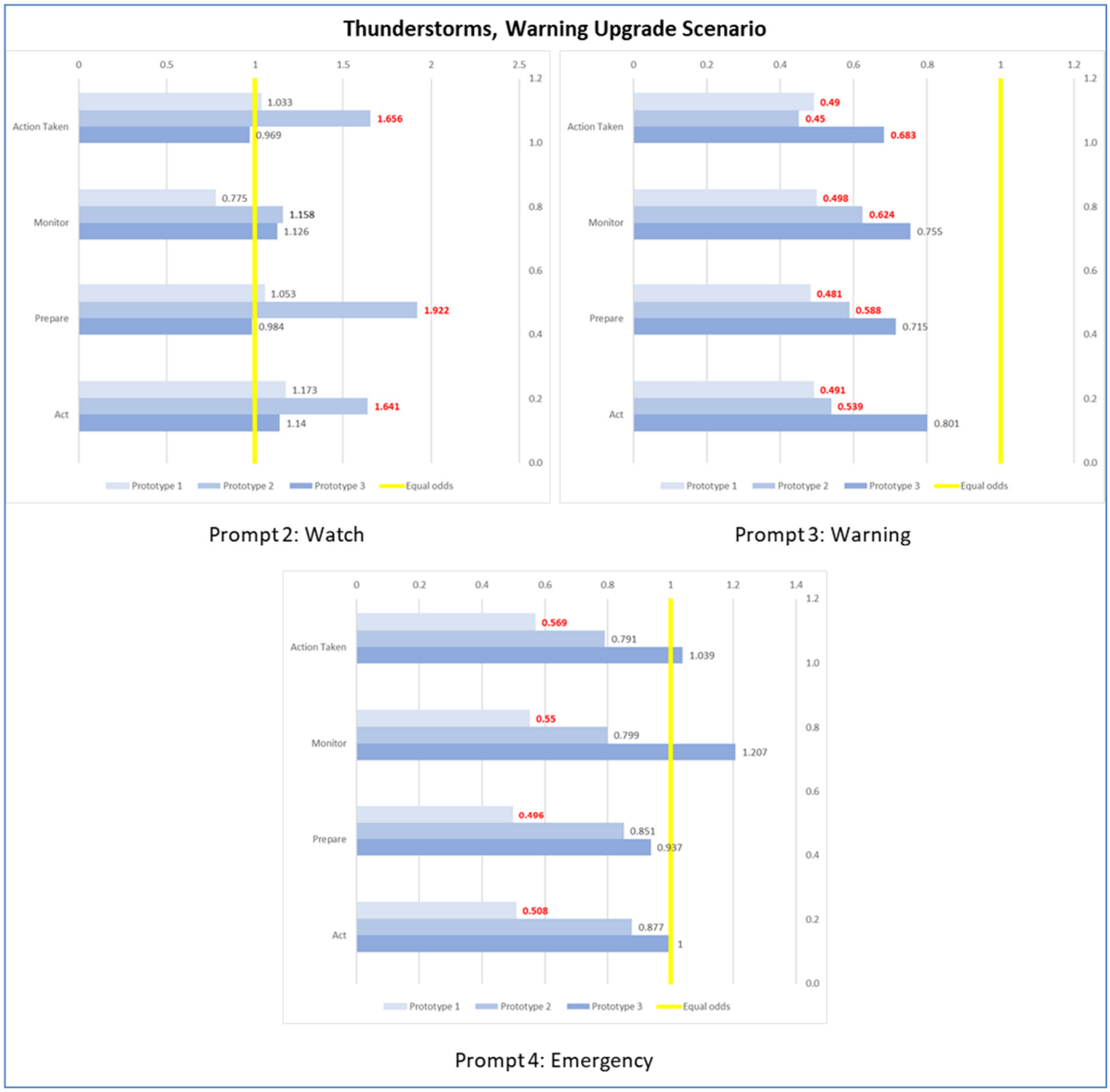

Figure 12. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Thunderstorms Survey

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

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

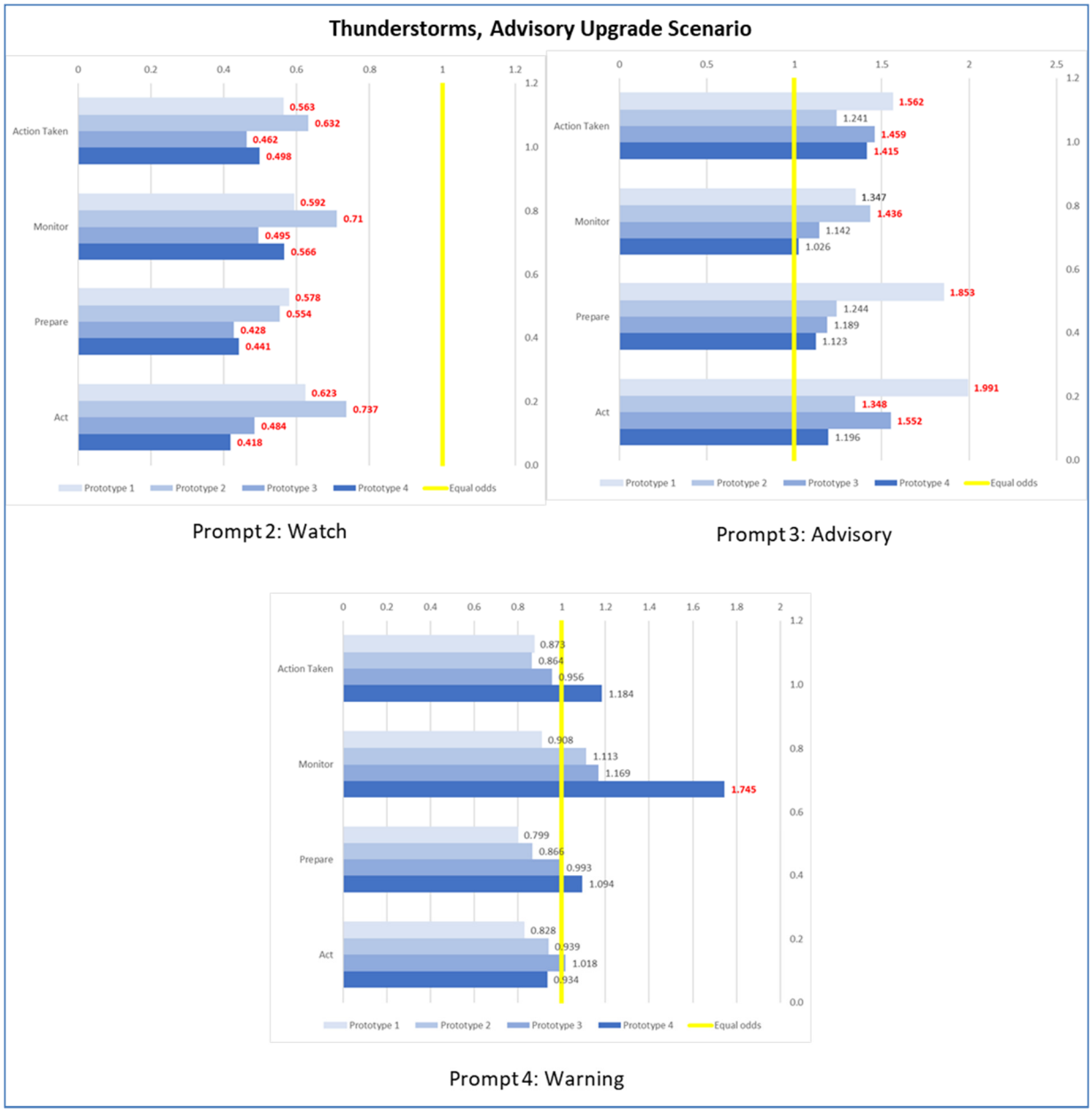

Figure 13. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: Thunderstorms Survey

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.

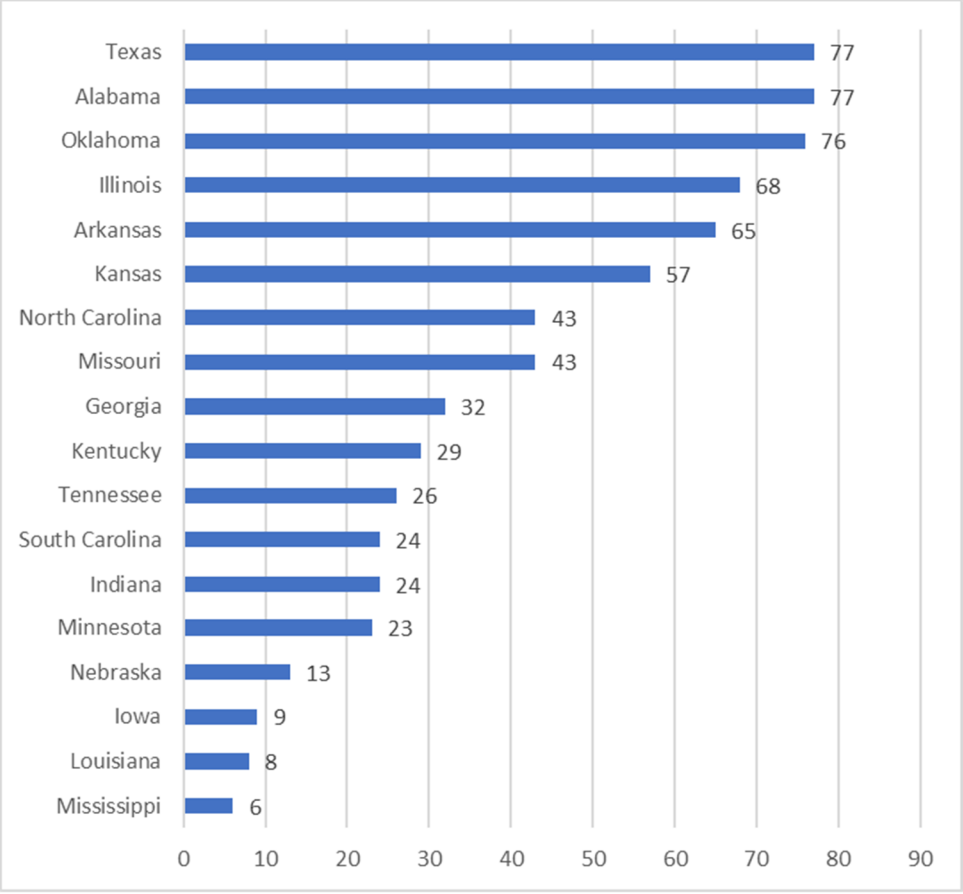

Figure 14. Numbers of Respondents from States Included in the Tornadoes Survey

Table 33. Basic Demographics for Tornadoes Survey

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
Age		**Race**	
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%	**Income**	
65+	13.6%	Less than $24,999	23.0%
Gender		$25,000 - $49,999	31.3%
Female	59.3%	$50,000 - $99,999	31.9%
Male	40.7%	$100,000 - $199,999	12.3%
Education		More than $200,000	1.6%
Less than college degree	56.6%	**Home Location**	
College degree	27.4%	Urban	20.0%
Post-undergraduate work/degree	16.0%	Suburban	48.6%
Hispanic origin		Rural	31.4%
Yes	8.3%		
No	91.7%	**Average number of adults in home**	**2.14**
		Average number of children in home	**0.70**

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[25] (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

[25] 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.[26]

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.

[26] 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
Prompt 2: Watch				
Prototype 1	0.673**	0.793	0.564***	0.610***
	(-2.37)	(-1.26)	(-3.75)	(-3.34)
Prototype 2	1.368*	1.005	1.013	1.083
	(1.86)	(0.03)	(0.08)	(0.51)
Prototype 3	1.555***	0.995	1.187	1.222
	(2.77)	(-0.03)	(1.15)	(1.28)
Prototype 4	0.899	0.828	0.787*	0.882
	(-0.71)	(-1.08)	(-1.66)	(-0.87)
Prompt 3: Warning				
Prototype 1	0.689**	0.715	0.879	0.901
	(-2.31)	(-1.47)	(-0.77)	(-0.61)
Prototype 2	0.930	0.769	0.934	1.048
	(-0.46)	(-1.14)	(-0.45)	(0.29)
Prototype 3	1.167	0.837	1.020	1.188
	(0.98)	(-0.82)	(0.13)	(1.07)
Prototype 4	1.310*	1.044	1.198	1.300
	(1.67)	(0.18)	(1.06)	(1.54)
Prompt 4: Emergency				
Prototype 1	0.401***	0.713	0.718**	0.596***
	(-4.84)	(-1.46)	(-2.01)	(-2.68)
Prototype 2	0.809	1.061	1.046	1.201
	(-1.04)	(0.25)	(0.27)	(0.93)
Prototype 3	1.008	1.060	1.046	1.157
	(0.04)	(0.25)	(0.26)	(0.71)
Prototype 4	0.731	0.881	0.965	0.841
	(-1.58)	(-0.54)	(-0.21)	(-0.91)

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

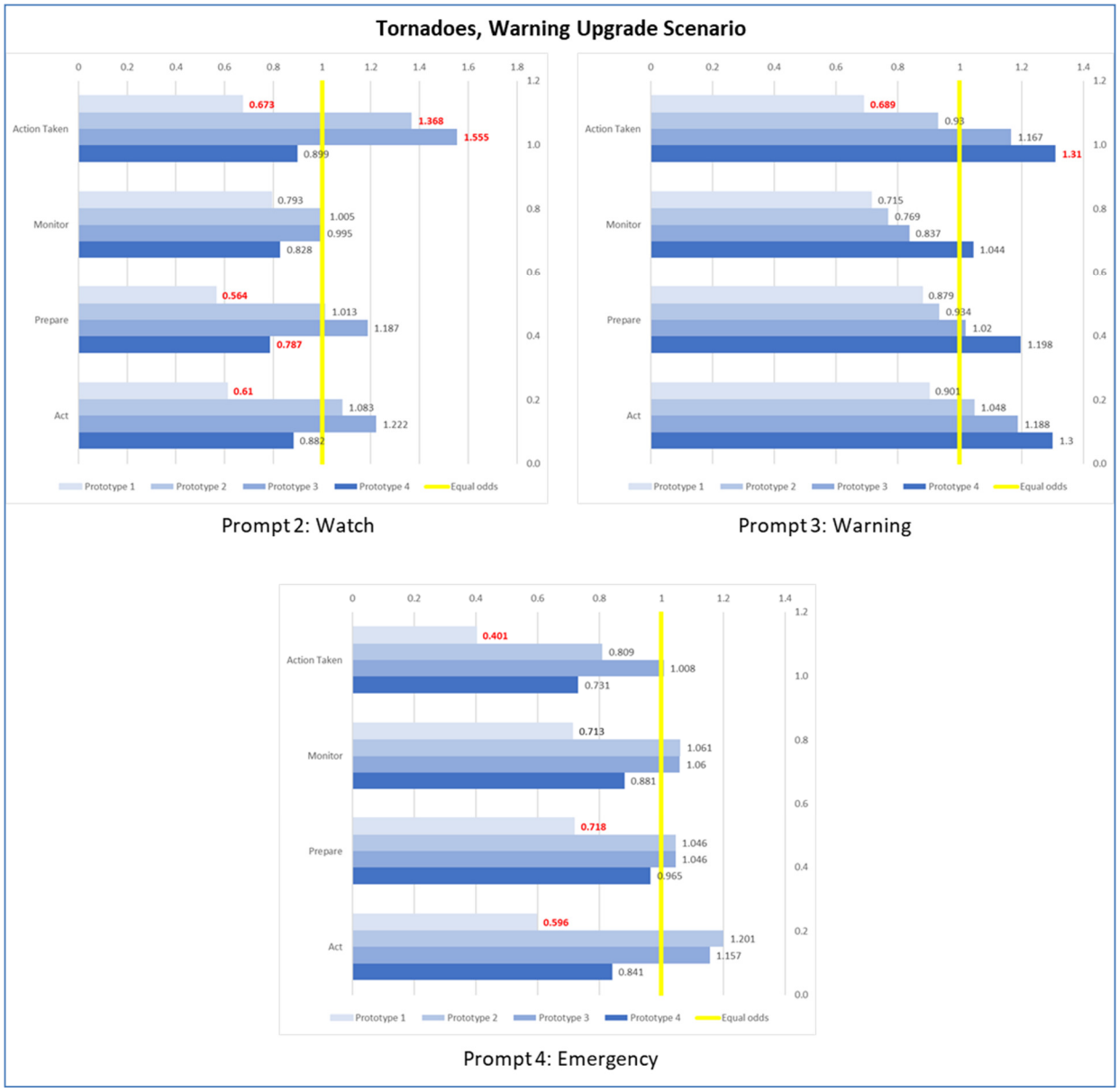

Figure 15. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Tornadoes Survey

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 t 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.

***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*

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.

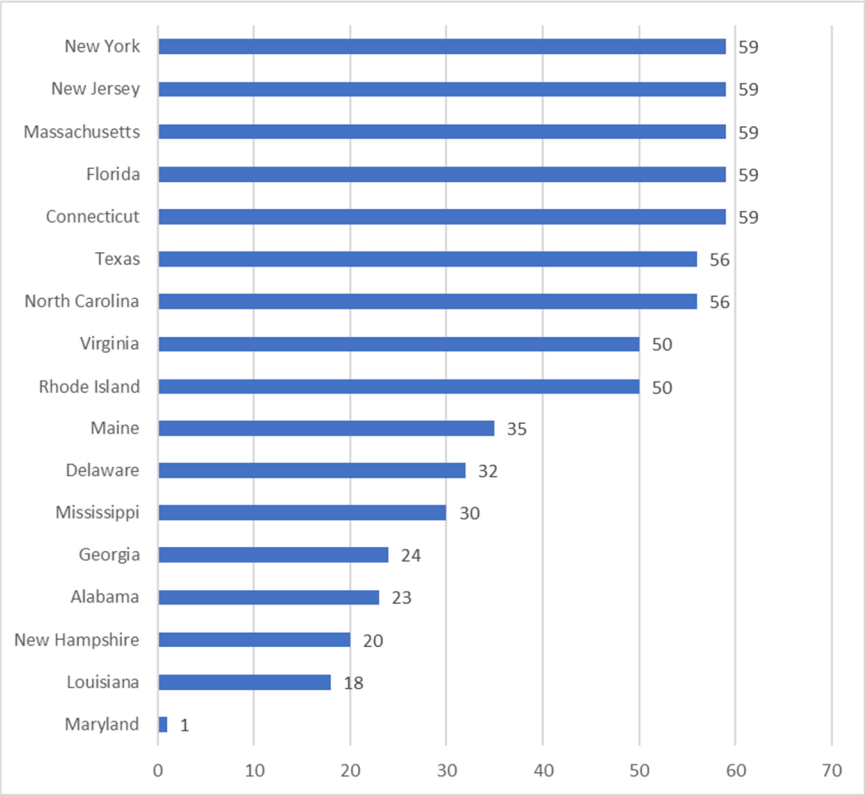

Figure 16. Numbers of Respondents from States Included in the Coastal Flooding Survey

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
Age		**Race**	
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%	**Income**	
65+	31.9%	Less than $24,999	12.6%
Gender		$25,000 - $49,999	18.8%
Female	61.9%	$50,000 - $99,999	38.0%
Male	38.1%	$100,000 - $199,999	24.6%
Education		More than $200,000	5.9%
Less than college degree	38.8%	**Home Location**	
College degree	31.2%	Urban	24.4%
Post-undergraduate work/degree	30.0%	Suburban	59.4%
Hispanic origin		Rural	16.2%
Yes	7.7%		
No	92.3%	**Average number of adults in home**	**2.23**
		Average number of children in home	**0.32**

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[27] (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

[27] 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.[28]

Table 42. Specific Prototype Language Tested for Coastal Flooding Survey

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

[28] 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
Prompt 2: Watch				
Prototype 1	0.632*	0.781	0.866	0.920
	(-1.85)	(-0.89)	(-0.60)	(-0.31)
Prototype 2	1.010	1.104	1.576**	1.921***
	(0.04)	(0.39)	(1.98)	(2.80)
Prototype 3	0.897	0.982	1.158	1.482
	(-0.49)	(-0.07)	(0.68)	(1.57)
Prototype 4	0.825	1.034	0.830	1.039
	(-0.81)	(0.14)	(-0.81)	(0.16)
Prompt 3: Emergency				
Prototype 1	1.205	1.327	1.536*	1.018
	(0.94)	(0.91)	(1.79)	(0.08)
Prototype 2	2.769***	2.344***	2.330***	2.692***
	(4.84)	(2.87)	(3.58)	(4.36)
Prototype 3	1.808***	1.936**	2.191***	1.473*
	(2.88)	(2.06)	(3.24)	(1.80)
Prototype 4	2.352***	1.819*	1.497*	2.143***
	(3.58)	(1.93)	(1.66)	(3.16)
Prompt 4: Advisory				
Prototype 1	0.801	1.321	1.257	1.091
	(-0.98)	(0.95)	(0.89)	(0.38)
Prototype 2	0.861	1.682*	1.117	0.958
	(-0.71)	(1.80)	(0.49)	(-0.20)
Prototype 3	0.401***	0.878	0.577**	0.414***
	(-4.38)	(-0.49)	(-2.35)	(-4.13)
Prototype 4	1.558*	1.910**	1.220	1.429
	(1.87)	(2.24)	(0.79)	(1.52)

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

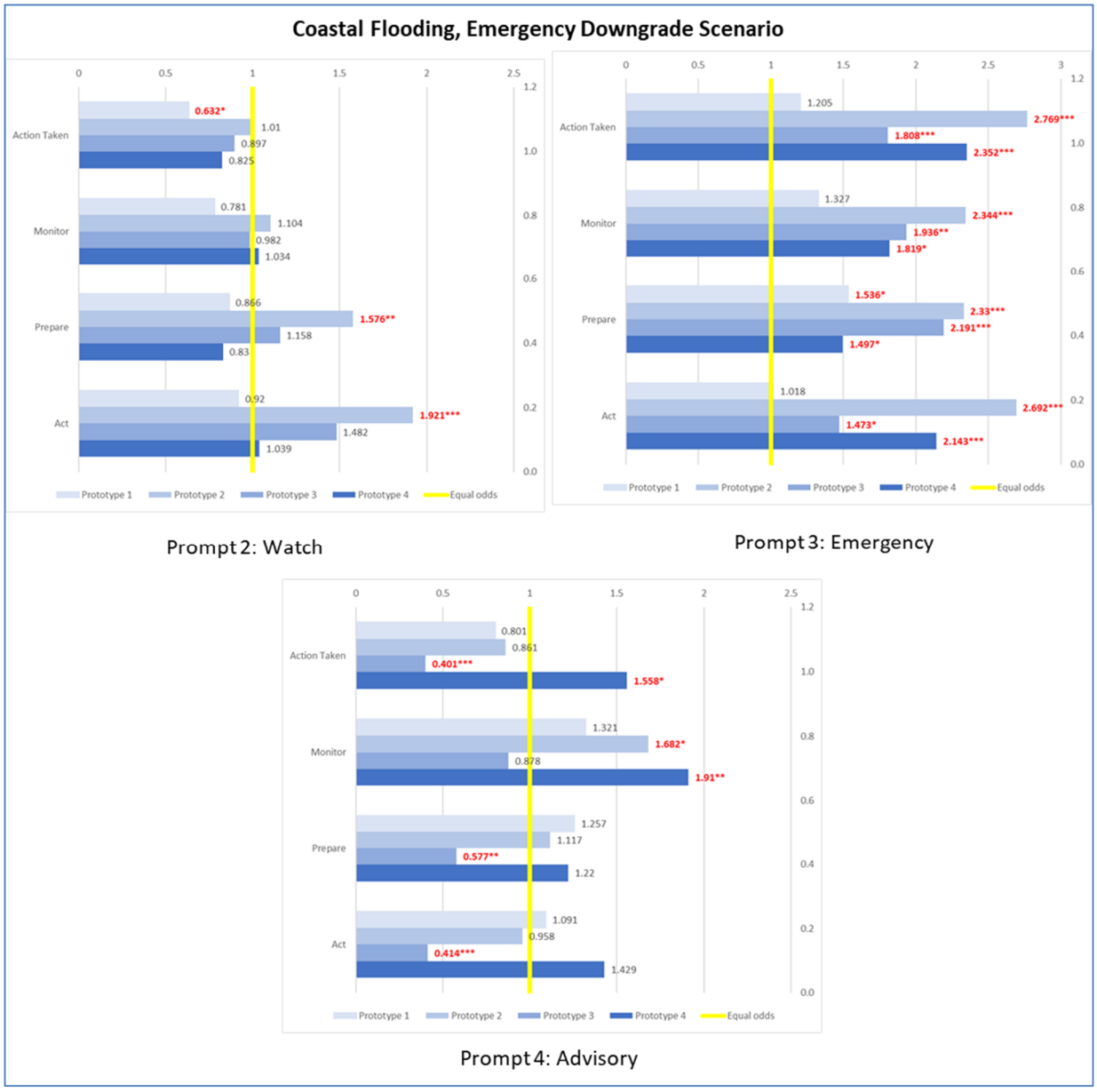

Figure 17. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Coastal Flooding Survey

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

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

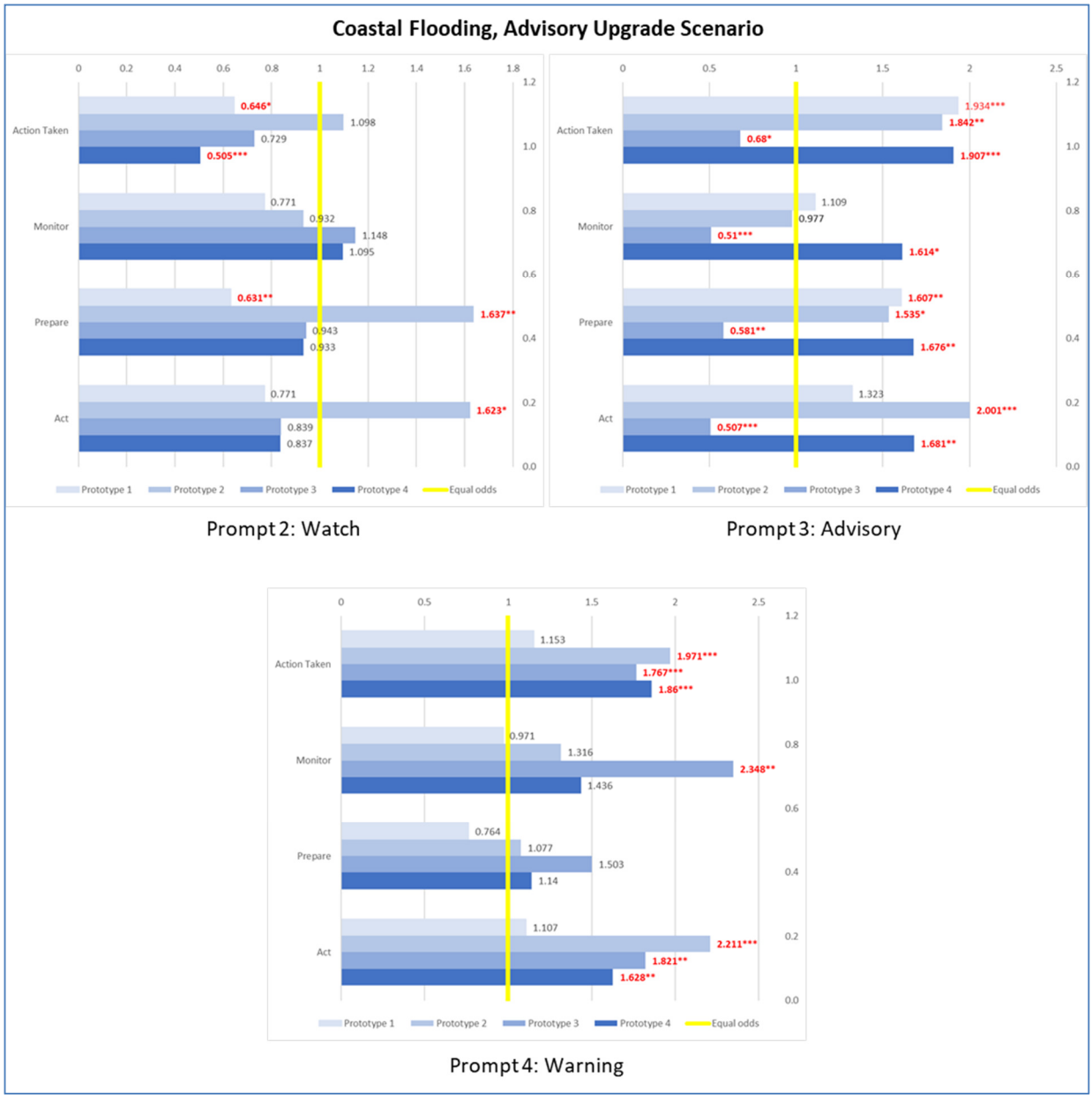

Figure 18. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: Coastal Flooding Survey

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.

***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*

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.

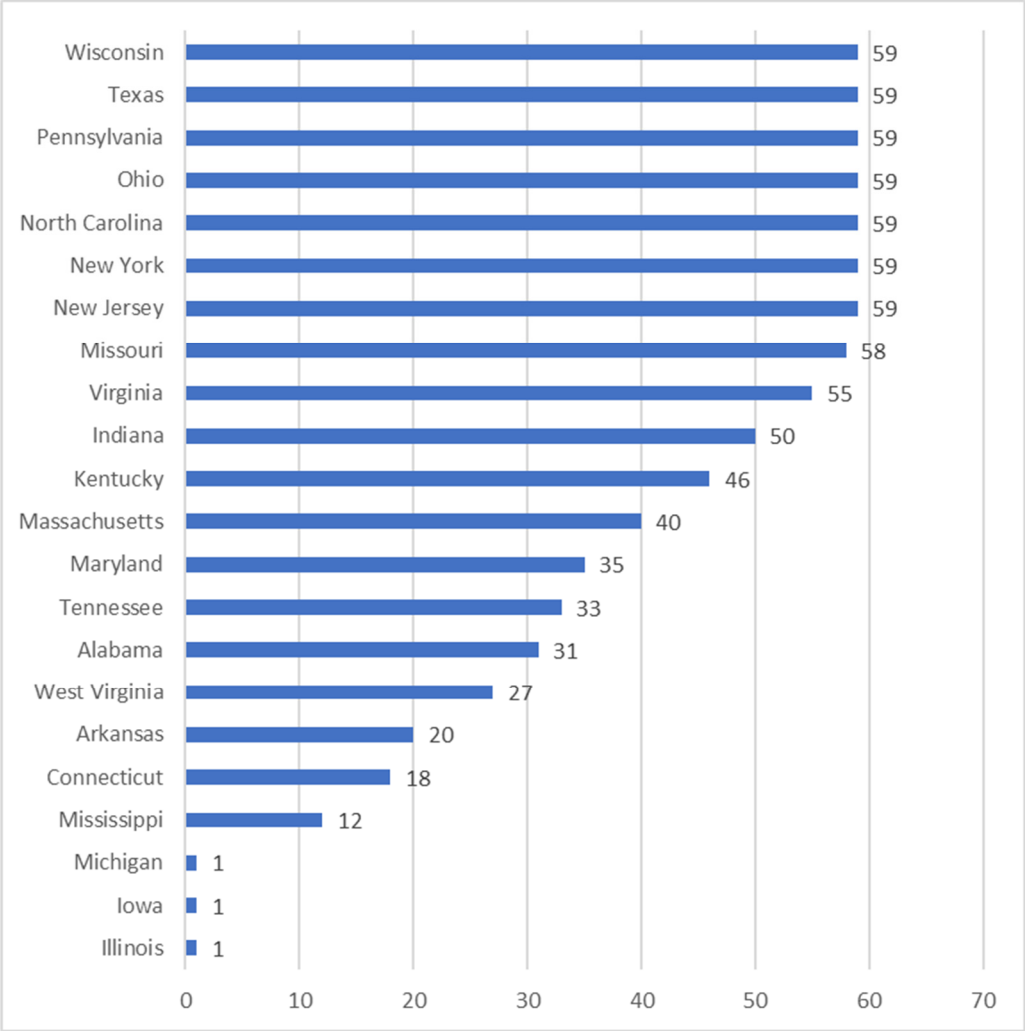

Figure 19. Numbers of Respondents from States Included in the Flash Flooding Survey

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
Age		**Race**	
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%	**Income**	
65+	17.5%	Less than $24,999	16.9%
Gender		$25,000 - $49,999	27.1%
Female	64.9%	$50,000 - $99,999	38.3%
Male	35.1%	$100,000 - $199,999	15.3%
Education		More than $200,000	2.4%
Less than college degree	50.3%	**Home Location**	
College degree	34.2%	Urban	15.9%
Post-undergraduate work/degree	15.5%	Suburban	52.4%
Hispanic origin		Rural	31.6%
Yes	3.9%		
No	96.1%	**Average number of adults in home**	**2.03**
		Average number of children in home	**0.59**

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:[29]

- **Action taken** – Respondents were asked about the action they would take in response to the prompt provided; the actions included[30] (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.

[29] The flash flood survey did not use the "likelihood of preparing" question and instead used two action questions.
[30] 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
Watch level	Flood Watch	Flood Outlook	Flood Notice	Possible Flood Event	Possible Flood Conditions
Warning level	Flash Flood Warning	Flood Warning	Flood Warning	Moderate Flood Warning	Level Red Flood Warning
Emergency level	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
Prompt 2: Watch				
Prototype 1	0.715	0.563**	0.716	0.861
	(-1.57)	(-2.42)	(-1.60)	(-0.71)
Prototype 2	1.183	1.010	1.229	1.486*
	(0.77)	(0.04)	(0.95)	(1.81)
Prototype 3	1.080	1.112	0.978	1.171
	(0.35)	(0.44)	(-0.11)	(0.71)
Prototype 4	1.069	1.000	1.025	1.066
	(0.30)	(-0.00)	(0.10)	(0.28)
Prompt 3: Emergency				
Prototype 1	0.508***	0.697	0.684*	0.512***
	(-3.03)	(-1.19)	(-1.70)	(-2.84)
Prototype 2	1.163	1.049	1.005	1.246
	(0.66)	(0.15)	(0.02)	(0.87)
Prototype 3	0.941	1.130	0.970	0.939
	(-0.26)	(0.37)	(-0.13)	(-0.27)
Prototype 4	1.038	0.832	0.968	0.937
	(0.15)	(-0.58)	(-0.13)	(-0.27)
Prompt 4: Warning				
Prototype 1	1.423*	0.939	0.991	1.098
	(1.72)	(-0.23)	(-0.04)	(0.45)
Prototype 2	1.305	0.947	0.919	0.884
	(1.24)	(-0.20)	(-0.40)	(-0.56)
Prototype 3	0.462***	0.588**	0.512***	0.401***
	(-3.95)	(-2.05)	(-3.25)	(-4.57)
Prototype 4	1.785**	1.412	1.229	1.659**
	(2.53)	(1.10)	(0.84)	(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
Prompt 2: Watch				
Prototype 1	0.760	0.823	0.790	0.995
	(-1.23)	(-0.82)	(-1.22)	(-0.03)
Prototype 2	1.533**	0.968	0.966	0.990
	(2.00)	(-0.14)	(-0.19)	(-0.05)
Prototype 3	1.225	0.855	1.229	1.231
	(0.95)	(-0.73)	(1.07)	(1.12)
Prototype 4	1.402	1.027	1.360	1.281
	(1.61)	(0.11)	(1.59)	(1.31)
Prompt 3: Warning				
Prototype 1	1.400	1.320	0.953	1.177
	(1.60)	(1.06)	(-0.22)	(0.88)
Prototype 2	1.197	0.695	1.036	1.116
	(0.91)	(-1.52)	(0.19)	(0.60)
Prototype 3	0.589***	0.577**	0.625**	0.731*
	(-2.62)	(-2.20)	(-2.20)	(-1.66)
Prototype 4	2.798***	1.735*	1.371	2.405***
	(4.48)	(1.85)	(1.32)	(4.20)
Prompt 4: Emergency				
Prototype 1	0.520***	0.979	1.140	0.675*
	(-3.10)	(-0.08)	(0.60)	(-1.92)
Prototype 2	1.189	1.082	1.222	0.904
	(0.82)	(0.27)	(0.94)	(-0.48)
Prototype 3	0.868	1.465	0.992	0.905
	(-0.66)	(1.43)	(-0.04)	(-0.46)
Prototype 4	1.133	1.583	0.930	1.048
	(0.55)	(1.62)	(-0.33)	(0.22)

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

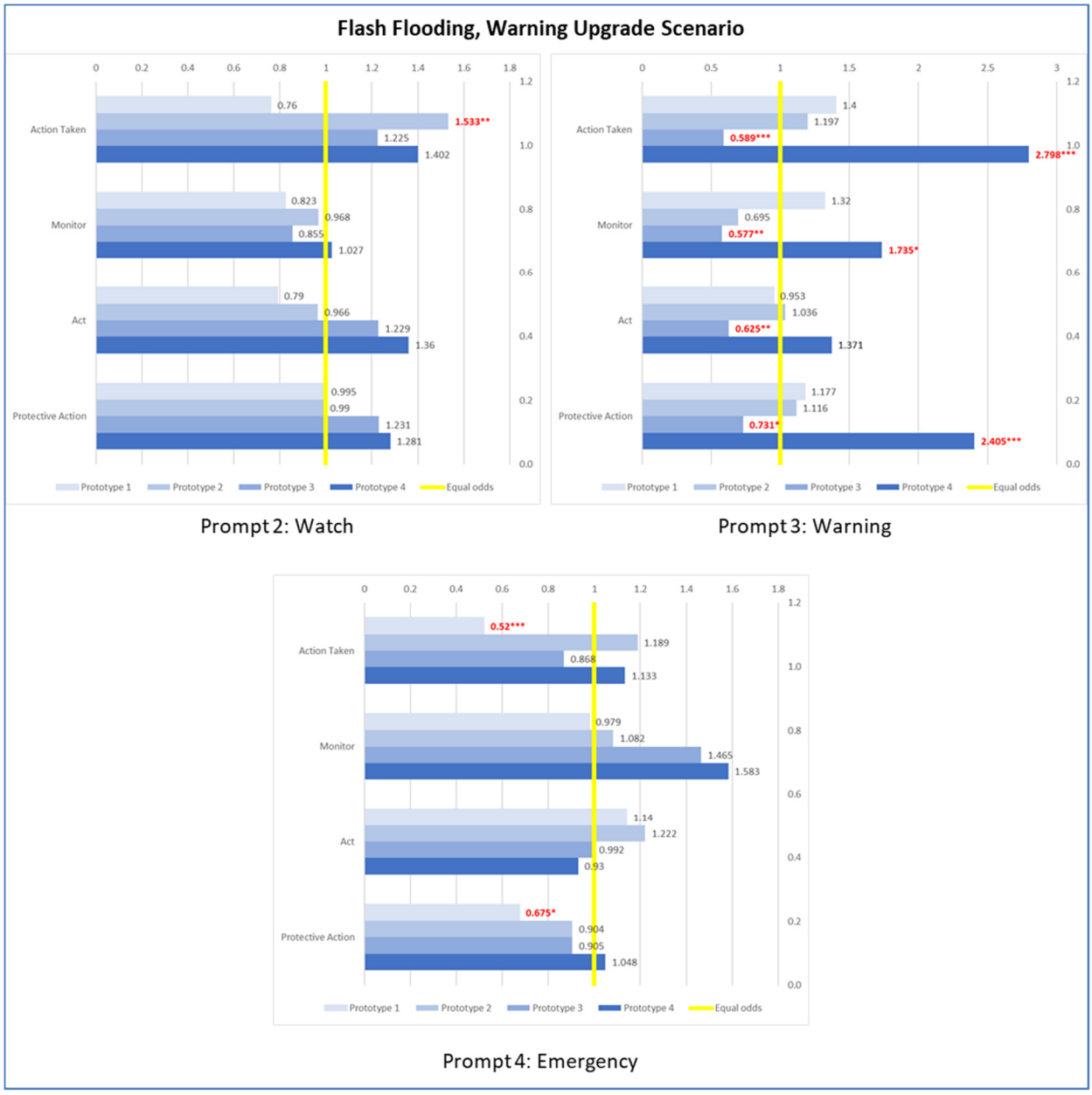

Figure 21. Graphical Depiction of Estimated Odds Ratios for Warning Upgrade Scenario: Flash Flood Survey

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.

***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*

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.

Table 56. Basic Demographics for Areal Flooding Survey

Category	Percentage of Sample / Sample Value	Category	Percentage of Sample / Sample Value
Age		**Race**	
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%	**Income**	
65+	18.3%	Less than $24,999	20.0%
Gender		$25,000 - $49,999	29.9%
Female	64.9%	$50,000 - $99,999	33.4%
Male	35.1%	$100,000 - $199,999	14.5%
Education		More than $200,000	2.3%
Less than college degree	54.6%	**Home Location**	
College degree	28.0%	Urban	24.9%
Post-undergraduate work/degree	17.4%	Suburban	49.7%
Hispanic origin		Rural	25.4%
Yes	6.4%		
No	93.6%	**Average number of adults in home**	**2.06**
		Average number of children in home	**0.63**

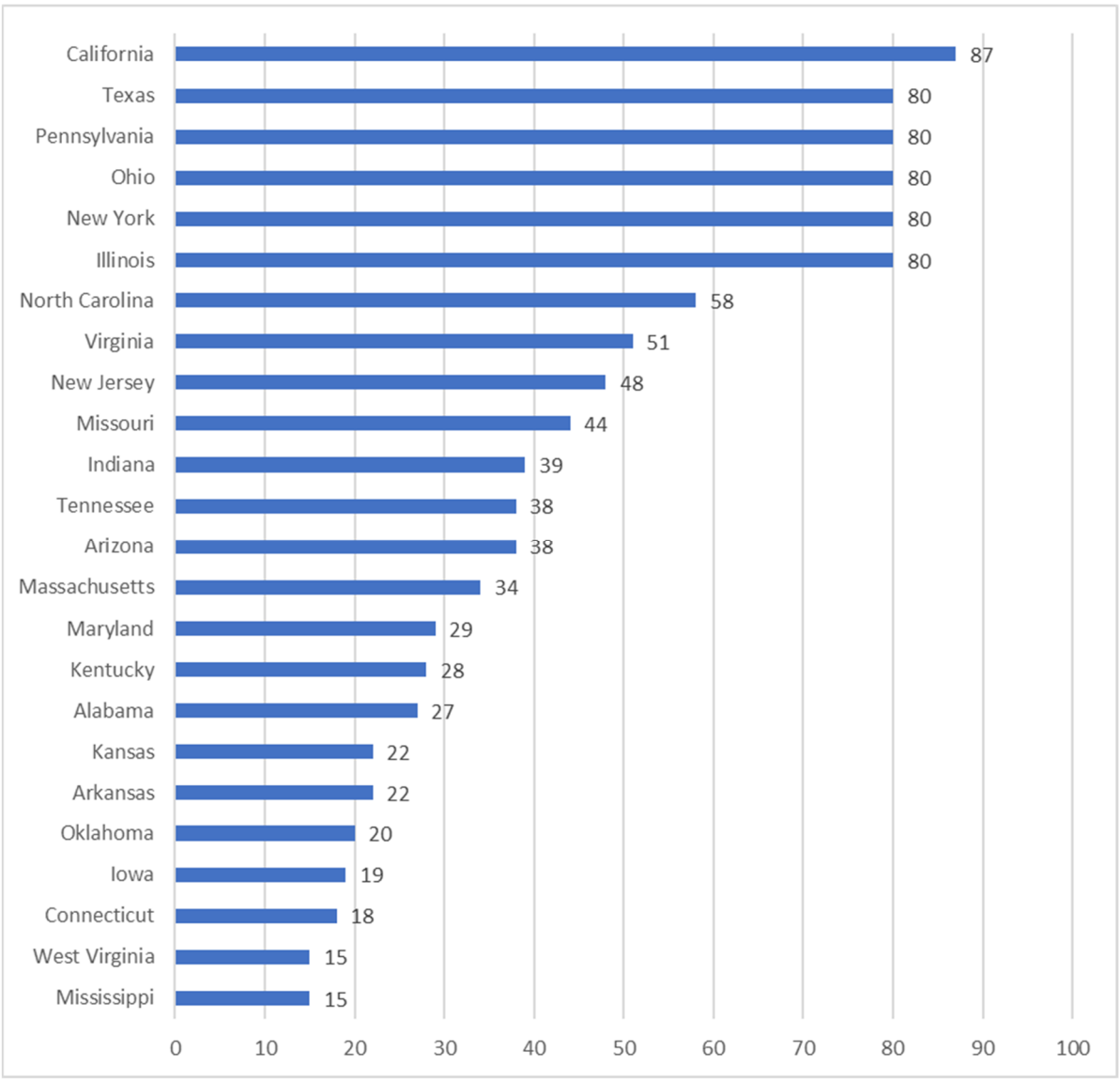

Figure 22. Numbers of Respondents from States Included in the Areal Flooding Survey

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[31] (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.

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

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

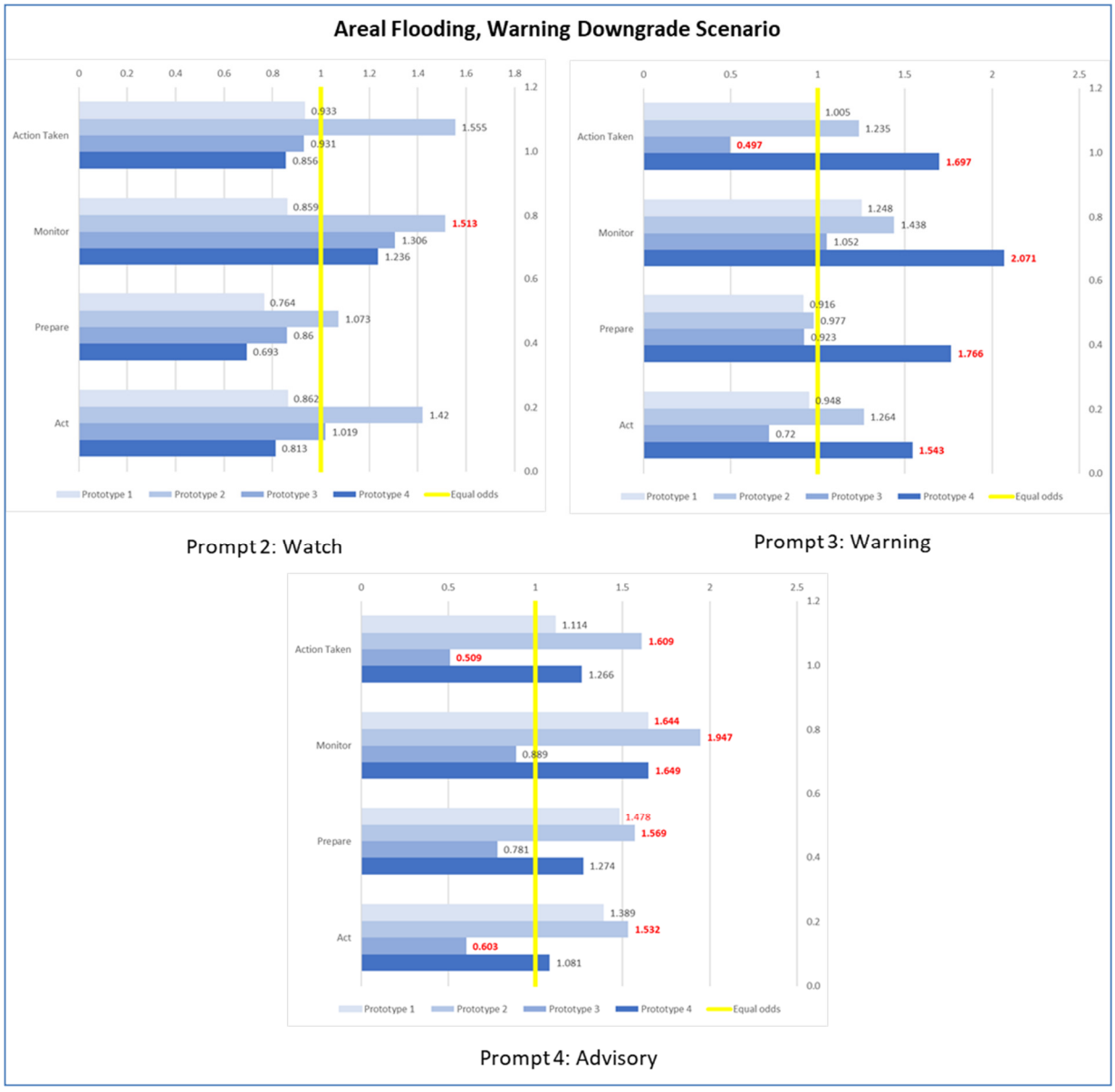

Figure 23. Graphical Depiction of Estimated Odds Ratios for Warning Downgrade Scenario: Areal Flooding Survey

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 rations 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 rations 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
Prompt 2: Watch				
Prototype 1	0.651*	0.549**	1.133	0.723
	(-1.77)	(-2.25)	(0.52)	(-1.43)
Prototype 2	1.129	0.756	1.489*	1.137
	(0.52)	(-1.06)	(1.75)	(0.58)
Prototype 3	0.825	0.513***	1.252	0.839
	(-0.81)	(-2.64)	(1.03)	(-0.77)
Prototype 4	0.822	0.762	0.990	0.809
	(-0.88)	(-0.97)	(-0.04)	(-0.91)
Prompt 3: Warning				
Prototype 1	0.975	0.924	1.175	0.875
	(-0.12)	(-0.27)	(0.75)	(-0.61)
Prototype 2	1.019	0.862	1.366	1.068
	(0.08)	(-0.55)	(1.33)	(0.29)
Prototype 3	0.535***	0.443***	0.753	0.560***
	(-2.80)	(-3.03)	(-1.36)	(-2.62)
Prototype 4	1.299	1.397	1.842***	1.762**
	(1.17)	(1.08)	(2.73)	(2.35)
Prompt 4: Emergency				
Prototype 1	1.292	1.455	1.182	1.355
	(1.19)	(1.18)	(0.81)	(1.36)
Prototype 2	2.119***	1.625	1.959***	2.659***
	(3.28)	(1.61)	(2.98)	(4.04)
Prototype 3	1.460*	1.514	1.323	1.552**
	(1.82)	(1.35)	(1.37)	(1.99)
Prototype 4	2.016***	1.353	1.845**	2.383***
	(3.09)	(0.95)	(2.52)	(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
Prompt 2: Watch				
Prototype 1	0.434***	0.467***	0.542***	0.661*
	(-2.98)	(-2.84)	(-2.59)	(-1.71)
Prototype 2	0.922	0.793	1.408	1.095
	(-0.34)	(-0.91)	(1.46)	(0.37)
Prototype 3	0.932	0.938	0.784	0.788
	(-0.30)	(-0.25)	(-1.08)	(-0.98)
Prototype 4	0.823	0.755	0.673*	0.876
	(-0.83)	(-1.19)	(-1.85)	(-0.53)
Prompt 3: Advisory				
Prototype 1	1.276	1.137	1.384	1.637**
	(1.10)	(0.50)	(1.62)	(2.38)
Prototype 2	1.276	1.197	1.284	1.705**
	(1.13)	(0.68)	(1.17)	(2.50)
Prototype 3	0.612**	0.756	0.524***	0.707*
	(-2.13)	(-1.09)	(-3.00)	(-1.67)
Prototype 4	1.634**	0.808	1.259	1.724**
	(2.29)	(-0.94)	(1.10)	(2.43)
Prompt 4: Warning				
Prototype 1	0.760	0.846	0.885	0.884
	(-1.23)	(-0.58)	(-0.59)	(-0.58)
Prototype 2	0.956	1.122	1.138	1.147
	(-0.20)	(0.42)	(0.59)	(0.62)
Prototype 3	0.670**	0.761	0.668*	0.521***
	(-1.99)	(-0.94)	(-1.95)	(-3.32)
Prototype 4	2.070***	0.700	1.166	1.490*
	(3.17)	(-1.40)	(0.69)	(1.83)

Exponentiated coefficients; z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

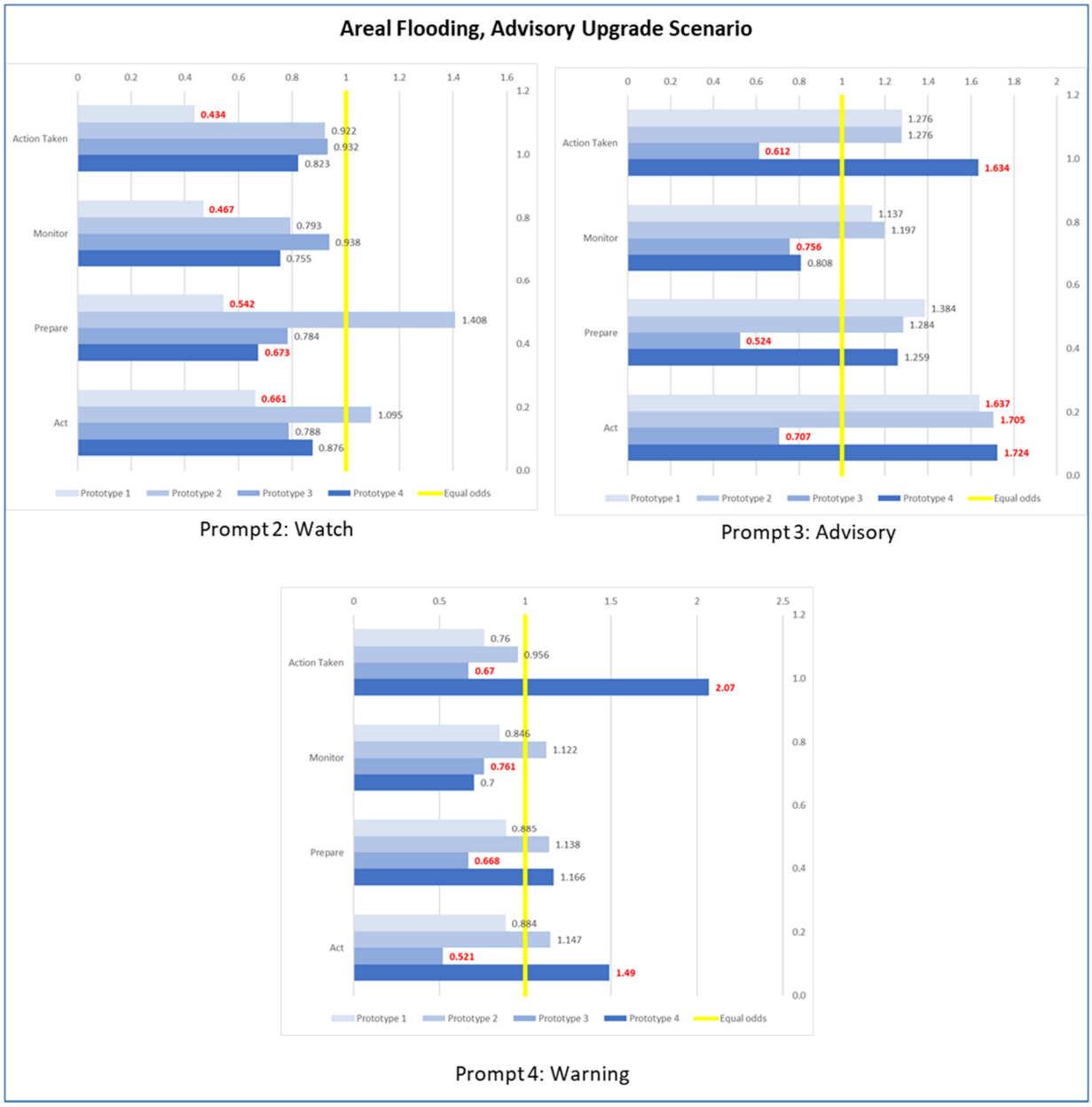

Figure 25. Graphical Depiction of Estimated Odds Ratios for Advisory Upgrade Scenario: Areal Flooding Survey

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.[32] 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.

[32] 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:

	Very negative feelings	*Rather negative feelings*	*Neither negative nor positive feelings*	*Rather positive feelings*	*Very positive feelings*
Snow storm	1	2	3	4	5
3-inch snow storm	1	2	3	4	5
12-inch snow storm	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	○	○	○	Calm ○
Displeased	○	○	○	Pleased ○
Sad	○	○	○	Happy ○
Depressed	○	○	○	Elated ○

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

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

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

	Very Unlikely				*Very Likely*
Monitor weather forecasts closely	1	2	3	4	5
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.	1	2	3	4	5
Take protective action such as canceling activities, preparing to telecommute or taking a day off from work, etc.	1	2	3	4	5

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

	Strongly disagree									*Strongly agree*
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 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:

	Very Unlikely				*Very Likely*
Monitor weather forecasts closely	1	2	3	4	5
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.	1	2	3	4	5
Take protective action such as canceling activities, preparing to telecommute or taking a day off from work, etc.	1	2	3	4	5

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

	Strongly disagree									*Strongly agree*
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 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:

	Very Unlikely				*Very Likely*
Monitor weather forecasts closely	1	2	3	4	5
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.	1	2	3	4	5
Take protective action such as canceling activities, preparing to telecommute or taking a day off from work, etc.	1	2	3	4	5

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

	Strongly disagree									*Strongly agree*
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:

	Very Unlikely				*Very Likely*
Monitor weather forecasts closely	1	2	3	4	5
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.	1	2	3	4	5
Take protective action such as canceling activities, preparing to telecommute or taking a day off from work, etc.	1	2	3	4	5

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

	Strongly disagree									*Strongly agree*
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

7. Part V - Sources

34. How closely do you follow …

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

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

Read weather in print?	Often	Sometimes	Hardly Ever	Never	No Answer
Listen to weather on the radio?	Often	Sometimes	Hardly Ever	Never	No Answer
Watch local television weather?	Often	Sometimes	Hardly Ever	Never	No Answer
Watch national evening network television weather?	Often	Sometimes	Hardly Ever	Never	No Answer
Watch cable television weather (such as The Weather Channel, WeatherNation, or AccuWeather)?	Often	Sometimes	Hardly Ever	Never	No Answer
Get weather from a social networking site (such as Facebook or Twitter)?	Often	Sometimes	Hardly Ever	Never	No Answer
Get weather from a website or application?	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	• Snow storm • 3-inch snow storm • 12-inch snow storm
Thunderstorms	• Thunderstorm • Thunderstorm with large hail • Thunderstorm with damaging winds
Tornadoes	• 65 - 85 mph (Tornado) • 111 - 135 mph (Strong Tornado) • 166 - 200 mph (Violent Tornado)
Coastal Flooding	• Coastal flood • High tide combined with a storm • Storm surge
Flash Flooding	• Heavy rain event • Flood • Flash flood
Areal Flooding	• Heavy rain event • Flood • River flood

Question 15

Survey	Customized Information
Winter Weather Mild	Same as winter cold
Thunderstorms	• My car handles wind and rain very well. • Driving in a thunderstorm makes me nervous. • I have Homeowner's Insurance or Renter's Insurance in case wind, rain, and/or hail damage my home. • I have access to a storm shelter or basement. • My job allows me to telecommute during bad weather. • As an essential employee, I am required to show up for work no matter the weather. • Thunderstorms influence me to change my schedule. • I enjoy staying inside during a thunderstorm (e.g., reading a book, watching a movie, sleeping). • Thunderstorms make me anxious and fearful. • The sounds during a thunderstorm are soothing (e.g., rumbling thunder, falling rain).

Survey	Customized Information
Tornadoes	• As an essential employee, I am required to show up for work no matter the weather. • I feel safe in my home during a tornado. • Potential tornadoes influence me to change my schedule. • I have a plan of action for my family when tornadoes are forecasted. • My job allows me to telecommute during bad weather. • I have access to a tornado shelter or basement. • Potential tornadoes make me anxious and fearful. • I have Homeowner's Insurance or Renter's Insurance in case a tornado damages my home.
Coastal Flooding	• My car handles wind and rain very well. • Driving in heavy rain makes me nervous. • While driving in heavy rain, I would take an alternate route to avoid low-lying areas. • I have Homeowner's Insurance or Renter's Insurance in case flooding damages my home. • My house has a second (or upper floor) that I can access easily. • My job allows me to telecommute during bad weather. • As an essential employee, I am required to show up for work no matter the weather. • Potential flooding influences me to change my schedule. • Hearing about potential flooding makes me anxious and fearful. • I would evacuate my home when instructed by local authorities. • I feel it's important to prepare my home for an impending flood.
Flash Flooding	• My car handles wind and rain very well. • Driving in heavy rain makes me nervous. • While driving in heavy rain, I would take an alternate route to avoid low-lying areas. • I have Homeowner's Insurance or Renter's Insurance in case flooding damages my home. • My house has a second (or upper floor) that I can access easily. • My job allows me to telecommute during bad weather. • As an essential employee, I am required to show up for work no matter the weather. • Potential flooding influences me to change my schedule. • Hearing about potential flooding makes me anxious and fearful. • I would evacuate my home when instructed by local authorities. • I feel it's important to prepare my home for an impending flood.
Areal Flooding	• My car handles wind and rain very well. • Driving in heavy rain makes me nervous. • While driving in heavy rain, I would take an alternate route to avoid low-lying areas. • I have Homeowner's Insurance or Renter's Insurance in case flooding damages my home. • My house has a second (or upper floor) that I can access easily. • My job allows me to telecommute during bad weather. • As an essential employee, I am required to show up for work no matter the weather. • Potential flooding influences me to change my schedule. • Hearing about potential flooding makes me anxious and fearful. • I would evacuate my home when instructed by local authorities. • I feel it's important to prepare my home for an impending flood.

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	• Severe Thunderstorm Watch • Significant Weather Advisory • Severe Thunderstorm Warning
	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	• Tornado Watch • Tornado Warning • Tornado Emergency
	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	• Coastal Flood Watch • Coastal Flood Advisory • Coastal Flood Warning
	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	• Flood Watch • Flash Flood Warning • Flash Flood Emergency
	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	• Flood Watch • Flood Advisory • Flood Warning
	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	• Nothing – I would continue my current activities as usual • Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc. • 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 • Take some action – I would cancel or move outdoor activities • Take protective action – I would go indoors and stay away from windows, pull over if in a car, etc.
Tornadoes	• Nothing – I would continue my current activities as usual • Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc. • 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. • Take some action – I would cancel or move outdoor activities. • Take protective action – I would seek shelter in a safe place, avoiding windows.
Coastal Flooding	• Nothing – I would continue my current activities as usual. • Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc. • 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. • Get prepared to leave – I would get ready to leave the area on short notice, such as by gathering essential papers and supplies. • Take protective action – I would leave the area immediately if it is safe to do so, avoiding bridges and roads that tend to flood.
Flash Flooding	• Nothing – I would continue driving along the route I had planned. • Monitor – I would listen to the radio or have a passenger monitor weather information on their mobile device. • Take action – I would take an alternate route, avoiding bridges and roads that tend to flood. • Take protective action -- I would stop driving, seek a safe place, and try to get more information about which routes are safe to travel.
Areal Flooding	• Nothing – I would continue my current activities as usual. • Monitor – I would monitor weather information sources such as TV news, websites, NOAA weather radio, etc. • Get prepared at home – I would start preparing for potential flooding by doing things like putting down sandbags and filling my car with fuel. • Get prepared to leave – I would get ready to leave the area on short notice, such as by gathering essential papers and supplies. • Take protective action – I would leave the area immediately if it is safe to do so, avoiding bridges and roads that tend to flood.

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

Survey	Customized Responses
Winter Weather Mild	Same as winter cold
Thunderstorms	• Monitor weather forecasts closely • Prepare by taking in loose outdoor items, checking that flashlights work, and reviewing safety information with those in my home • Take protective action, such as canceling or moving outdoor activities or seeking shelter
Tornadoes	• Monitor weather forecasts closely • Prepare by bringing in loose items, checking emergency kit, making sure my shelter is ready, and/or reviewing my family communication plan • Take protective action, such as canceling or moving outdoor activities or seeking shelter
Coastal Flooding	• Monitor weather forecasts closely • Prepare by moving in outdoor furniture, filling my car with fuel and gathering essential papers and supplies to leave on short notice • Take protective action, such as leaving the area immediately if it is safe to do so
Flash Flooding	• Monitor weather forecasts closely • Take action by using an alternate route to avoid bridges and roads that tend to flood • Take protective action, such as stopping the car, seeking a safe place, and searching for a safer route to travel
Areal Flooding	• Monitor weather forecasts closely • Prepare by putting down sandbags, filling my car with fuel and gathering essential papers and supplies to leave on short notice • Take protective action, such as leaving the area immediately if it is safe to do so

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.