NOAA/SEES Supplemental Report: Social, Behavioral and Economic Science Data in the National Weather Service

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Executive Summary

The National Weather Service's (NWS) mission is to "provide weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy" (National Weather Service [NWS], n.d.a). As part of a recent modernization program, emphasis was placed on improving physical data collection, forecasts, and computer processing. However, despite these improvements in the science of detection and prediction, we continue to see weather-related property damage, injury, and deaths. It is through these events and the concerted efforts of a number of leaders and communities that the National Oceanographic and Atmospheric Administration (NOAA) and the NWS have begun to seriously consider the importance of integrating Social, Behavioral, and Economic (SBE) Sciences into the design and communication of NWS forecast and warning information. SBE science data is needed to continuously improve scientists' understanding of the way the public understands, utilizes, and responds to NWS forecasts, products, and services. Despite this identified need, currently, the NWS does not collect and maintain a large array of SBE science data that would allow the organization to make science-informed, strategic decisions about the human dimensions of perception and response to weather information.

This report evaluates current NWS and NOAA programs that collect some form of SBE science data. Of the four programs reviewed, just one meets the standards of science within any specified discipline of SBE sciences. However, with some adjustments in methodology, the NWS can strengthen these existing data collection programs so that they can begin to provide quality SBE science insights that are relevant to the agency.

National Weather Service Assessments

After high-impact weather events, the NOAA Administrator can charter a group of experts to assess various components of the NWS or applicable NOAA agencies during the event. Each assessment consists of a different team of experts and focuses on different topics depending on the event and the needs of NWS. Historically, SBE topics have received little focus, although there has been a larger push over the last decade including limited inclusion of SBE scientists. Over the last 18 years of NWS service assessments, there has been great improvement in the overall process. A common format has been established that provides continuity. Team members are more diverse in terms of disciplines and expertise. Many different topics have been explored. Although inclusion of SBE science has increased, more collaboration is needed. We make the following recommendations to improve the quality of SBE insights gained from the SA process:

1. Adopt a multiple case study design to provide easier comparisons between SAs, and to assess NWS progress and needed improvements
2. Set standards of when to have a SA and conduct them more frequently.
3. Maintain consistency among SA operations and create depth by including more SBE scientists from different disciplines.
4. Include more emphasis on SBE topics through more variety and breadth in SBE topics.
5. Provide a detailed explanation about the methods used to collect data in the final reports, while also broadening the types of methods used during data collection.
6. Use additional sampling methods to better identify relevant stakeholders and gain more detailed information.

7. Include a more detailed, standard data analysis section in the final reports.

NWS Customer Satisfaction Survey

Since 2003, NWS has conducted a quarterly Customer Satisfaction Survey (CSS) to collect feedback on NWS products and services. In addition to standard questions on information access and emergency plans, the CSS addresses a different hazard and NWS service each quarter. Data is collected from two NWS customer segments: people who visit NWS websites (Pop-Up Sample); and the general public who access NWS information in other ways (Internet Panel Sample). The CSS produces a Customer Satisfaction Index which is tracked as one of the Government Performance and Results Act (GPRA) metrics. The Customer Satisfaction Index is also used to compare NWS to other federal agencies. CSS is valuable as an external metric, as it is based in SBE science and methods in organizational performance measurement. In order to improve the usefulness of the survey for internal NWS strategy, we recommend the following:

1. Continue NWS' development of a version of the CSS for NWS IDSS partners that incorporates all the ways (both digital and face-to-face) that IDSS partners interact with NWS forecast offices.
2. Focus all data collection efforts for the current CSS on the Internet Panel sample as this sample represents the people that the NWS serves and the multiple ways people access NWS information. The size of the Internet Panel sample should be increased to enable sub-national analyses and potential linkages to NWS warning performance metrics.
3. Increase the value of this data collection effort by conducting additional qualitative analyses of the open-ended responses on how NWS can improve its products and services.
4. Add survey questions to the CSS that assess the accuracy of customer perceptions and capture actual customer behaviors to enable high-level analysis of protective action decision-making.

Quick Response Survey

NWS created a series of Quick Response Surveys (QRS) that could be deployed following significant weather hazards. The QSR was created to gather forecast office-level information on perceptions, decision-making and behavior by the public in response to specific NWS warnings and other information. The QRS was complementary to other data collection efforts; however, the QRS was rarely used because of the burden it places on forecast offices often underequipped to manage the data collection and analysis process. The survey is no longer supported by the NWS. However, QRS could be an important tool for gathering information for forecast offices and their IDSS partners. Therefore we recommend the following:

1. Conduct a pilot project to modify the QRS to make it scientifically rigorous and organizationally feasible. The goal would be to re-introduce the QRS across NWS.
2. Purchase and implement a survey software system.
3. Standardize the QRS process including survey questions, triggers for data collection, population sampling, and standardized analyses and reports.

4. Link QRS to other NWS SBE data collection efforts such as the Service Assessments, Customer Satisfaction Surveys, Storm Events data, and warning performance data by creating common data fields among these data sources.

National Centers for Environmental Information (NCEI) Storm Events Database

NOAA's National Centers for Environmental Information (NCEI), formerly the National Climatic Data Center (NCDC), provides a clearinghouse of weather and climate data from January 1950 to the current year. The Storm Events dataset includes storm occurrences, paths, deaths, circumstances of deaths, injuries, and property damage which is entered by the NWS after significant weather phenomena occurs in the U.S. The Storm Events Database is the most comprehensive dataset for U.S. weather events and impacts and is widely used by SBE researchers, however, the database is not without bias. The dataset has been used widely for SBE researchers despite not hosting SBE data directly. Recommendations to improve the usefulness of the database for SBE research include:

1. Include information on NWS warning performance (lead time) within the Storm Events database.
2. Standardize loss data collection, documentation, accessibility, and dissemination across the agency to increase reliability of results.
3. Link this data to Storms Events and other databases in order to relate public perception and behavior and event outcomes.

General Recommendations

Over the last several years, the National Weather Service worked to improve Social, Behavioral, and Economic data collection through their ongoing practices. This report is designed to help move their progress to the next level by focusing directly on how to strengthen SBE data collection in the work they are already doing. Through more developed methods based on SBE research standards, data collection can help further the understanding of SBE interaction with the weather enterprise. To conclude, this report, discusses overall findings about how the NWS can make small but impactful system wide changes that will improve SBE data collection throughout all of their efforts.

- **Collect SBE data as a primary focus in addition to physical meteorological data.**
- **Use SBE methodological approaches to data collection.**
- **Standardized some SBE data collection processes to allow for easy comparisons over time.**

These three overall recommendations are not actions NWS should take to improve a specific operation, but rather important strategic objectives that will promote a shift in mindset for the entire organization. By recognizing the importance of SBE research and data collection, the NWS can make progress towards understanding how their customers utilize their products. Small but wide-spread structured changes to the agency will promote the benefits, importance, and legitimacy of SBE research and make the data collection and analysis process a priority rather than an extra initiative. This shift is needed at all levels of the agency to realize the potential for SBE research within the National Weather Service.

INTRODUCTION

The National Weather Service (NWS), a federal agency that is part of the National Oceanic and Atmospheric Administration (NOAA), is responsible for overseeing weather, water, and climate information for the United States. Their mission is to "provide weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy" (National Weather Service [NWS], n.d.a, p. 4). Originally chartered in 1890 as the United States Weather Bureau, the NWS has continued to adapt to the needs to the public and the country. Such changes have been important for the agency and have improved its ability to meet the mandate laid out by the American people.

The most dramatic shifts for the NWS occurred between 1989 and 2000, when the U.S. dedicated 4.5 billion dollars on a "Modernization and Associated Restructuring" process that invested in new technology to improve operations. (National Research Council, 2012). As part of this process, emphasis was placed on improving physical data collection efforts, including in situ (instruments) and remote sensing (radar and satellite) technologies, as well as computer processing. The intent was to use sensing technology and models supported by advances in computing and information technology to measure and predict the weather more accurately. The result of this significant investment in the modernization of the agency was improvement in observations, forecasts, and other services. The assumption was that these advances were necessary to allow the NWS to better meet their mission to protect people, property, and economic prosperity. In addition, the federally funded infrastructure and data streams have enabled the growth of a robust Weather Enterprise where a combined set of public and private actors interpret this data, analyze it, develop competing models and then deliver the results to decision makers, including members of the public. While tensions exist among the NWS, private sector, and other public actors, most agree that these investments are paying off and that the ability to detect and forecast weather has improved markedly.

However, despite these improvements in the science of detection and prediction, we continue to see property damage, injury, and even deaths in events where scientifically accurate information was available from a physical and technical science perspective. It is through these events and the concerted efforts of a number of thought leaders over the past three decades that NOAA and the NWS have begun to seriously consider the importance of integrating Social, Behavioral, and Economic (SBE) Sciences into the design and communication of forecast information. A true and complete integration of SBE sciences into the NWS may be the next paradigm shift in weather forecasting, a shift with the potential to produce improvements in process and approach not seen since modernization.

Such a change, however, will not be easy, yet it is important tangible steps be taken. Given this increasing interest in integrating SBE sciences in the weather enterprise, a diverse community of physical, social, behavioral scientist, forecasters, engineers, administrators, and consultants have been working towards that end. Progress has been slow, but great gains have been made. This report provides insights into how several modest improvements, if implemented, would increase scientific understanding of human behaviors relative to the NWS mission. Specifically, we focus on opportunities to improve data collection methods within several existing NWS efforts. Adopting these improvements would allow the agency to leverage conventions in SBE science methodology to bring added rigor to the collection and analysis of SBE science data, thus improving the ability of NWS to fulfill its mission. Implementing these changes is an important first step.

Why We Need Social, Behavioral, and Economic Sciences in the Weather Enterprise

Members of the weather community have been discussing the importance of understanding human behavior at least since the first NWS Service Assessment of *The Tornadoes in Dallas, TX, on April 2, 1957*, where the authors noted the difficulties associated with interviewing those affected by the tornado and the importance of understanding their perceptions (U.S. Department of Commerce, 1960). Over the 60 years since, awareness of the benefits from including SBE science research have grown increasingly apparent, including the need for investment. It is commonly recognized that theories and knowledge from SBE science disciplines can offer insight to understanding how communities, weather, and climate interact (American Meteorological Society [AMS], 2014). The collaboration of SBE scientists and atmospheric scientists helps develop new ideas and approaches as well as more useful scientific, technical, and applied information from a variety of perspectives (AMS, 2014). Additionally, incorporating SBE science research improves the accuracy and consistency of disaster loss estimates and improves user-friendliness of weather products (National Oceanic and Atmospheric Administration [NOAA], 2015).

Over time, the NWS and weather community's posture toward SBE science has evolved and a series of programs along the way have been developed to champion understanding of public perceptions, impacts of weather, and how to utilize those understandings to improve forecasting, warnings, and communication with communities. Many of these initiatives were conceptualized and managed by a small contingency of dedicated scientists from within and outside the agency who have worked tirelessly in a severely resource constrained environment. Those pushing for SBE integration spanned several disciplines who all saw the benefits their studies could have within the weather enterprise. As the benefits of SBE science integration grew, so did opportunities for funding (National Academies of Sciences, Engineering, and Medicine [NASEM], 2018). With the increase in funding, a better understanding of society interactions with the weather enterprise also grew, strengthening the desire for additional integration.

A recent study conducted by the National Academies of Sciences, Engineering, and Medicine, (2018) highlights many of the previous SBE integration initiatives. The report also calls for expansion and continued advancement of SBE sciences within the weather enterprise. The authors encourage additional partnerships between the public and private sectors, a focus on filling literature gaps, and strengthening of capacity and leadership within NWS.

The need for SBE sciences within NOAA and NWS has also been reinforced by new directives created by the Weather Research and Forecasting Innovation Act of 2017. This act mandates that NOAA maintain projects to improve forecasting and data collection, especially in the case of tornadoes and hurricanes. There is also a call for additional focus on improving forecasting, building partnerships, and understanding the needs of various communities. Meeting these goals requires SBE science data.

NWS has embraced the importance of building these insights within the agency through a goal articulated in the strategic plan for 2019 to 2022 (NWS, n.d.a) by committing to "Reduce the impacts of weather, water, and climate events by transforming the way people receive,

understand, and act on information. (p. 5)" In particular, the following sub-objectives demand additional work:

- 1.3 Increase understanding of society's needs and provide targeted outreach and education to ensure public awareness, understanding, preparedness, and responsiveness for extreme events. (p. 7)
- 1.5 Integrate social, behavioral, and economic sciences to simplify the communication of information and improve the understanding and utility of forecasts and warnings. (p.8)

To help support these objectives, the NWS has hired a limited number of SBE scientists, partnered with private and public sector organizations, and issued grants to academics conducting related research. However, the scope and depth of information needed to meet these goals is still limited. Further, much of the information is significantly influenced by the important but sometimes divergent needs of those outside the agency. In order to fully integrate SBE sciences into the NWS, strong leadership, funding, and support is needed. Only by making SBE science data a priority will the NWS begin to meet the needs that have been identified.

Social, Behavior, and Economic Data Collection

NOAA and NWS are dedicated to the "protection of life and property and enhancement of the national economy" (NWS, n.d.a, p. 4). This goal can best serve the general public with an emphasis on incorporating SBE sciences into the weather enterprise. Promoting an understanding of the SBE sciences within the weather enterprise directly increases the impact of NOAA (NOAA, 2015). To see how NOAA and NWS directly impact society, there is a need for more focus on collecting data on these interactions. NWS spends a significant portion of their budget on collecting, processing, and storing data about weather conditions (NASEM, 2018). This data is what allows meteorologists to run forecast models and continuously strengthen their understanding of the physical environment and improve weather forecasts. Improving forecasts for the public directly supports their mission.

In the same way, SBE science data is needed to continuously improve scientists' understanding of the way the public utilizes and understands NWS forecasts and other products and how the agency operates. By collecting, analyzing, and maintaining data within the scope of the work that NWS does, a better understanding can be gleaned about how their work impacts the public. Just as it is important to keep the pulse on the current weather conditions all across the country, it is vital to keep a pulse on the publics' needs and perceptions about the NWS. Since forecasts, warnings, and other products need to be interpreted by people that are not atmospheric scientists, it is paramount this information is conveyed in ways that are understandable if the agency is to meet its mandate. NWS employees can only fulfill their mission by ensuring stakeholders, including the public, can understand their products and further, that the products that are developed fill an actual need someone has. This is only possible by collecting data, through various forms, focused on building that understanding. Therefore, collecting and using SBE data is critical to not only the operation of the NWS, but also to carrying out their Congressional mandated mission. Collecting SBE data should be considered a high priority and seen as an important effort that occurs in tandem with environmental data collection.

Despite this need, currently, the NWS does not collect and maintain a large array of SBE science data. In many cases, if this type of work is warranted, a contractor will be hired specifically for that project (NASEM, 2018). While it is important that the NWS recognizes that well-trained discipline experts should lead this type of work, it does limit the scope and understanding of the NWS. Contractors may only have specific data to work with for their assigned project. They cannot maintain a holistic approach to trends across several different data sources. Further, they will not forge the types of integration needed to ensure data inform the agency's mission. One option is to focus on collecting and analyzing data in-house, with agency SBE science experts. An alternative interim step would be for a trained core staff of SBE scientists could serve as the link between agency needs and the broader capabilities of the weather enterprise. Such changes are needed to allow the NWS to realize the potential benefits of this type of data.

Report Approach and Overview

This report focuses primarily on various methods the NWS and NOAA uses to collect human subjects, or SBE science data. Much like the physical sciences, such as meteorology, climatology, and hydrology, the SBE science fields such as sociology, psychology, and communications each have their own methods for collecting and analyzing data. While NWS currently engages in several quasi-SBE science efforts, our review suggests that, to a large extent, these do not meet the standards of science within any specified discipline of SBE sciences. With some adjustments in methodology, the NWS can strengthen their data collection efforts. As a result, this report analyzes several different NWS and NOAA initiatives and provides insight on how they could be improved to provide quality SBE science insights that are relevant to the agency. The suggestions represent one path forward, but certainly not the only path forward. We include discussions of the following:

1. National Weather Service Assessments – After high-impact weather events, the NOAA Administrator can charter a group of experts to assess various components of NWS or other applicable NOAA agencies during the event. Over 100 individual Service Assessments have been competed on various meteorological and geophysical events since the 1950's. Each assessment consists of a different team of experts and focuses on different topics depending on the event and the needs of NWS. Historically, SBE topics have received little focus, although there has been a larger push over the last decade including limited inclusion of SBE scientists.

2. NWS Customer Satisfaction Survey – Since 2003, NWS has conducted Customer Satisfaction Surveys (CSS) "to help the NWS achieve its strategic and tactical goals by providing feedback on NWS products, services, and overall customer satisfaction as well as making recommendations for future focus" (CFI Group, 2013a, p. 8). The CSS produces a quarterly Customer Satisfaction Index which is tracked as one of the Government Performance and Results Act (GPRA) metrics.

3. Quick Response Survey – NWS has created a series of Quick Response Surveys (QRS) that can be deployed following significant weather hazards. The QSR is complementary to other existing data collection efforts and collects unique local level information on

decision making and behavior by the public in response to specific NWS warnings and other information. The QRS is an important, but very underutilized data collection tool for SBE research and is no longer supported by the NWS.

4. NOAA's National Centers for Environmental Information (NCEI) - NCEI, formerly the National Climatic Data Center (NCDC), provides a clearinghouse of weather and climate data from January 1950 to the current year. The Storm Events dataset includes storm occurrences, paths, deaths, circumstances of deaths, injuries, and property damage which is entered by the NWS after significant weather phenomena occurs in the U.S. The Storm Events Database is the most comprehensive dataset for U.S. weather events and impacts and is widely used by SBE researchers, however, the database is not without bias.

Since each effort is different, the specific methods will be discussed in more depth within each chapter of this report. Each chapter will include the methods used for document analysis, specific findings and recommendations, and a summary of salient observations. The final chapter of this report summarizes findings across all four sections and provide concrete recommendations for the NWS to immediately start implementing practices that are more in-line with SBE science methods and techniques.

CHAPTER 1: NATIONAL WEATHER SERVICE ASSESSMENTS

Introduction

Since the 1960's, the NWS has published Service Assessment (SA) reports following significant weather events. These assessments evaluate how the NWS contributed to a better understanding, prediction, and communication of a specific weather event. In addition, these reports serve to assess the operations of the NWS and make recommendations for further improvements. There have been 101 assessments over the last nine decades at the time of this report. This section of the report focuses on providing analysis of SAs from 2000 to 2018. More specifically, it explores the often-stated suggestion that these reports are an important source of SBE science data for NWS operations. The discussion includes an overview of the stated purpose of SA, a discussion of the potential for SA reports to provide deeper insights by adopting SBE science methods, overview, critique, and recommendations for improvements in the current SA process, and conclusions and a summary of recommendations for these efforts.

Service Assessment Process Overview

According to the Service Assessment website, "NWS conducts Service Assessments to evaluate its performance after significant hydrometeorological, oceanographic, or geological events" (NWS, n.d.b). The primary purpose of the SA is to review how the NWS offices and products worked during the identified event. The process begins after a weather-related event has had a large impact on the public or NWS partners. Once the NWS Administrator has initiated a SA, they then select team members to travel to the affected area and collect data on the event. Team members are generally a mix of NWS employees and other experts depending on the type of weather event and the desired objectives of the assessment. The team, along with the Administrator, identify topics they wish to better understand from the event. The topics include forecast accuracy, information dissemination, social impacts, and technical issues, to name a few.

The team then collects data in several different areas depending on the needs of the SA. The majority of data collection includes qualitative conversations and interviews with stakeholders. Teams also collect quantitative data when it is appropriate. This data is generally included in tables or appendixes within the SA report. With this information, the team complies a report that is reviewed by many members of the NWS and then published on their website. The report format has changed over the years but has included the same basic components including an overview of a meteorological analysis of the event, review of NWS office operations and products, such as watches and warnings, during the event, and a review of NWS interactions with partners, including, but not limited to, emergency managers, media, broadcast meteorologists, and members of the public. They identify facts of the event, best practices that were identified, findings for areas of improvement, and recommendations for future NWS practice. Several reports reflect on previous recommendations to show how progress has been made. Overall, each document is a standalone report of a particular event designed to help improve the operations of the NWS.

The SBE Science Potential of Service Assessments

Since each SA is conducted after a specific weather event, they can be generally thought of as "case studies" of NWS operations. Each event is a specific example of the operations for the specific case. Team members conduct interviews of NWS staff and other partners including emergency managers and sometimes the public focused on the event. The team then analyzes how well the NWS offices operated in relation to their policies and best practices. The team reports any issues that arose and makes recommendations for future policy changes, operational changes, and forecasting or communication considerations. Each best practice, finding, and recommendation is labeled for easy identification and use.

From a SBE science context, each SA would be considered a "case example" rather than a "case study" as previously mentioned. A case example is generally used to illustrate an example of some phenomenon in the real world. SAs are exactly that. Each assessment tells the story of a specific weather event and what the NWS did during that event. A true scientific case study, in contrast, is much more rigorous and requires significantly more in-depth study of an event (Yin, 2009). Case studies explore the context around the event and how this context impacted outcomes (Yin, 2009). They can also be used to evaluate programs, test theories of regular occurrences, and compare unique events.

This "single case study" procedure provides the benefit of each event being looked at individually, however, it also has some disadvantages. By treating each event as separately, NWS loses the ability to compare events and track how the NWS has changed and improved. There is some mention in various SAs of previous findings and recommendations, but they are few and far between. There is no system, at least publicly available system, for tracking findings and recommendations from each SA or summarizing overall themes between cases. By using a modified technique, such as a multi-case study approach, there is an opportunity to utilize the aggregate data over many different events to drive policy and procedural changes.

A multiple case study design allows researchers to explore individual case context while also analyzing themes across all of the cases (Yin, 2009). Figure 1-1 contrasts two different types of multiple-case designs with single-case designs. Assessments would be best suited for the embedded multiple-case design for several reasons. First, since each event can be unique from other events, this design allows for the specific context to be fully understood. Secondly, it allows for different units of analysis that may differ between cases. A future section will discuss previous units of analysis, or topics of study within each SA. Generally, there are multiple topics within each SA that the assessment team studies. Some topics are found in almost all of the SAs, such as forecast verification, while others are specific to certain types of events, for example tsunami warning systems. Each case will be able to stand as its own study of the event. The multiple-case component would then allow for researchers to study the similarities and differences between the different cases. The topics, or units of analysis, that are common throughout the different cases can be

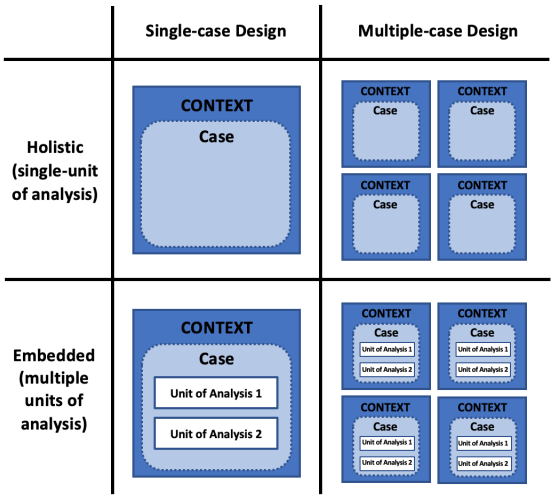


Figure 1-1: Case study design. (Adapted from Yin, 2012)

assessed and generalized across NWS operations in extreme events overall. This will provide NWS with a more holistic approach to assessing their impact and performance for extreme weather events.

Recommendation 1-1: The NWS should set up a more intentional method for conducting SAs that treats them as part of a multi-case "study". This will allow for easier comparisons between the case studies and set up a method for a multiple case study design. Such an approach would better specify when to field teams and it would also give clear guidance on what topics should be addressed to allow comparison while leaving space for unique case specific concerns to also be explored. For example, every five years, a team can be assembled to review the findings and recommendations from previous SAs. The team can assess if recommendations are being followed and implemented, adjust the deployment criteria, adjust the data collection instruments that are regularly used based on findings and needs, or other needed adjustments. These individual assessments should be part of a longitudinal approach to help improve NWS operations. It will also serve as a vital data collection source to provide SBE data. The following section reviews how SAs have been structured in the past, and outlines steps that should be taken to transform the "case example" format into a scientific multi-case study approach to data collection and analysis.

Overview, Critique, and Recommendations for the Service Assessment Process

This section reviews the data collection process as described in SA reports. For each of the focus areas defined below, we review how the NWS has handled the specific area in past SA reports, a discussion of benefits and limitations of these methods, and recommendations for improvements, from a SBE science perspective. Our goal is to make recommendations for the NWS to improve their SBE science data collection process in future SAs to improve the understanding of societal impacts from weather events. We have identified five decisions that are necessary to make when initiating a SA that are discussed in this section: 1) When to initiate a SA, 2) Deciding who to send, 3) Deciding what topics to focus on, 4) Deciding how to collect information, 5) Deciding who to talk to, and 5) Making sense of the information. Each component impacts other decisions and the overall outcome of the assessment. They must be considered together to provide the best possible understanding of each event, in addition to a larger-scale SA process.

When to initiate a SA (Case Selection)

Current Practice

There are two types of "Service Assessments": national and local. Local Weather Forecast Offices (WFO) have the option to assess events through their own office, however they are not provided the same resources as national SAs. This report focuses on the national SA reports. According to NWS policy, the Assistant Administrator for Weather Services determines when to conduct a SA. The policy states:

"*Assessments may be initiated when one or more of the following criteria are met:*

- *Major economic impact on a large area or population*
- *Multiple fatalities or numerous serious injuries*
- *Extensive national public interest or media coverage*
- *Unusual level of attention to NWS performance"* (NWS, n.d.b)

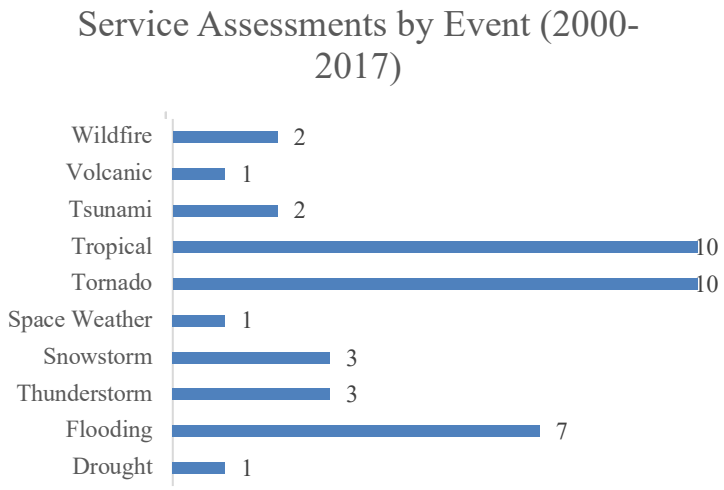


Figure 1-2: Service Assessments by Event (2000-2017)

For each SA, the NWS administrator and personnel identify specific goals for the team and the report. The goals generally depend on the type of event and the impacts the event had on the economy, society, or the meteorological community. As part of our review of the service assessments as outlined above, we explored the major themes within the reports. Below we provide some insight into their focus. Those insights center on the type of hazard/event that motivated the assessment and the distribution over time.

Between 2000 and 2017, there were 40 SAs completed. As shown in Figure 1-2, the assessments have reviewed the following: tropical systems (10), tornadoes (10), flooding (7), severe thunderstorms (3), snowstorms (3), wildfires (2), tsunamis (2), volcanic activity, drought, and space weather. Most cases are directly under the purview of the NWS, while others are more general, such as drought, volcanic activity, tsunamis, and space weather. In all cases, the NWS or some component of their parent organization, the National Oceanic and Atmospheric Administration (NOAA), provided services for the public or private organizations in these events.

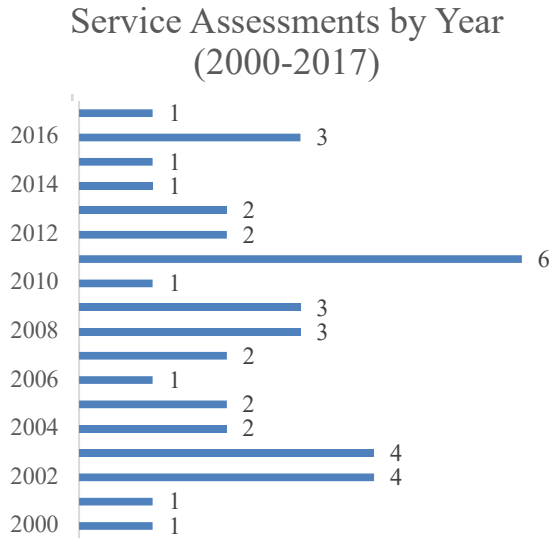


Figure 1-3: Service Assessments by Year (2000-2017)

SA frequency has varied by year but has been fairly consistent, as seen in Figure 1-3. There was at least one SA each year between 2000 and 2017. On average, there were two assessments per year with a few years that had more. The year with the most SA, 2011, had six reports, two tornadoes, two flooding, and two tropical events. The distribution of SA by month shows that there tend to be more during the late spring to early fall (Figure 1-4). Since the majority of SAs have been focused on tropical, tornado, and flooding events, which typically occur within these seasons, this distribution seems reasonable. Surprisingly, there have been no events between 2000 and 2017 that occurred in July. Every other month is represented by at least one event. Three events covered a season (California Drought 2014, Spring 2011 Middle & Lower Mississippi River

Valley Floods, Northern Idaho and Western Montana Summer 2000 Wildfires) and are not included in Figure 1-4.

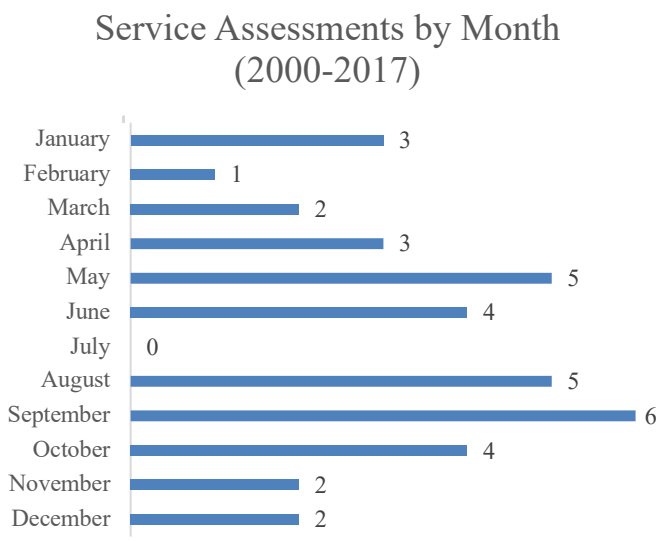


Figure 1-4: Service Assessments by Month (2000-2017)

Recommendations

The overall breadth of SA events demonstrates the NWS is interested in understanding its performance across all areas of their responsibility. They have mostly reviewed hazards that the NWS is directly responsible to forecast and warn communities and other hazards where they have provided direct support to other agencies, such as space weather. Not all impactful weather events are studied though the SA process. Generally, only events that have high media focus, cost many lives, or have profound impacts are worthy. In other words, SAs are focused on outlier events. This process, while cost effective and reasonable, does introduce some limitations.

Recommendation 1-2a: There should be a more standard method for determining when to conduct a SA. While it is good to have some flexibility in determining when a SA should be conducted depending on the type and impacts of an event, not having a set standard can cause delays in response. The extra time needed to determine if a SA is warranted may result in a decrease in the availability of data collection. For example, in the case of Super Tuesday Tornado Outbreak of February 5-6, 2008, by the time the assessment team had visited the area, homeowners whose homes were destroyed were no longer in the area and could not be part of the SA data collection efforts. By developing a set standard or decision-making model for SA initiation, teams can deploy to impacted areas faster and recover more perishable data. A standard may allow administrators to assess if an expected event, especially synoptic scale events such as hurricanes, is likely to warrant a SA. If so, a preliminary list of team members can be created and notified. This could allow for faster response to the impacted area.

Recommendation 1-2b: If looking at SA as a way to collect SBE data as a multiple-case study methodology, it is important to have consistent data sources. By conducting more SAs more frequently and on different types of events, the NWS can better analyze how their work influences societal impacts. Based on the temporal distribution, it also seems SAs are happening less frequently since 2011. The NWS should review the resources needed to conduct SAs and, if at all possible, increase the frequency of data collection. This can be justified as a method to continuously assess and improve products and service to the nation.

Who to send (Team Composition)

Current Practice

This section reviews the composition of the SA team that is selected to conduct the SA. Team members are listed, along with their professional affiliation, in each SA report, with one exception (California Drought 2014). When a SA is initiated, various experts are chosen to serve on the assessment team depending on the specific objectives for the SA. Generally, members are identified from anywhere in the United States and are not native to the region of the event. It seems this is to provide various perspectives from those who are not intimately knowledgeable about the event the team is reviewing. On average, there are nine team members, although the range has varied from three to 18, depending on the type of event. There does not seem to be a desired number of team members, however it does seem that events that have a higher impact have more team members. For example, the largest team was for Hurricane Katrina (18), and the smallest team reviewed a thunderstorm that popped up over Baltimore Inner Harbor (3).

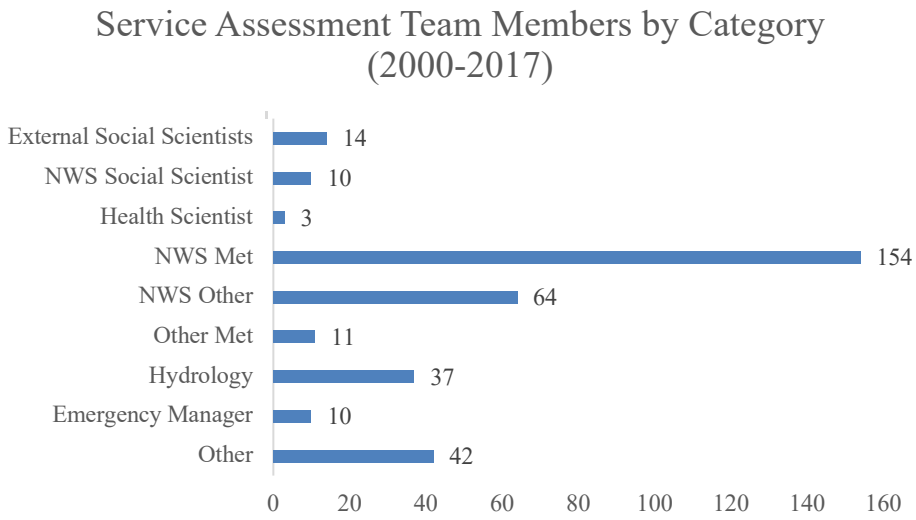


Figure 1-5: Service Assessment Team Members by Category (2000-2017)

Overall, the majority of SA members are meteorologists from various WFOs or other NWS river forecasting or regional offices. Senior meteorologists from Weather Forecast Offices represent almost half (40%) of the total team members. There were also many scientists and meteorologists from other NWS and NOAA teams, such as the National Center for Environmental Prediction, Hydrometeorological Prediction Center, National Severe Storms Laboratory, the Storm Prediction Center, and others. There were also scientists from non-meteorological agencies such as the Unites States Geological Service and the Army Corps of Engineers.

Since the first Service Assessment published in 1960, there has been an interest in the social impact of these events. The first assessment noted collecting information from the public about their thoughts around weather phenomenon was more difficult than originally anticipated. Since then, there has been a larger focus on incorporating SBE scientists and SBE science data collection within the assessments. Within the teams, SBE scientists have made a small appearance. Past teams have included external SBE science experts (4%) and SBE scientists from the NWS or other NOAA agencies (3%). A list of SBE science fields presented over the time span are represented in the table above. Some teams also included heath scientists from

External SBE Scientists	
Anthropology	2
Communications	2
Environmental Policy	2
Geography	1
Psychology	1
Public Safety	1
Science and Technology	1
Sociology	3
Unknown	1

Table 1-1: External SBE Scientists Team Members

various organizations (1%). Other teams included Public Affairs representatives from NWS or other NOAA affiliates (7%). Over the last several years, teams have been comprised of more SBE science, health, and communications experts.

Recommendation

The wide variety of disciplines represented as part of the teams offers a broad base of expertise. It is good to be flexible with who serves on the team and have broad representation from knowledgeable experts in pertinent fields for the specific event. Each event is different, so it is important to have experts based on the SA needs. Over time, the NWS has done a better job at selecting team members from various areas outside WFOs. At the beginning of the sample, the majority of team members were from WFOs or other NOAA offices. More recently there is a better representation of hydrologists, meteorologists from outside agencies or organization, engineers, and non-technical personnel, such as program coordinators, communication experts, and SBE scientists. Despite the additions of SBE scientists and other non-technical perspectives to SA teams, more are needed in the future.

Recommendation 1-3a: When determining who to send as part of a SA team, there should be a representative that is familiar with the SA process who can ensure consistency in the process, preferably the team lead. This could come in the form of someone who has been a part of a SA in the past, or a position within the NWS that is dedicated to overseeing the SA process. This would allow for congruency in both the format of the structure of the report as well as data collection, analysis, and reporting.

Recommendation 1-3b: In addition to an experienced leader, each team member should have some training on the SA process prior to going into the field. This process would take some time and additional resources; however, it could be organized strategically. As previous stated in Case Selection, we recommend identifying potential team members prior to an event to allow for faster deployments to the affected area. By identifying potential members beforehand, the NWS can structure trainings on the SA process to these people in advance in the event they need to be deployed. These trainings can consist of a general overview of NWS operations, and understanding of the mission of NWS, potential data collection topics and methods, as will be discussed later, and general SA policies and procedures. Once a SA team has been commissioned, those who are selected from the pre-trained group can have a virtual meeting to discuss logistics and specific topics for the SA as needed. This way, everyone on the team will have a better understanding of the process and intended results.

Recommendation 1-3c: SBE scientists should be included on all assessment teams. This recommendation follows the suggestion that SBE sciences need to be included within the weather enterprise. This general recommendation has been made numerous times in various capacities, both formally and informally, including the NASEM (2018) report among others. Recommending SBE scientists within the SA process has also been noted in two previous SAs:

> Hurricane/Post-Tropical Cyclone Sandy, October 22–29, 2012: *Recommendation 4: NWS needs to broaden and expand its social science and communications capacity by hiring at*

least one more social scientist/behavioral expert within NWS or by increasing contracts with outside experts. This expanded capacity should be used to develop products, services, and communications tools (e.g., Internet, social media) to drive the appropriate public response to severe weather events. (NOAA, 2013a)

Super Tuesday Tornado Outbreak of February 5-6, 2008: *Recommendation 8a: A pool of societal impacts experts should be established. NWS should use experts from this pool for service assessments. A pool of NWS employees with experience in social science data collection methods should also be established.* (NOAA, 2009)

Super Tuesday Tornado Outbreak of February 5-6, 2008 *Recommendation 8d: The NWS should expand participation with academic and other partners in social science to study the complete warning process from issuance to response, and systematically incorporate those findings into NWS products and services.* (NOAA, 2009)

Super Tuesday Tornado Outbreak of February 5-6, 2008 *Recommendation 8e: The NWS should consider adding a societal impacts program to operational branches of NWSH and the Regions, in order to organize and focus these efforts.* (NOAA, 2009)

It is difficult to know if these recommendations to expand SBE science within the NWS were implemented based on proceeding reports. There have been more SBE scientists as part of teams more recently, but they have not been included on every assessment. There have also been more SBE scientists that are listed as internal NWS employees which may indicate more attention within the agency.

There are many benefits to including SBE scientists as part of SA teams and within the NWS overall. SBE scientists can provide their expertise on how to better collect and understand data from the public and SBE topics. Additionally, they can provide a different perspective on understanding internal dynamics from within the NWS, based on practices within their fields. As we will discuss in the Research Questions section, SA teams have reviewed relationships within NWS offices on a consistent basis. It would be beneficial to have those training on human behavior or social relationships reviewing these topics than someone who focused on the physical environment.

Additionally, the term "social scientist" is used consistently throughout SA reports; however, there is little attention paid to the discipline of the scientist. Those within the SBE science field have a very different lens depending if they are a sociologist or a psychologist for example. Each SBE scientist focuses on a very different area and can provide different perspectives. It is important to have a broad view within SA teams, so having SBE scientists from different disciplines on each team is desired. It is also important to provide this context within the report. Only half of the external SBE scientists included in the teams, as seen in the table above, had their disciplined identified in the report. The others were simply referred to as "social scientists" without additional information. Their disciplines were later identified thought internet searches for this analysis.

What topics to focus on (Research Questions)

Current Practice

There have been a wide variety of topics discussed within service assessment reports. Given the nature of the mission of SA teams, there is a high emphasis on how the NWS has

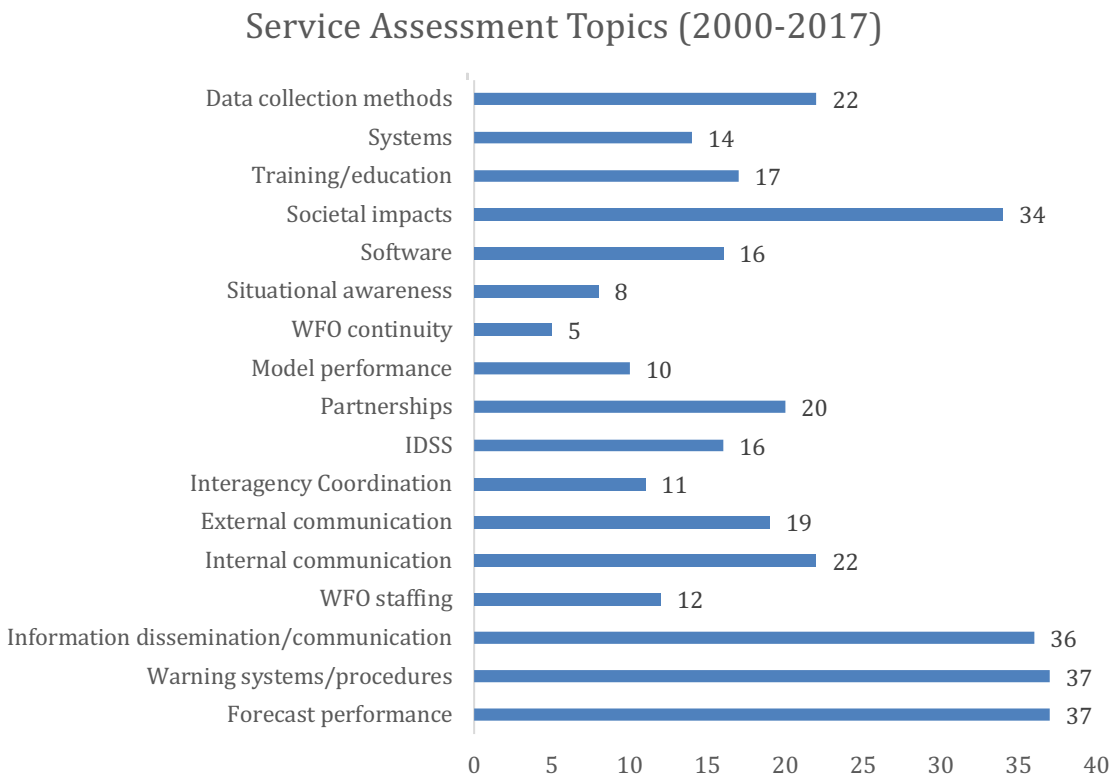


Figure 1-6: Service Assessment Topics (2000-2017)

performed and what they can do better. Figure 1-6 shows how frequently different topics are addressed in reports from 2000-2017. Some reports included topics very specific to a certain event and are not included in the graph because of their uniqueness. Most categories are rather broad as they are examined from various perspectives. The most common topics for all service assessments include: 1) reviewing NWS forecasting, at the local and national office level; 2) reviewing warnings that were issued and the process behind deciding where and when to warn or issue another product; 3) how forecasts and other weather information was disseminated; and 4) understanding the impacts the event had on society- both the public and other NWS partners. There were some subtleties within this data over time. For example, within the information dissemination topic, social media usage has played a large role since 2011. Previously it was never mentioned but was discussed nine times over the last 15 reports. This shows how the NWS SA teams have considered new topics as society begins to use new forms of technology. The other topics can be divided into three categories. The first is NWS interactions and communications. This includes staffing at Weather Forecast Offices or other NWS offices; operation continuity between NWS offices; communication and coordination internally between various NWS offices and externally with other organizations; interagency between other NOAA affiliates; partnerships with non-weather organizations; Impact Decision Support Services (IDSS); situational awareness of NWS staff in the forecasting and wanting process; and training and education efforts. The second area is reviewing tools that the NWS utilizes. This includes different data collection methods, such as radar, radiosondes (weather balloons), river depth sensors, and others; software NWS uses for forecasting and internal communications, such as AWIPS or NWSChat; and system issues, such as internet outages or other interruptions in

Service Assessment	SBE Science Topics
Mentions SBE Science Data Collection	
Hurricane/Post-Tropical Cyclone Sandy, October 22–29, 2012	Outside research institutions used for public response
South Pacific Basin Tsunami September 29-30, 2009	Education and outreach around tsunamis
Central United States Flooding of June 2008	Societal perceptions, impacts and responses to forecasts
Tornadoes in Southern Alabama and Georgia on March 1, 2007	Impacts of tornadoes on society
Includes SBE Scientist in SBE Science Data Collection Efforts	
May 2013 Oklahoma Tornadoes and Flash Flooding	Behavior and actions of EM, first responders, media, government officials, weather professionals; how public received warnings and what actions they took; How NWS contributes to hazard resiliency
The Historic Derecho of June 29, 2012	How the NWS contributes to hazard resilience in the areas of decision support, operational procedures, collaboration, and communication; How people received warnings and the actions they took
The Historic Tornadoes of April 2011	Warning systems lead to protective actions
Joplin, Missouri, Tornado – May 22, 2011	Understanding response to NWS warnings and external warning systems.
Mother's Day Weekend Tornado in Oklahoma and Missouri, May 10, 2008	Sources of warning information; perceptions; decision-making and actions
Super Tuesday Tornado Outbreak of February 5-6, 2008	What information was available and how it was interpreted; perceptions and decisions; sheltering options; Why so many people died

Table 1-2: Service Assessment SBE Science Topics

services that impact NWS operations. The third topic, SBE science topics, will be discussed in more detail below.

The majority of the SA over the past 18 years have not included specific SBE topics in the reports, despite having some SBE expertise as part of the team. Of the 41 reports, 10 have included specific SBE data collection methods focused on social impact topics. These SA team members identified specific areas to focus depending on the type of event and societal impacts the event caused. Table 1-2 displays the SBE science topics for each SA that included them. This table is divided into two different sections. The first set discusses the important of SBE science data collection but does not specifically report data collection efforts. The second set of SAs includes detailed SBE science data collection and analysis. For example, the Mother's Day Weekend Tornado in Oklahoma and Missouri, May 10, 2008 and Super Tuesday Tornado

Outbreak of February 5-6, 2008 events had many more deaths than previous storms. For this reason, the teams decided to focus their interest on how those who were killed received information and took protective actions based on interviews with their friends and family. A deeper look into how data was collected for this case will be discussed on the next several sections. Other SBE data collection efforts have included topics of perceptions and uses of tornado warning systems, personal protective actions, the use of sirens, and availability of storm shelters.

Recommendations

Since the early 2000's, SA topics have become more varied. At the beginning of this period, the main focus of SA reports was on forecasting and the process for issuing products, such as watches and warnings. Over the last ten years, there has been a greater focus on interpersonal communication and interactions between the NWS, other government agencies, emergency managers, engineers, the media, and the public. It seems there has also been a high emphasis placed on social media, specifically Facebook and Twitter, over the last five years. Much of the information dissemination now focuses on how well and quickly NWS staff publishes information on their social media sites to keep the public informed, as well as communicating with partners such as broadcast meteorologists and emergency managers. As technology has changed, the NWS seems to be trying to adapt and find more ways to connect with the public to share information.

Despite the strides the NWS has taken to adapt their information dissemination to the public, the use of SBE science data has not been fully recognized or developed by the NWS SA process. In fact, there seems to have been a concentration of SBE data collection between 2007 and 2013. There were 10 reports that included some kind of SBE science data usage over 18 reports within this time period. Of those, only six have collected and analyzed SBE science data directly.

Recommendation 1-4a: More emphasis needs to be put on collecting SBE science data. SBE science topic have not been directly studied since 2013. Several SA reports issued their own recommendations about the importance of including SBE science topics as part of the SA process, yet the last one was only two years after the recommendation.

> Joplin, Missouri, Tornado, May 22, 2011 *Recommendation 1: For future Service Assessments, NWS should plan a more structured approach to collecting information on societal aspects of warning response. This should include developing sub-teams well-versed in social science and NWS warning operations that can be quickly deployed to the field following any given severe weather disaster.* (NOAA, 2011)

Recommendation 1-4b: There should be more variety in the types of hazards that are used to study SBE science topics. The reports that have included SBE science data collection efforts have also had a limited scope in the hazards they studied. Of the six reports, all focused on tornadoes or other types of severe small-scale wind events. Only studying one type of hazard is very limiting and only allows us to better understand that specific type of hazard. While the impacts of localized severe winds may be easier to collect data on than larger scale events such as hurricanes, is it still important to recognize there are likely to be major differences between different types of events. The forecasting and warning processes are also very different between hazards. By expanding SBE science topics into all types of events, the NWS can better assess their proficiencies and areas of improvement across all types of weather.

Recommendation 1-4: More breadth is needed in SBE science topics. Of the six reports, the majority of them focused on the same themes, public perceptions of warnings and the protective actions the public took due to their perceptions and the information communicated to them. It is likely these topics were chosen due to the type of event and the ease in collecting information. As one recommendation indicated, these topics seemed to be of high importance during this timeframe.

> The Historic Derecho of June 29, 2012 *Recommendation 7: To promote a better public response, the NWS should experiment with new approaches for highlighting impact-based wording in severe thunderstorm warnings, especially during unusual events. NWS should collaborate closely with social scientists to develop wording clearly defining impacts of a storms based on its severity.* (NOAA, 2013b)

As with studying different types of events, it is important to focus on many different SBE science topics. Topics should range from many different disciplines within SBE science, from sociology, psychology, communications, behavioral, health, and many others.

Approaches to collecting data (Data Collection Protocol)

Current Practice

This section explores the data collection methods that are explicitly stated within SA reports. It is possible additional methods were used that have not been included in this analysis because they were not discussed in SA reports. The primary method for collecting data for SA is through interviews. All of the SAs within the 2000-2017 period used interviews in some form. The majority of these seemed to be internal interviews within WFO offices or between NWS offices. A full review of data collection participants is discussed in Sampling and Participants. The second most utilized data collection method is conducting damage surveys after the event. Most of these occur after tornado and tropical events and serve as a way to better understand the impact the event had on communities. Another often used method is evaluating NWS products, such as warnings, watchers, advisories, and emergencies. Although only 10 reports specifically mentioned this process was used, almost all reports commented on how WFOs issued products and their accuracy.

More specifically, in relation to SBE science topics, there have been three different methods used for interviewing the public after an event. The most popular, used in three events, is semi-structured interviews (Joplin, Missouri, Tornado, May 22, 2011; Mount Redoubt Volcanic Eruptions March-April 2009; Super Tuesday Tornado Outbreak of February 5-6, 2008). Other methods of interviews by two SA teams each include pre-validated triangulated field interviews (May 2013 Oklahoma Tornadoes and Flash Flooding; The Historic Derecho of June 29, 2012) and facilitating focus groups of event survivors (May 2013 Oklahoma Tornadoes and Flash Flooding; The Historic Derecho of June 29, 2012). A few other reports utilized additional methods of collecting data. Two teams distributed surveys to event survivors and used descriptive statistics to analyses the results (May 2013 Oklahoma Tornadoes and Flash Flooding; The Historic Derecho of June 29, 2012). Another team (Northern Idaho and Western Montana Summer 2000 Wildfires) used surveys for Incident Meteorologists (IMETS) which are internal to the NWS. Two other teams conducted qualitative field observations (May 2013 Oklahoma Tornadoes and Flash Flooding; The Historic Derecho of June 29, 2012). Others reported reviewing other information sources such as newspapers or other reports (The Historic Derecho

of June 29, 2012; Mother's Day Weekend Tornado in Oklahoma and Missouri, May 10, 2008) or making qualitative observations (The Historic Derecho of June 29, 2012). One SA also used the findings of external researchers who published their findings (Hurricane/Post-Tropical Cyclone Sandy, October 22–29, 2012). The SAs that included higher emphasis on SBE science data collection, as described in Research Questions, all used multiple methods of data collection.

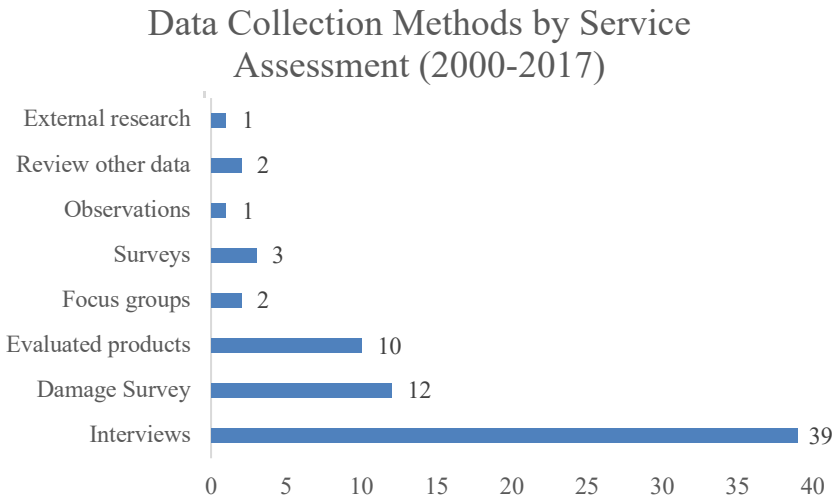


Figure 1-7: Data Collection Methods by Service Assessment (2000-2017)

Recommendations

The main source for data collection has been through interviews, which can provide detailed data the SA team can use to study their desired topics. It also provides an opportunity for those selected to be interviewed to share their perspective and for the researcher or investigator to ask questions to gain a better understanding of their experience. It can also be a limiting factor. Often interviews take a significant amount of time and limits the number of participants that are involved in the data collection process. Since a large majority of data collection efforts have been through interviews, there may have been voices that were not included in the process that has valuable information to share. The NWS should explore using other methods in addition to interviews in future SAs based on the following recommendations.

Recommendation 1-5a: Surveys should be utilized more to gain a fuller understanding of the perceptions of those within NWS WFO and other offices that were involved with the event. This could be used as an initial stage to the SA process. As soon as a SA is initiated, while the team is in the process of being organized and deployed, a general survey can be created that is sent to all NWS internal and external partners. This initial survey can serve as the framework for the rest of the SA. The initial data collection can then be used for team members to target the specific topics they want to investigate for the SA in additional to who they should spend time interviewing. This process would speed up the time needed to collect data and also conserve resources. More people could be reached and there may be a need for fewer interviews overall. It would also allow for collection efforts to begin before the team arrives in the event location. By better utilizing resources, more attention can be focused on gathering additional data, especially the SBE science topics. This fits in line directly with one recommendation previously made in a SA report:

> Super Tuesday Tornado Outbreak of February 5-6, 2008 *Recommendation 8b: The NWS should use a common set of societal impacts survey questions for all future service assessments, similar to those used in this assessment. This would allow the NWS to*

> *continue to build a database of societal impact information to help support service and product improvements in the future.* (NOAA, 2009)

Recommendation 1-5b: Data collection based on societal impacts and other SBE science topics needs to be expanded within SAs. The few cases that did involve SBE science data collection used very similar approaches. Even then, there was not a lot of information provided on how teams collected their data other than the general type. There was no explanation as to why they chose these specific methods and the process they used for them. The NWS noted the importance of SBE science data collection in several of their SA recommendations. In one case, they considered using contractors to help support SBE science data collection.

> Hurricane/Post-Tropical Cyclone Sandy, October 22–29, 2012 *Recommendation 23b: NOAA/NWS should secure long-term contracting mechanisms for securing the services of data collection contractors that can execute the public survey component for future service assessments.* (NOAA, 2013a)

This specific example is from the only SA where they used a study conducted by external researchers as part of the SA. Based on proceeding reports, this recommendation was not used. In other SAs, they noted the importance of having SBE science data collection instruments available to use that were pre-approved by various organizations.

> Hurricane/Post-Tropical Cyclone Sandy, October 22–29, 2012 *Recommendation 23a: NOAA/NWS should expedite the development and clearance of survey and focus group questions teams can use as part of service assessments. NWS needs to develop a generic list of questions and obtain OMB approval in anticipation of future service assessments.* (NOAA, 2013a)

> The Historic Tornadoes of April 2011 *Appendix C: Office of Climate, Water, and Weather Services is collaborating with the White House Office of Management and Budget to develop a structured approach to social science data collection for future Service Assessments. This should not be a standard instrument, but rather a standard process that balances repeated use of standardized measures with the ability to focus on unique and important elements of any particular event.* (NOAA, 2009)

In one report (The Historic Tornadoes of April 2011), the authors discussed the difficulty getting approval for SBE science research with short notice. Based on proceeding reports, it is difficult to tell if there has been any movement on securing pre-approved SBE science surveys for the public since these recommendations were made. We recommend the NWS continues to work on this process. Given the level of oversight needed to approve surveys to distribute to the public, there needs to be some sort of ongoing process to ensure there is always some instrument ready to use should a SA be necessary.

Recommendation 1-5c: There should also be more explanation as to why teams chose specific methods and how they collected data. Outside of the SBE science focused studies, that provided specific types of interview methods, there is no additional explanation about how interviews were conducted. Some reports will specify if phone interviews were used rather than in person interviews, but that is the greatest extent. Reports should provide additional information to provide additional context and to help promote uniformity in the process. For example, the reports do not indicate who was responsible for leading the interviews or what kind

of questions were asked. By developing set guidelines on how interviews and other instruments should be used, teams, no matter their composition, can follow the same processes and collect data in similar ways.

Recommendation 1-5d: SBE scientists should lead the SBE science data collection process, not only with the public, but with internal collection efforts as well. Anytime a survey, interview, or focus group is used, those with advanced training and understanding of various methods should lead the process. In the same way meteorologists are the best to review NWS products, SBE scientists are the best to work with human subjects, given their advanced training. For example, in-depth interviews are not a typical conversation. Specific skills are required to properly collect relevant data from participants. When conducting interviews with NWS and other technical participants, SBE scientists should work alongside technical experts. The technical experts can capture the required depth of information while SBE scientists use their training in interviewing skills.

Deciding who to talk to (Sampling and Participants)

Current Practice

Each SA typically describes the types of people the team selects to participate as part of their data collection efforts, usually in the form of interviews. In all cases with two exceptions (California Drought 2014; Intense Space Weather Storms October 19 – November 07, 2003), the primary interview focus is on NWS employees at the local WFO(s) who were responsible for forecasting and issuing products for the event. There is also a high emphasis on interviewing employees of others NWS offices that assisted in the event, such as regional offices, the Storm Prediction Center, National Center for Environmental Prediction, National Severe Storms Laboratory, and others. There has also been a high focus on interviewing emergency managers, at the federal (Federal Emergency Management Agency), state, and local levels to understand the direct impacts the storm had on the community. The media, including broadcast meteorologists, are often referenced as contributing to insights, along with the general public. Other outside organizations, such a local businesses, private partners, military instillations, and state agencies can also be included in the interview process. Government agencies are interviewed depending on the needs for the report.

For SBE science aspects of SA, as discussed in Research Questions, the main sampling technique has not been described consistently. The respondents interviewed has depended on the specific topics identified by the team. For example, in the Mother's Day Weekend tornado outbreak and the Super Tuesday tornado outbreak, the teams wanted to better understand why there more deaths than on average. To gage why people died, the team interviewed the family of those who died to see if victims had received warnings, had a safe place to go, and any other pertinent information if known. Other sampling method included stopping by homes that had visible damage to interview (Mother's Day Weekend Tornado in Oklahoma and Missouri, May 10, 2008), speaking to business owners that sustained damage (Joplin, Missouri, Tornado, May 22, 2011), and interviewing those who lived in the path of a tornado outbreak (The Historic Tornadoes of April 2011). There was also an explanation of one survey that was conducted by the SA team for the Historic Derecho of June 29, 2012. The team asked people who lived in

high-impacted areas to complete the survey and publicized their staging locating for members of the public to seek them out and complete the survey.

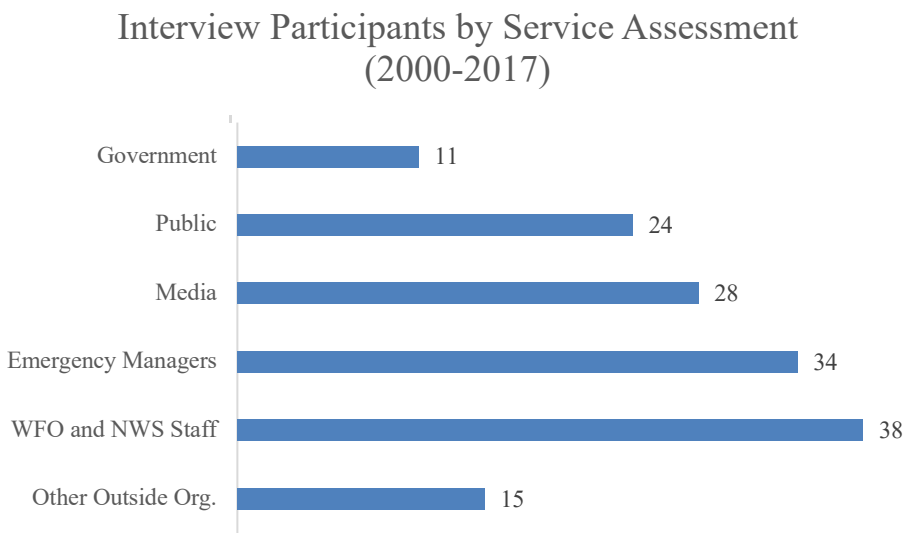


Figure 1-8: Interview Participants by Service Assessment (2000-2017)

Recommendations

Despite the information provided in SA reports, there is very limited explanation about the participants selected for interviews other than broad categories. We are told where team members look to interview but not their selection process for general data collection. It is difficult to know who specifically the team interviewed at the WFO or other NWS office unless they are specifically quoted somewhere in the report. It is also not always clear how many people were interviewed from different areas. Few reports specifically say the number of people that were interviewed, although some will provide a rounded number, for example the Intense Space Weather Storms October 19 – November 07, 2003 event specified that they spoke to around 100 private partners. By not providing additional information, it is difficult to gage if those interviewed were a representative sample of the office or agency interviewed. It also seems that in some reports, the media, emergency managers, or other partners are used to infer the general public perspective. When reports indicate the public was interviewed, there was generally no further information about who was chosen or how they were chosen to participate, other than in the few SBE science focused SA teams. To better define how participants are selected for interviews and other data collection efforts we make the following suggestions.

Recommendation 1-6a: A structured sample selection process is needed. Based on the information provided throughout the entire SA collection, it seems participant selection is based on convenience samples. Given the short amount of time available for teams, this is reasonable, but a more structured approach may provide better representation. There are many different methods researchers can use to select participants that each have their own benefits and shortfalls. Using multiple methods can be beneficial depending on the type of data collected. SBE scientists on the team can determine the best method depending on the research question. This should be done for both internal interviews and interviews with partners and the public. There should also be a higher emphasis on collecting information from the public, either through interviewing or other means as discussed in Data Collection Protocol.

Recommendation 1-6b: The NWS should identify relevant groups to interview depending on the type of event or dependent on the topics selected as discussed in Research Questions. In this way, the SA team would know who to reach out to as soon as the SA is established to streamline the process. This would allow for faster response times and for team members to collect more information. SBE scientists on the team should also be included in the decision-making process and lead efforts on selecting members of the public for collection

efforts. With their expertise, they can identify the best methods available depending on the specific needs for the SA.

Recommendation 1-6c: There should be more explanation as to why teams chose to reach out to certain populations along with statistics as to who was sampled and some of their demographics. This would allow team members to better assess the data collect to see if there are patterns based on demographics. There may be specific patterns based on the backgrounds of individuals, both when interviewing the public and other external partners as well as internal participants. All participants, whether internal or external, are an important part of the data collection process and therefore should be treated the same way.

Making sense of the information (Data Analysis)

Current Practice

There is very little information provided on how SA teams analyze the data they collect. Data analysis is described very broadly and summarized in all SA reports as a list of findings followed by recommendations for improvements or sets of best practices that were observed during the event. In the few reports that focused specifically on SBE science data, the authors drew some conclusions based on the data that was collected and made recommendations for future NWS products and practices based on the findings. All SA reports included several quotes from either media, emergency managers, or the public that are used to support the best practices, facts, or recommendations for the report. Only a few SA reports included a summary of the findings teams identified (May 2013 Oklahoma Tornadoes and Flash Flooding; The Historic Derecho of June 29, 2012; The Historic Tornadoes of April 2011; Joplin, Missouri, Tornado – May 22, 2011; Mother's Day Weekend Tornado in Oklahoma and Missouri, May 10, 2008).

Recommendations

General quotes are helpful in making points for NWS operations and perceptions of forecasts; however, it only displays one positive view. It seems that SA authors pick quotes that are very positive of NWS operations. Only a few include negative quotes. Since there is a lack of analysis of interviews and other data collection, it is difficult to assess if most interactions are positive, or if only positive quotes are picked to be displayed in the report. Overall it does not provide a full image of the data collected from either the public or specific NWS partners.

Recommendation 1-7: In order to provide research quality results, there should be some explanation of how data was analyzed and what conclusions were made from the findings. There should be more summarization of findings from data collection rather than quotes selected to illustrate specific points. Quotes can still play an important role to highlight ideas, but a full analysis would provide a comprehensive understanding of the full range of insights from the data.

Summary of Recommendations

Over the last 18 years of NWS service assessments, there has been great improvement in the overall process. A common format has been established that provide continuity. Team members are more diverse in terms of disciplines and expertise. Many different topics have been

explored and continue to become broader. Topics are also changing with the times, incorporating things such as the importance and usefulness of social media into daily operations of the NWS. Although not typically considered part of the NWS wheelhouse, SBE science has become a larger part of their considerations; however, more collaboration is needed. With these important changes we urge the NWS to continue working with SBE scientists and include their expertise as part of daily operations and considerations. They have made great strides which has opened the door for even more expansive improvements. Throughout this report we have made many recommendations on small and large areas of improvement for the NWS SA process. To conclude, we review the recommendations to improve SBE science data collection.

1. Adopt a multiple case study design to provide easier comparisons between SAs to assess NWS progress and needed improvements
2. When to initiate a SA (Case Selection)
    a. Set standards of when to have a SA so that the decision to respond faster and more predictable
    b. Conduct SAs more frequently over more events to provide a more comprehensive data set
3. Who to send (Team Composition)
    a. Maintain a consistent SA administrator who is part of each SA to ensure consistency between SA operations and reporting
    b. Provide more training to SA participants including information about SBE data collection methods and maintain a running list of those who are trained and ready to respond when needed
    c. Include more SBE scientists from different disciplines to form multi discipline teams
4. What topics to focus on (Research Questions)
    a. Include more emphasis on SBE topics and provide pre-approved data collection methods team members can use in a quick-response form
    b. Include more variety when choosing the types of events to study with SBE topics
    c. Allow for more breath in SBE topics including ones that have and have not been studied in the past
5. Approaches to collecting data (Data Collection Protocol)
    a. Provide surveys to NWS personnel and other stakeholders involved to gain a better understanding of overall operations and identify who should be interviewed
    b. Include more focus on societal impacts by having more interviews or other data collection methods with the public or other stakeholders
    c. Provide more detailed explanation about the methods used and reasoning for those methods
    d. Allow SBE scientists to lead data collection efforts given their training and expertise with these forms of data
6. Deciding who to talk to (Sampling/ Participants)
    a. Use additional sampling methods rather than strictly using a convenience strategy
    b. Better identify relevant stakeholders through initial surveys to streamline interview procedures
    c. Provide more detailed information about those sampled to better understand the sample

7. Making sense of the information (Data Analysis): Include a more detailed data analysis section in addition to using quotes

CHAPTER 2: NWS CUSTOMER SATISFACTION SURVEY

Introduction

Since 2003, the NWS has conducted Customer Satisfaction Surveys (CSS) "to help the NWS achieve its strategic and tactical goals by providing feedback on NWS products, services, and overall customer satisfaction as well as making recommendations for future focus" (CFI Group, 2013a, p. 8). The CSS produces a quarterly Customer Satisfaction Index that is tracked as one of NWS' Government Performance and Results Act (GPRA) metrics. These metrics are included in the NOAA Annual Performance Plan Report (APPR) that is used to brief senior management and adjust NOAA's yearly budget.

NWS contracts with the Claes-Fornell International Group (CFI Group) to conduct quarterly Customer Satisfaction Surveys. The CFI Group (2013b) uses a long-standing methodology that they call the American Customer Satisfaction Index (ASCI), to derive the customer satisfaction metrics. Claes Fornell, a faculty member and expert in customer service measurement, developed ASCI at the University of Michigan Business School. The method is intended to benchmark overall satisfaction for an industry's or an organization's products and services. ACSI uses psychometrics and structural equation modeling to link perceived performance (service/delivery of products), attitudes (customer satisfaction), and future intentions/trust (customer intentions use the services again). Over the past 30 years, ACSI has been used to compare customer satisfaction across industries, including the federal government, through the National Quality Research Center (NQRC) at the University of Michigan. The CFI Group, a spin-off of NQRC, applies the ASCI methodology to individual organizations in the public and private sector.

NWS Customer Satisfaction Survey Overview

The NWS Customer Satisfaction Survey (CSS) is a quarterly, cross-sectional survey of NWS customers. The survey asks a set of standard questions to enable quarterly trend analysis. In addition, each survey addresses a different hazard and NWS service each quarter, enabling year-to-year trend comparison. The survey covers:

- Hazards Specific Information
- NWS Products/Services
- Information Access and Preparedness
- Overall NWS Satisfaction.

Table 2-1 shows topics from recent surveys.

	Q1_FY2019	Q2_FY2018	Q3_FY2018	Q4_FY2018
Hazard Specific Information	Tropical Storms/Hurricanes, Hazardous Flooding	Winter Weather, Extreme Cold/Wind Chill	Severe Thunderstorms & Tornadoes	Extreme Heat Events
Services/ Products	Storm Surge Maps	Probabilistic Snow Maps	NWS Radar Displays	Wireless Emergency Alerts, NWS Climate Services
Other Topics		Influence of Social Media and Websites	Influence of Social Media and Websites	

Table 2-1: Hazards, services and other topics addressed for the last year quarterly reports

Topics of special interest can be added to the survey. For example, questions about social media and websites have been added to the Q2 and Q3 surveys. See Appendix A for the most recent survey.

Sample

CFI recruits survey participants from two different NWS customer segments:

1. **People who visit NWS websites, (the Pop-Up Sample)**. To recruit this sample, a pop-up notification may be displayed to NWS website visitors inviting them to complete the survey during data collection periods. The size of the Pop-Up sample ranges from 2,300 – 7,000 participants for recent surveys and represents a random sample of website users. Since ACSI and CFI have a focus on e-government and how digital services can improve performance and satisfaction, it is not surprising that up until 2015, the NWS CSS only evaluated website users.
2. **General Public, the Internet Panel (IP Sample).** This sample represents people who access NWS information in many different ways and may not visit the NWS website. This second sample is recruited through an Internet Panel where participants are paid to complete on-line surveys. The IP sample is a stratified random sample, according to the CFI Group, designed to include participants that are representative of the demographics of the general public. The IP sample size is typically just under 500 people.

In addition, the survey may sometimes include a specific NWS customer segment. For example, surveys have been distributed to Weather Ready Nation ambassadors, aviation stakeholders, emergency managers, and those who use NWS's hydrologic services. Results are reported separately for the Pop-Up, IP, and stakeholder samples.

Customer Satisfaction Model

Survey responses are used as input to the customer satisfaction model, an application of the American Customer Service Index (ASCI). ACSI is part of performance measurement and management research which started in the private sector, but then increasingly became utilized in the public sector at all levels. The core methodology and the results of ASCI have been published in numerous peer-reviewed journals in marketing, business strategy, administration, and social psychology (Fornell et al. 2005; Sun, K. A., & Kim, D. Y. 2013; Grigoroudis, E., & Siskos, Y 2003; Hackl, P., & Westlund, A. H.,2000). Morgeson and Petrescu (2011) provide a general overview on using ACSI for federal agencies. These indices are used to benchmark performance among different federal agencies and also provide insights for areas for improvement within an agency. ASCI's conceptual model of government performance is based on the performance-satisfaction-trust linkage, a commonly accepted framework. (See for example, Bouckaert & Van de Walle 2003; Fornell et al. 1996; Morgeson et al. 2010; Van Ryzin 2007) ASCI has operationalized this concept by evaluating government performance as a function of "citizen perceptions of 1) the quality of services received and 2) the information disseminated by government agencies" (Morgeson and Petrescu, 2011, p.457). Morgeson and Petrescu (2011) note that because federal agencies have such different missions, services and information types, care must be exercised in the interpretation of satisfaction indices for different agencies.

According to the CFI Group's white paper on methods (CFI Group, 2013b), ASCI creates causal linkages among three dimensions of customer satisfaction:

1. Satisfaction Drivers. Drivers are based on the performance delivered by the various facets of the product and/or service experience. These are defined as the ease of obtaining services, the timeliness and efficacy of delivery of services, the ease of accessing information and the clarity of information.
2. Satisfaction. Overall attitudinal evaluation of the experience.
3. Future Behaviors. Future intentions towards the product or service in question.

ASCI/CFI Group uses customer interviews and focus groups to derive what should be measured given an agency's mission. Using best practices in psychometrics, there is also a focus on asking about satisfaction in multiple ways to ensure that the survey is making an accurate measure of satisfaction. Then ACSI uses causal models, such as structural equation modeling to create linkages among the different dimensions.

For the NWS model, Drivers are defined as NWS Contribution to the Understanding of the Dangers/Threat of the hazard; NWS accuracy of information; NWS helping people to make decisions; Ease of finding NWS information on the topic; NWS improving knowledge about the hazard. The topics may be altered slightly depending on the hazard that is being covered.

For Satisfaction, respondents are asked to rate their overall perception of NWS service based on their expectations, an ideal experience, and their current experience.

For Future Behaviors, respondents are asked whether they are likely to recommend NWS to others, whether they will continue to use NWS services, and whether they are likely to take action based on NWS information. Satisfaction scores are aggregated to create an overall Customer Satisfaction Index (CSI). The model also estimates which of the dimensions has the greatest impact on improving the CSI, and how changes in the CSI impact future intended behavior.

Figure 2-1 shows a specific example from a recent report (CFI Group, 2018a) that addressed severe thunderstorms. The driver "Information for Severe Thunderstorms and Tornadoes" has an overall satisfaction rating of 84 (gray box). The model also estimates that a 5-point increase in the satisfaction rating of this driver will increase the CSI by 2.6 points (blue box). For future behaviors, a 5-point increase in the overall CSI is expected to increase

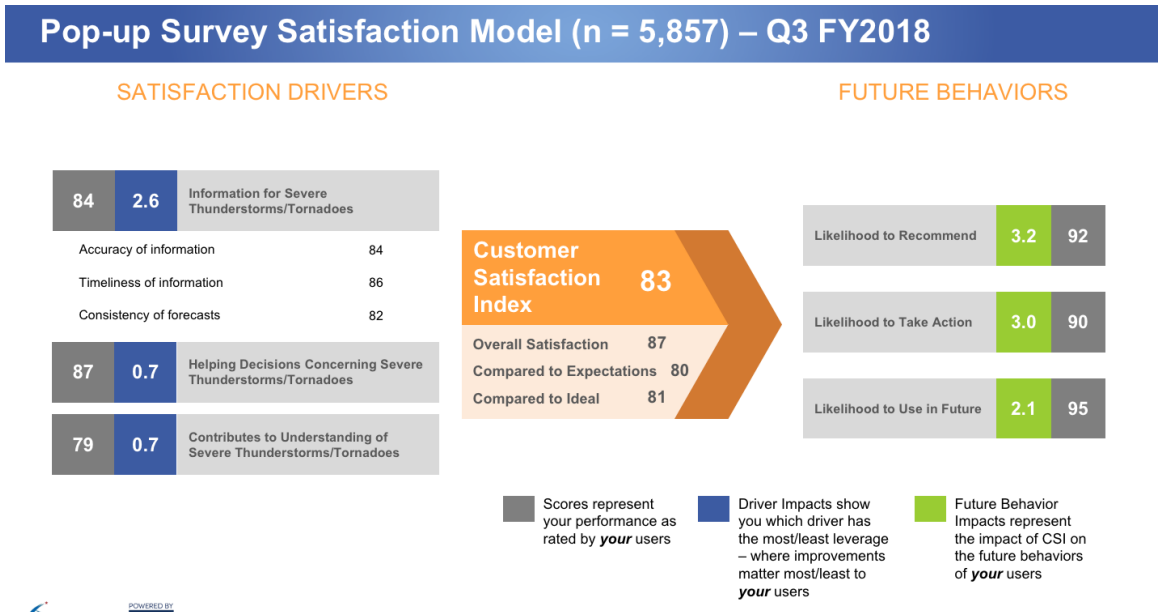


Figure 2-1. Results from customer satisfaction model for Severe Thunderstorms and (CFI Group, 2018a)

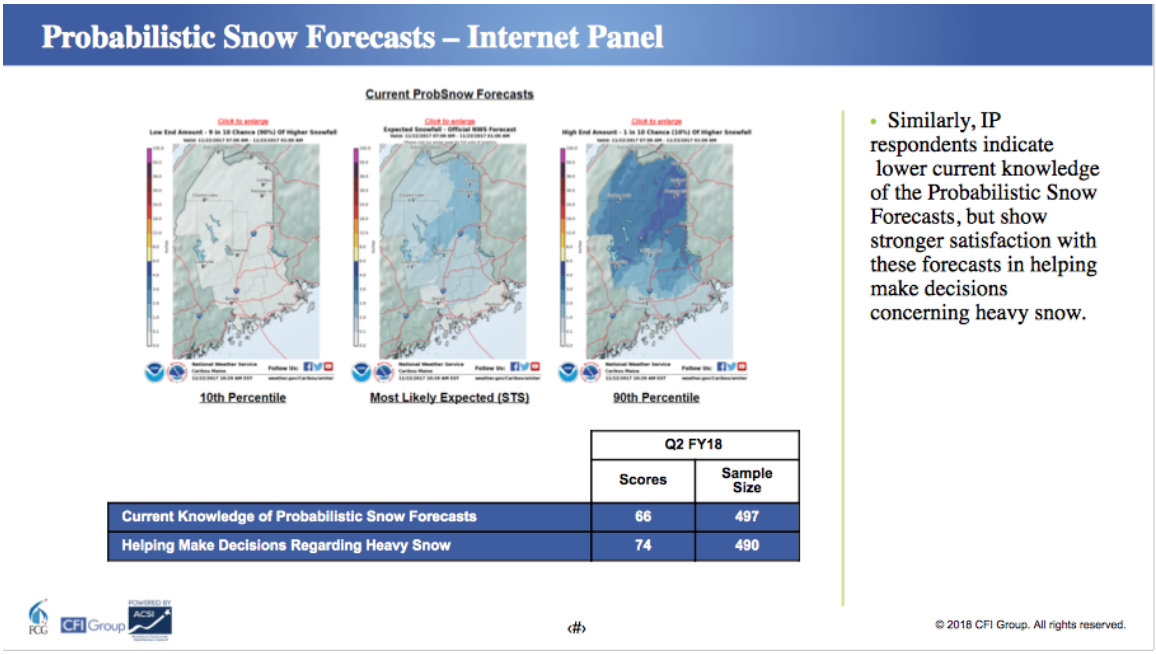


Figure 2-2: Results from the Internet Panel revealing knowledge of Probabilistic Snowfall Forecast maps (CFI Group, 2018b)

"Likelihood to take action" by 3 points, for example. This is a strategic tool to show NWS how the different drivers of satisfaction can improve the overall rating.

Products, Information Access and Preparedness

Every quarter, the survey asks question about experimental products and services. Prior surveys have sought feedback on Wireless Emergency Alerts (WEA), radar products, storm surge maps, and probabilistic snow maps. Figure 2-2 shows an example of a recent survey on probabilistic snow maps. Each survey also asks respondents about how they access weather information, and also whether they have an emergency plan for various hazards. See Table 2-4 for a report on weather information access.

Qualitative Data

Open ended questions are asked in each survey about how NWS can improve its services with reference to the selected hazard topics. Seven or eight of these responses are reported along with the respondent's customer satisfaction index. For the qualitative analysis, CFI developed their own tool to analyze open-ended responses that tags and categorizes responses, similar to NVivo software. NWS does not conduct its own qualitative analysis of this information.

Report and Recommendations

The quarterly report presents current results, year-to-year trends for specific hazards, and quarter-to-quarter results for the standard set of questions. It also compares the NWS Customer Satisfaction Index to the Index for the National Aeronautical and Space Administration (NASA), the General Service Administration, Pension Guarantee Fund, and the overall federal government rating. The NWS score is typically in the top two of the agencies presented. While the report may discuss trends in customer satisfaction, it does not discuss the reasons behind the

numbers. NWS-wide, high-level recommendations are provided in each report. Sample suggested actions from recent reports are shown below:

- Q3_FY2018 Report. *Continue the efforts that have resulted in improved satisfaction levels among the general public, including maintaining the focus on accuracy/reliability and increasing public awareness about hazardous weather.* (CFI Group, 2018b)

- Q2_FY2018 Report. *Pop-up respondents recorded significant improvements to how well NWS provides information to help make decisions concerning both winter weather events and extreme cold/wind chill. However, their perceptions of accuracy of winter weather forecasts have declined five points over the past two cycles.* (CFI Group, 2018a)

- Q2_FY2018 Report. *Accuracy (satisfaction) is down one-point for both hazards [both winter weather events and extreme cold/wind chill] for IP [Internet Panel] respondents.* (CFI Group, 2018a)

- Q1_FY2019 Report. On open response data from severe thunderstorm and tornado questions, *Comments focus on desire for better localization, timeliness, and alerts to mobile devices*. (CFI Group, 2018c)

- Q3_FY2018 Report: *To keep users of NWS services engaged and attract new users, prioritizing development and ongoing investment in mobile-friendly technology is a key opportunity. Users have a high degree of trust in NWS, but often gravitate towards other tools that are more compatible with mobile devices and provide alerts.* (CFI Group, 2018b)

Usage

The Customer Satisfaction Survey (CSS) is used for NWS-wide strategy. In the 2018-2022 strategic plan, the Department of Commerce included the CSI as a key measurement tool for NWS services (NWA, n.d.a). The CSS is tracked as a Government Performance and Results Act (GPRA) metric and is included in the NOAA Annual Performance Plan Report (APPR) which is used to brief senior management and adjust NOAA's yearly budget. Each quarter, the report is presented via PowerPoint/GoToMeeting by the CFI Group to program leaders/managers at NWS Headquarters as well as NWS Regions. The PowerPoint slides are distributed via email to these program leaders/managers. Occasionally, the quarterly report gets disseminated throughout the NWS within an internal electronic newsletter, NWS Insider. The CSS is also serving as a basis for NOAA's Strategic Plan Long Term Goal of having a new "IDSS customer experience metric that holistically assesses engagement and relationship with core government to government partners and based on foundational NWS products and services" (M. Scotten, NOAA, personal communication, September 10, 2019). Currently the quarterly CSS covers the general public, but not stakeholders such as emergency managers. The CSS has also been used for getting feedback on and improving experimental products such as the Potential Storm Surge Flooding map, probabilistic snow forecasts, NWS radar displays, and Wireless Emergency Alert (WEA) messages.

The SBE Science Potential of Customer Service Surveys

The CSS is the only multi-year data collection effort by the NWS on public perception that uses SBE science and methods. The Customer Satisfaction Index is grounded in the theory and practice of organizational measurement and benchmarking (CFI Group, 2013b). The methods are based on social psychology and causal statistics. The Customer Satisfaction Index provides a way for NWS to compare itself across federal agencies, given the caveat, as discussed by Morgeson and Petrescu (2011), that agencies can differ widely in the type of services they provide and how they deliver services. The NWS Customer Satisfaction Index ranges between 74- 86, ranking it among the top performers for federal agencies and well above the overall federal government average of 69 (CFI Group, 2019). Externally, the NWS benefits from tracking and reporting this simple metric that is broadly used.

Recommendation 2-1: Continue using CSS as an external metric as it is based in SBE science and methods and broadly used in government agencies.

For internal NWS-wide strategy, NWS can derive actionable information on new products and services and monitor trends. For example, the CSS has shown the growth of mobile phone usage among customers accessing weather information and offers insight into how the public uses social media. The hazard specific questions each quarter enables tracking of year-to-year trends in customer perception of NWS information quality. However, a key weakness in the survey for NWS internal strategy is the inability to determine potential causes for changes in ratings of customer perceptions. Additional research would need to be conducted to analyze potential causes, and NWS has not undertaken this additional research based on past surveys. Some of the recommendations and insights appear to be too general to be actionable for NWS. Recommendations such as "improve accuracy of forecasts" are far too general to result in any strategy. The analysis and recommendations in the next section focus on adjustments to CSS implementation within NWS that could significantly improve the value of the data for NWS internal strategy.

Analysis of NWS Customer Satisfaction Survey

The CSS could be improved by addressing the population it samples, clarifying how the CSI is derived, conducting additional analysis of the existing data, linking CSS data to other NWS databases, and adding additional questions to the survey that address warning response.

Is CSS Surveying the Right Customers?

There appears to be a difference between NWS customers as defined in NWS strategy and the customers that the CSS measures. The NWS mission is "protection of life and property and enhancement of the national economy" (NWS], n.d.a, p.4). Impact Based Decision Support (IDSS) is a key strategy for realizing the mission. IDSS is defined as "science-based analysis, forecasts and partnership interactions in a consistent way across the agency to effectively deliver accurate and timely weather, water and climate information to decision makers at the federal, state, local and tribal nation levels" (NWS, 2018). IDSS was codified as a strategy in The Weather Research and Forecasting Innovation Act of 2017 (Public Law 115-25). Subsequently,

NWS created guiding principles for IDSS in The National Weather Service (NWS) Service Description Document (SDD) Impact-Based Decision Support Services for NWS Core Partners April 2018 (NWS, 2018). Three important points are articulated in this document:

1. NWS customers are IDSS partners. The document reaffirms that "NWS will support disaster management efforts of federal, state, local, tribal and territorial governments" (p. 3).
2. NWS goal is "ensuring the safety of the public and particularly vulnerable populations" (p. 3).
3. NWS disseminates its products and services in many different ways. NWS acknowledges the key role that IDSS partners, such as Emergency Managers and media, play in amplifying the delivery of NWS products and services. Empirical data on how people access weather information (Lazo, Morss, & Demuth, 2009) supports this idea of an integrated warning team involving multiple organizations disseminating information in many different ways to reach the different segments of the public.

Measurements of customer satisfaction should reflect these guiding principles, which define who NWS customers are and how they access information.

How does the CSS align with NWS strategy? Currently, the CSS does not consistently measure IDSS partners. On a one-time basis, CSS has been distributed to Weather Ready Nation ambassadors, aviation stakeholders, emergency managers, and those who use NWS's hydrologic services, but there is not a consistent data collection effort for IDSS partners. Currently, the NWS Performance Management branch is developing customer satisfaction measures of IDSS partners, based on the CSS survey. These metrics should measure all the ways in which IDSS partners interact with weather service personnel, such as face-to-face interaction, NWSChat, and integrated warning team meetings. A CSS focused on IDSS partners should be separate from the current CSS.

Race	US Population	Pop-Up Sample	Internet Panel
White/Caucasian	61 %	86 %	75 %
Black /African American	12 %	1 %	13 %
Hispanic or Latino	18 %	1 %	9 %
Asian	6 %	1 %	2 %
American Indian or Alaska Native	1 %	1 %	0 %
Other	2%	2 %	1 %
Prefer not to Answer	N/A	9 %	0 %
Gender			
Female	51 %	24 %	48 %
Male	49 %	73 %	52 %
Prefer not to Answer	N/A	3 %	0 %
Age			
15-24	18 %	1 %	7 %
25-34	18 %	5 %	19 %
35-44	20 %	9 %	25 %
45-54	17 %	18 %	27 %
55-64	11 %	34 %	18 %
65+	16 %	33 %	4 %

Table 2-2: Demographic make-up of US (2018 Census estimate) compared to the Pop Up and the IP samples from the Q3 2018 Customer Satisfaction Survey (CFI Group, 2018a)

Recommendation 2-2: Continue development of a CSS for IDSS partners and ensure that the index incorporates all the ways that IDSS partners interact with NWS.

As for the general public, the CSS addresses two customer groups, the Pop-Up sample (general public/website users), and the Internet Panel (general public/not selected based on how NWS info is accessed). Table 2-2 compares the demographic make-up of the Pop-Up Sample, the Internet panel, and the overall US population. If we compare the two samples, we see the Pop-Up panel is not representative of the general public demographically. The Pop-Up sample is predominantly male (73%), white (86%), and over 55 years old (67%), while the IP sample is more representative of the general population, except for representation of people over 65. It should be noted that the Pop-Up panel does not represent IDSS partners as surveys show that the Pop-Up sample uses the information for their own personal purposes.

The two samples also differ significantly in how they access weather information. The Pop-Up sample accesses weather information primarily by computer/laptop (65%) and by smart phone (23%), while the IP sample relies strongly on smart phones (63%) and television (22%), as seen in Table 2-3. The Pop-Up sample is a random sample of NWS website users, but is not representative of NWS customers as described in NWS's own strategy above. This significant bias in the Pop-Up sample could lead to incorrect strategic decision-making for the NWS customer base.

Recommendation 2-3: Phase out the use of the Pop-up sample in light of current NWS strategies. The Pop-Up sample does not represent NWS IDSS partners, nor the public that NWS serves.

The Internet Panel is more representative of NWS customers. The key drawback of the current IP sample is its size, a maximum of 500 people. This size allows analyses on a national level, but only allows for limited analysis on a regional level, and no analysis on a County Warning Area (CWA)-level. It is important to have the ability to evaluate and track regions or CWAs as hazard exposure, communications to the public through IDSS partners, and outcomes vary considerably by region and by CWA. While CWA-level analysis would most likely be very costly, a region-level analysis would enable NWS to better target strategic efforts where they would have the most impact.

Recommendation 2-4: Increase the size of the IP sample. The IP sample represents NWS customer base and the different ways they access weather information (including the NWS website). NWS should consult with CFI about the exact sample size requirements and cost for a stratified sample that reflects the demographics of their customers. CFI claims their methodology reduces measurement error so that they can recruit smaller samples and still obtain significant results (CFI Group, 2013b). Without the ability to drill down to a regional level, the survey will continue to function mainly as an externally-facing metric, with limited use for internal strategy.

Preferred method to check weather	Pop-up	Internet Panel
My personal computer (i.e., laptop, desktop)	65%	10%
Television	2%	22%
NOAA Weather Radio/All Hazards	2%	2%
Commercial Radio Broadcast	0%	1%
My smartphone	23%	63%
My tablet	8%	1%
Number of Respondents	**6,574**	**500**

Table 2-3: Ways of Accessing Weather Info by IP and Pop-Up Samples (CFI Group, 2018a)

Recommendation 2-5: Link customer satisfaction ratings to warning performance metrics. It would be useful to understand if

and how warning performance metrics and NWS customer satisfaction metrics are linked. Once the IP sample is of sufficient size to enable detailed analysis on a regional level, NWS can explore these linkages. For example, are customer ratings of accuracy linked to false alarm rate and probability of detection for flash floods or tornados? Are changes in lead-time linked to changes in perceptions of NWS accuracy? Again, due to the geographically specific nature of hazards, this analysis should happen at an NWS region level, and if cost-feasible, at a CWA level. Understanding the linkages between warning performance and customer satisfaction would be a first concrete step towards linking meteorology performance and human perceptions dimensions of response.

Analysis of Open-ended Responses

In current practice, the CSS asks survey respondents who rate NWS services/information below 60 (out of 100) how NWS services could be improved. Select answers to these questions are included in the quarterly report along with the person's overall satisfaction rating. The open-ended responses are an untapped source of information for NWS.

Recommendation 2-6: Ask open ended questions about ways in which NWS can improve to all survey respondents, not just to those with lower satisfaction ratings. There should be no additional cost for NWS to expand this question. Asking open ended questions of satisfied and dissatisfied customers provides important insights into how these customers vary and provides more feedback for NWS for potentially no added cost. NWS, however, may want to examine how asking open ended questions of all respondents impacts completion rates for the survey.

Recommendation 2-7: Conduct additional qualitative analysis of the open-ended questions contained in the CSS so that trends can be identified and tracked, and new ideas/concerns are flagged. NWS should conduct a content analysis of the IP sample to identify themes relating to accuracy, timeliness, understanding of information, information access, and other topics. The occurrence frequency of themes can be tracked over multiple surveys, and new topics can be identified as they emerge. In addition, results can be analyzed by satisfaction rating, by demographic categories, by NWS regions to provide additional insights into the ratings and highlight topics that might require further investigation, or new questions that could be added to the survey. Given the bias of the Pop-Up sample, only the IP sample should be analyzed. Qualitative analysis is time consuming. Therefore, we recommend that NWS collaborate with a university to conduct the initial content analysis to establish the themes and a methodology to ensure internal validity. Once a structure is in place, NWS could take over the analysis, potentially using student interns or Research Experiences for Undergrads (REU) at collaborating universities to conduct the coding under the supervision of NWS SBE scientists.

Protective Action Decision-Making

Although CSS is intended to measure satisfaction, the addition of three or four questions on protective action decision-making could expand the usefulness of the survey at a relatively low cost. Protective action decision-making is the process people go through to keep safe as hazards occur or are predicted to occur. The process involves many factors including warning receipt and comprehension, perception, trust, mental models, prior experience with hazards, situational factors, and social vulnerability which all lead to a response (Drabek, 1999; Lindell & Perry, 2012; Mileti & Peek, 2000; Mileti & Sorensen, 1990; Nigg, 1995). The CSS provides useful data on some aspects of protective action decision-making and response, as perceptions,

intentions, and trust play a key role in how people respond to weather information. In addition, the CSS questions on how people access information, whether they have preparedness kits, and the open questions about how NWS can improve its services are very useful for understanding protective action behaviors. However, the CSS lacks information about actual behaviors which frequently differ from intended behavior due to the situational circumstances of an event. For example, the CSS reports a metric for "likelihood to take action based on NWS Information" which typically has a very high rating (90s on a 100-point scale). However, empirical research shows that many people drive on flooded roads (League, Philips, Meyers, & Westbrook, 2020), and do not take immediate protective action in response to tornado warnings (Sherman-Morris, 2005; Simmons & Sutter, 2011). In addition, although the survey asks people to rate their knowledge of different hazards, the survey does not assess the accuracy of that information.

Recommendation 2-8: Add several questions about actual behavior and accuracy of customer perceptions that would enable analysis of protective action decision making. For example, Ripberger et al. (2019) created a survey that does address actual behaviors and understanding of NWS information for tornado warnings. The questions are developed using psychometrics, as in the CSS, where multiple questions are used to measure understanding of NWS information. It also asks whether people have taken protective action recently and the type of protective actions. These types of questions could be added into the CSS to provide more insight into people's understanding and actual response to information. As trends in this data are collected, they can be used to gain more insight into the results.

Methodological Clarification

As stated earlier, the quarterly reports use a causal model to link satisfaction with specific hazard products/services to overall satisfaction with the NWS. For example, the Q3 report addresses products and services for tornadoes and severe thunderstorms and show how these items contribute to the general NWS CSI; the Q1 report addresses tropical storms/floods and links these items to overall NWS CSI. Conceptually, should there be a causal link between hazard specific information and general CSI, or should they be disconnected? Are trends in overall NWS CSI comparable from quarter to quarter? Or, should only annual comparisons be made which focus on the same hazard? A slide from the Q3 report in Figure 2-3 illustrates the issue below.

Recommendation 2-9: Discuss with CFI how the hazard-specific satisfaction index generalizes to an overall NWS CSI through the causal model and the most appropriate way to track and compare overall NWS CSI.

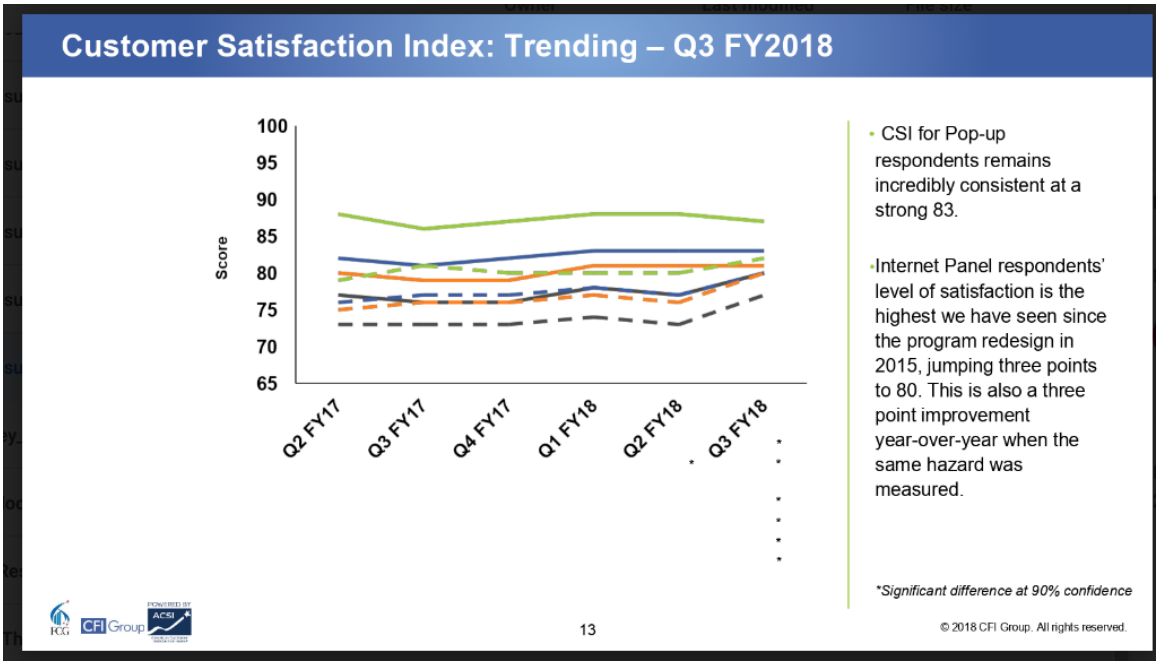


Figure 2-3: Quarterly comparisons of overall NWS CSI based on questions about Q1 (Tropical Storms/Hurricanes/ Flash Floods), Q2 (Winter Weather), Q3(Thunderstorms/Tornados), Q4 (Heat) (CFI Group, 2018a)

Summary of Recommendations

The CSS enables the creation of a science-based metric for comparison of NWS to other agencies, which is important for external strategy. However, there are opportunities to improve CSS's usefulness for internal NWS strategy. The most important opportunities are creating a CSS for IDSS partners and changing the sampling strategy for the current CSS, so the survey is more representative of NWS customers. The sample should also be increased in size to allow detailed analysis by NWS region (and if cost-effective by CWA). These recommendations and others are summarized below:

1. Continue using CSS as an external metric as it is based in SBE science and methods and broadly used in government agencies.
2. Continue development of a CSS for IDSS partners and ensure that the index incorporates all the ways that IDSS partners interact with NWS.
3. Phase out the use of the Pop-up sample in light of current NWS strategies. The Pop-Up sample does not represent NWS IDSS partners, nor the public that NWS serves.
4. Increase the size of the IP sample**.** The IP sample represents NWS customer base and the different ways they access weather information. Having a sufficient sample size for regional and CWA-level responses would increase the value of the data significantly and enable detailed analyses.
5. Link customer satisfaction ratings to warning performance metrics. It is important to understand if and how warning performance metrics and NWS customer satisfaction metrics are linked.
6. Ask open ended questions to all survey respondents on ways that NWS can improve, not just to those with lower satisfaction ratings.

7. Conduct additional qualitative analysis of the open-ended questions contained in the CSS so that trends can be identified and tracked, and new ideas/concerns are flagged.
8. Add several questions to the CSS about actual behavior and accuracy of customer perceptions that would enable high-level analysis of protective action decision-making.
9. Discuss with CFI how the hazard-specific satisfaction index generalizes to an overall NWS CSI through the causal model to determine the most scientifically rigorous way to track and report overall NWS Customer Service Index.

CHAPTER 3: QUICK RESPONSE SURVEYS

Introduction

NWS created a group of Quick Response Surveys (QRS) to understand public perception and response to significant weather events. Quick response research is a method used by hazard researchers to collect perishable data soon after a disaster occurs. Most often, the research involves qualitative field interviews of stakeholders and the public, but it can also include surveys with multiple choice and open-ended questions. Separate surveys exist for the hazards listed below.

- Air Stagnation
- Dense Fog
- Dust Storms
- Flash Floods
- Freeze and Frost
- Heat and Excessive Heat
- High Surf, Marine – Convective and Non -Convective
- Hurricanes, Tropical Storms
- Severe Thunderstorms, Tornados
- Wind and High Winds
- Wind Chill and Extreme Cold
- Winter Storms and Winter Weather

Quick Response Survey Overview

Brent MacAloney's article in the summer 2015 edition of Peak Performance (the newsletter of the NWS Performance Branch) summarizes the approach (NWS, 2015, pp. 10-11). The survey was developed with extensive input from the local forecast offices and therefore reflects their needs for information. The multiple choice and open-ended questions are tailored to the specific hazard and cover the following topics:

- Sources of weather information and actions leading up to and before the event
- Actions taken once the warning was issued
- Sources of weather information and actions taken once the event was ongoing
- Level of satisfaction with regard to the quality, timeliness, accuracy, threat explanation, and format of the products
- Degree to which the NWS products helped in decision making and overall satisfaction with NWS products during the event
- Moving away from a specific weather event
- Understanding of an advisory, watch, and warning in an open-ended question
- Likelihood of taking action in the future
- Demographics

The QRS had Office of Management and Budget approval through May 2018 and could be used by any office to collect data from the general public. The survey could be administered as a paper-based or internet-based survey. However, each forecast office had to determine how to field the survey, collect answers, and analyze the data. There were no standard methods for sampling strategies or data analysis. In addition, there was no central repository for surveys results to enable analysis of aggregated data. See Appendix B for survey examples for different hazards.

Results and Usage

In practice, the surveys were used for Service Assessments (see Chapter 1) to guide the field interviews. They were not used by forecast offices because they placed too much of a burden on the forecast offices to administer the survey and then analyze the results.

SBE Potential of Quick Response Surveys

The QRS could serve as a powerful and useful tool for WFOs to uncover their unique strengths and challenges in hazard warning and communication, and to track how the publics' perceptions, trust, and behaviors evolve over time. The QRS could be a unique source of data on specific perceptions and actions by the public, such as sheltering or preparations, in response to specific NWS warnings and other information. Collecting information regularly with a consistent set of questions, focusing on medium to high-end events, would provide actionable, WFO-specific information. QRS questions are consistent with other scientifically rigorous surveys that address hazards perception and response (Nagele & Trainor, 2012; Trainor, Nagele, Philips, & Scott, 2015). The QRS lessens recall bias (Spinney & Millward, 2011) as it is administered soon after an event; in addition, asking people how they responded to a specific event can provide more detailed answers and insights than asking about a hazard type generally, or about a hypothetical situation. See Drobot, Benight, & Gruntfest (2007); Nagele & Trainor (2012); and Schultz et al., (2010) as examples of these different approaches. WFOs could share QRS results with IDSS partners in post-event analyses to strengthen relationships and improve the integrated warning team. Thus, the QRS could be an important tool to advance NWS IDSS goals and strategies for forecast offices that is informed by SBE science.

The QSR is *complementary* to other existing data collection efforts. The Customer Satisfaction Survey (Chapter 2) collects national level and some regional level data on public perceptions and intentions, but not actions, while Service Assessments (Chapter 1) collect one-time qualitative data on response to selected high-end events. As a bottom-up approach, QRS can collect the type of event-specific and detailed information that is useful for a WFO and its IDSS partners. The aggregated data would also provide a very detailed record of human perception and response across the NWS that could be linked to warning performance metrics.

Getting SBE value from the QRS would require putting a process in place that would enable collection of high quality, multi-year, cross-sectional data, but at the same time not impose a burden on forecast offices. Issues that need to be addressed are survey administration, survey content, survey dissemination, sampling methods, and survey triggers.

Recommendation 3-1: In order to move forward at a low cost, use the current QRS to put a pilot plan into action, evaluate the pilot, and make modifications for a NWS-wide rollout. The analysis and recommendations in the next section focus on steps to re-introduce the QRS so that it can realize its potential.

Analysis and Recommendations for QRS

Survey Software

Recommendation 3-2: NWS should purchase and implement a survey software system. To overcome the burden on WFOs of disseminating this survey on a regular basis, the NWS Performance Management Branch should create a flexible survey infrastructure by purchasing a license to survey software. There are several companies, such as Qualtrics, Survey Monkey, and others that offer software for administering and analyzing survey data. Setting up a survey system would take time up front, but once established, it would make administration, dissemination and analysis very efficient. As a first step, the QRS for each hazard would be entered into the survey software. To initiate a survey for a specific event, a forecast office would "activate" a survey by entering specific information on a one time basis (for example on hazard type, date, time, counties impacted, warning IDs, WFO), and then make an internet link with the survey available to the public via NWS Facebook, Twitter, local emergency management social media or email lists. The survey would be completed by the general public on computers, laptops and mobile phones. Surveys would be collected and aggregated through the survey software. As part of the setup, standard descriptive statistics, statistical tests, such as t-tests or chi-squared tests, and visualizations could be pre-configured. These statistics would be the basis of standard reports that could be generated and shared with forecast offices days after data collection is completed. This would allow WFOs to have relevant and timely data to share with their partners. In a future phase, the system could have the capability to incorporate additional survey questions that a WFO would like to have answered for a specific event. These optional questions could be generated by forecast offices in advance and pre-approved by OMB so there is a menu of additional questions that can be asked. Data could be aggregated by hazard type, by date, by WFO, region, by demographic variables, and by survey questions to gain NWS-wide insights into human response and perception. The benefits for implementing a survey software system in NWS would go beyond the QSR survey and could be used for the IDSS partner surveys, and many other one-time efforts.

Survey Dissemination Strategy

Recommendation 3-3: NWS should define thresholds of when to disseminate surveys based on hazard type, frequency, population, warning performance, and impacts for a given forecast office. As an example, a trigger strategy might include each office conducts a minimum of two surveys each year on the highest impact hazards (based on historical NOAA storm data on injuries, deaths, and economic impacts). In addition, offices in the top quartile of warning activity will conduct two to three more surveys, while offices in the second quartile will conduct an additional survey. Warning Coordination Meteorologists would be responsible for initiating the surveys; however, as described above, most of the decisions would be pre-specified. In this way, in a fully rolled out QRS program, NWS could collect between 300 – 500 public response surveys covering a variety of hazards over the course of a year.

Sampling Strategy

Recommendation 3-4: Create a consistent sampling strategy for reaching NWS target populations by evaluating the cost and quality trade-offs among different sampling strategies. To ease the burden on WFOs, the sampling process should be predetermined for each survey based on SBE methods. The most economical way to approach this data collection is

through a convenience sample, a non-probability sample comprised of people who are easy to reach (Groves et al., 2004). To obtain a convenience sample, a forecast office would disseminate the link to the survey on Facebook, Twitter, and the NWS website, and encourage its IDSS partners to share the link. This approach should be used initially since it is low cost, allowing the project to be implemented quickly. However, such a sample is likely to be biased. The main biases stem from 1) only reaching those who have access to the internet, although that gap is narrowing each year (PEW Research Center, 2019); and 2) a selection bias due to the type of person who tends to use weather and public safety social media. Ideally, to ensure generalizability of results, NWS should use probability sampling, a stratified random sample that is representative of the public demographic make-up (Groves et al., 2004). A random sample is typically purchased through a company that specializes in sample generation. This approach can be very expensive, especially if the overall goal of this effort is to conduct multiple surveys each year in CWAs across the country. An alternative would be a mixed-mode approach which uses NWS and IDSS partner websites and social media to obtain a convenience sample, and an internet panel (people who have agreed to complete surveys on the internet for compensation, another convenience sample) to reach demographic segments that do not typically respond to surveys. This approach is a modified version of quota sampling, which is a stratified sample without random selection of respondents.

As an example, the Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA) has been conducting post-event surveys through social media and has found that in the Dallas Fort Worth area, it is very difficult to obtain survey responses from Hispanic and African American populations and people in the 18-25-year-old range. As a result, they have started targeting African Americans and Hispanics and young respondents though Internet Panels to ensure the survey responses are representative of the general public. This deliberate non-probability sampling for different demographic group is called quota sampling. Researchers pay per response for the internet panel, so the NWS would want to conduct an analysis to determine the cost/bias trade-off of stratified random sampling vs. representative quota sampling. As response rates to surveys have plummeted in general, several studies have shown that even random samples contain bias. Therefore, there may not be a large enough advantage for using a traditional stratified sample versus having convenience sample that is demographically representative through quota sampling.

Linkages to other NWS SBE Data Collection Efforts

Recommendation 3-5: To best utilize QRS, they should be incorporated into other NWS SBE data collection processes. This should include the appropriate metadata (forecast office, region, hazard type, warning ID), in the overall design of the survey system, so that QRS will enable aggregation of the data and enable linkages to other NWS data sources. Some of the suggested linkages are listed below:

Warning Performance Metrics - By aggregating QRS data, NWS could learn which dimensions of perception and response are linked to NWS warning performance metrics false alarm, lead time, and missed events. Compared to the CSS in Chapter 2, the QRS can provide data on a WFO-level.

Storm Events Database - By specifying dates, times and warning IDs, human perception and response data could linked to deaths and injuries.

Customer Satisfaction Survey - There are questions about perceptions, satisfaction and trust that are very similar in the QRS and the CSS. These questions should be made identical in both surveys so that specific responses to weather events in the QRS and the general responses the CSS can be compared and contrasted.

Service Assessments - Once the QRS has a standard implementation, it should always be included in Service Assessments to strengthen the SBE value of Service assessments. By using standardized data collection methods (see Chapter 1), such as the QRS, localized WFO data will provide a more nuanced look at the event from an impact perspective.

Summary of Recommendations

The QRS is an effort that is no longer supported by NWS. However, the QRS could serve as a powerful and useful tool for WFOs to uncover their unique strengths and challenges in hazard warning and communication, and to track how the publics' perceptions, trust, and behaviors evolve over time. Getting SBE value from the QRS would require putting a process in place that would enable collection of high quality, multi-year, cross-sectional data, but at the same time not impose a burden on forecast offices. We make the following recommendations to improve the QRS program:

1. In order to move forward in the shorter term, and at a low cost, use the current QRS to put a pilot survey effort into action, evaluate the pilot, and make modifications for a NWS-wide rollout.
2. NWS should purchase and implement a survey software system.
3. NWS should define thresholds of when to disseminate surveys based on hazard type, frequency, population, warning performance, and impacts for a given forecast office.
4. Create a consistent sampling strategy for reaching NWS target populations by evaluating the cost and quality trade-offs among different sampling strategies.
5. To best utilize QRS, they should be incorporated into other NWS SBE data collection processes.

CHAPTER 4: NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION (NCEI) STORM EVENTS DATABASE

Introduction

NOAA produces and hosts one of the most significant archives of environmental data which is publicly accessible through the National Centers for Environmental Information (NCEI), formerly the National Climatic Data Center (NCDC). The NCEI provides over 25 petabytes of comprehensive atmospheric, coastal, oceanic, and geophysical data available to the public. The Storm Events Database contains U.S. storm data entered by the NWS from January 1950 to the current year. According to the Storm Events Database website (National Centers for Environmental Information [NCEI] (n.d.a), the database documents:

1) The occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce;
2) Rare, unusual, weather phenomena that generate media attention, such as snow flurries in South Florida or the San Diego coastal area; and
3) Other significant meteorological events, such as record maximum or minimum temperatures or precipitation that occur in connection with another event.

These storm events are compiled into the monthly Storm Data Publication (available for pdf download at www.ncdc.noaa.gov/IPS/sd/sd.html). Publications contain a chronological listing, by state, of storm occurrences, paths, deaths, injuries, property damage, and unusual weather phenomena. The database is also searchable by state, county, date, and event type with filters for severe weather classifications (ex. Tornado EF rating, wind speed and hail size). This section will focus on NCEI's Storm Events Database including methods for data collection, usage, limitations and recommendations. Other sources of weather and climate data useful for SBE science are mentioned such as NOAA's Weather Related Fatality and Injury Statistics or Haz Stats and the Storm Prediction Center's (SPC) SVRGIS database.

Storm Events Database Overview

The Storm Events Database archives all reported storm events and significant weather phenomena for 55 types of events (ex. floods, droughts, severe weather, blizzards, tsunamis, etc.). The information is collected and submitted by local NWS offices using the *Storm Data* software program. Procedures for documentation are described in NWS Instruction 10-1605 (2018). NWS retrieves information from a variety of sources, which include but are not limited to: county, state and federal emergency management officials, local law enforcement officials, SKYWARN spotters, NWS damage surveys, newspaper clipping services, the insurance industry and the general public, among others. The Storm Data website notes "An effort is made to use the best available information but because of time and resource constraints, information from these sources may be unverified by the NWS… Property and Crop damage should be considered as a broad estimate" (NCEI, n.d.b).

Data is available approximately 75 days after the end of a month. Due to changes in the data collection and processing procedures over time, event types available for download may vary by year. For example, tornado data is available from January 1950 to the current year, while thunderstorm wind and hail was included beginning in 1955. All event types are available from

1996 to present. Today, the NWS manually enters event data into the database. Prior to 1993, narratives were only typed for the Storm Data Publication, and earlier records had to be extracted from the Publication using Optical Character Recognition software. Events are categorized by state and county, and contain event type, dates, times, magnitude, deaths, injuries, and reported property and crop damage. Furthermore, fatality data contains details about event-related deaths when available, as well as the geographic location of each event.

With regards to documenting weather related injury and fatality data, a determination must be made on a case-by-case basis whether the weather event caused a direct versus indirect injury or fatality. "A direct fatality or injury is defined as a fatality or injury directly attributable to the hydrometeorological event itself, or impact by airborne/falling/ moving debris… Fatalities and injuries, occurring in the vicinity of a hydrometeorological event, or after it has ended, but not directly caused by impact or debris from the event (weather event was a passive entity), are classified as indirect" (NWS, 2018). NWS notes these determinations are often difficult to make, and that they are not a *legal* determination. Data are intended for internal use for statistical review in support of its mission.

Damage estimates are reported in US Dollars and are obtained from emergency managers, U.S. Geological Survey, U.S. Army Corps of Engineers, utility companies, and newspaper articles. Insured loss estimates for disasters totaling $25 Million may be obtained from Verisk Analytics' Property Claim Services, however losses do not include flood damage which is covered by the National Flood Insurance Program. Crop damage may be obtained from the United States Department of Agriculture (USDA), agricultural extension agents, state departments of agriculture, crop insurance agencies, etc. Preparers are encouraged to make a good faith attempt to estimate damages. If estimates are not available, the preparer may enter "no information available" or make an estimate.

Using Storm Reports data compiled from the NCEI database, NOAA also produces other databases useful for SBE research including the Weather Related Fatality and Injury Statistics, or HazStats, available at www.weather.gov/hazstat/. HazStats tracks weather-related fatalities including lightening, tornado, flood, hurricane, heat, winter, rip current, and wind fatalities. Summaries provide 10- and 30-year averages, and circumstance of death, such as in water, mobile home, outside, vehicle, etc.

The Storm Prediction Center (SPC) also houses the SVRGIS page which contains the U.S. severe report database for tornadoes (1950-current), and hail/wind (1955-current) available at www.spc.noaa.gov/gis/svrgis/. The data can be viewed in graphical, tabular, and statistical formats depending on end-user needs. The SPC also provides up to date and archived local storm reports, outlooks, and severe weather watches available at www.spc.noaa.gov/archive/. Fatal tornadoes and tornado summaries are available at www.spc.noaa.gov/climo/online/ or www.spc.noaa.gov/wcm/.

Usage

The Storm Events Database is described as the most comprehensive dataset available for detailing U.S. weather and climate events and impacts (NCEI, n.d.a) and has been widely utilized by the SBE research community. For example, flood fatalities in the U.S. have been analyzed including age and gender victims, location, cause and circumstance of death including vehicle-related fatalities, and flood type (Ashley & Ashley, 2008; Kellar & Schmidlin, 2012;

Sharif, Jackson, Hossain, & Zane, 2014; Terti, Ruin, Anguetin, & Gourley, 2017). Tornado hazards have been studied including spatial and temporal distribution of events and losses (Ashley 2007; Boruff et al., 2003). Economic losses and impacts due to weather and climate have also been investigated using data derived from the Storm Events Database (Changnon & Hewings 2001; Simmons & Sutter 2013). The database is also utilized for tornado and severe storm climatology studies (Brooks, Doswell, & Kay, 2003; Doswell & Burgess, 1988). Brotzge, Erickson, & Brooks (2011) also investigated climatological trends of tornado false alarms and factors impacting the false-alarm ratio.

Gourley et al. (2013, p. 800) state "The NWS Storm Events Database is essential for evaluating and improving operational forecast products and procedures." Examples of NCEI data used by NWS forecasters is a study by Blair and Leighton (2014) who assessed the occurrence of real-time tornado confirmations contained within the warning, suggesting the possibility of achieving a stronger public response. Blair et al. (2017) also used NCEI data to compare hail size in a project called HailSTONE with the goal to better anticipate and forecast hail sizes during convective warning events. The Storm Events database is well utilized by the SBE research community as well as for climatology studies, but perhaps an underutilized resource by the NWS.

Recommendation 4-1: Include information on NWS warning performance (lead time) within the Storm Events database so that an association could be made between warning performance and event outcomes. The Storm Events database might then be utilized more by NWS forecasters with the possibility of improving operational forecast products and procedures.

Limitations

While the Storm Events Database is the most comprehensive dataset available, there are also important limitations to point out. Lazo, Bushek, and Laidlaw (2008) demonstrate the bias that occurs in damage estimation for extreme weather events in that irregularities in reporting may result in damage estimates varying by 40% or more among different data sources. In a study looking at billion-dollar disaster losses, Smith and Katz (2013) also found bias in loss estimation, which led to an underestimation of losses. In a study using *R* statistical data analysis of the Storm Events database, dos Santos (2016) found incomplete reports (ex. damage reports were missing) and inconsistent data (ex. non-standardized event types being reported, and irregular loss data mixing up $Million and $Billion). Gall, Borden, and Cutter (2009) point out there is a lack of standard methods across agencies for collecting and reporting disaster loss data, which results in losses being inconsistently reported. Other biases may include an uneven representation of hazard types, changes in reporting requirements over time, subjectivity in the reported event locations and timing, and little or no information about the site's societal exposure, response or antecedent conditions (Gourley et al., 2013).

Reservations and appropriate precautions should be made before making inferences from the data (dos Santos, 2016). Gall et al. (2009, p. 807) recommend standardizing loss data collection, documentation, accessibility, and dissemination for all natural hazards across the various federal agencies tasked with collecting hazard event and loss data. Lazo et al. (2008, p. 1) also advocate for "a longer term effort to standardize collection, reporting, and archiving of data on weather related damage to provide reliable information for future decision making."

Despite procedures in place, and the dedicated efforts of each NWS WFO, the Storm Events database is inherently biased with regards to estimating losses, incompleteness, inconsistencies, and standardized reporting. Furthermore, the Storm Events database lacks societal impact information such as public perception, exposure and response that would be useful both to SBE scientists and the NWS.

Recommendation 4-2: There should be a push to standardize loss data collection, documentation, accessibility, and dissemination across the agency to increase reliability of results.

Recommendation 4-3: As metrics on reception, perception, behavior, is gathered (through the Customer Satisfaction Survey, for example), there should be ways to link this data to Storms Events and other databases in order to relate public perception and behavior and event outcomes.

Summary of Recommendations

The Storm Events Database is widely used by SBE researchers, but the database is not without bias. Recommendations to improve the usefulness of the database for SBE research include:

1. Include information on NWS warning performance (lead time) within the Storm Events database so that an association could be made between warning performance and event outcomes.
2. There should be a push to standardize loss data collection, documentation, accessibility, and dissemination across the agency to increase reliability of results.
3. As metrics on reception, perception, behavior, is gathered (through the Customer Satisfaction Survey, for example), there should be ways to link this data to Storms Events and other databases in order to relate public perception and behavior and event outcomes.

CHAPTER 5: CONCLUDING RECOMMENDATIONS

Conclusion

Over the last several years, the National Weather Service worked to improve Social, Behavioral, and Economic data collection through their ongoing practices. This report is designed to help move their progress to the next level by focusing directly on how to strengthen SBE data collection in the work they are already doing. Through more developed methods based on SBE research standards within the initiatives already in place, data collection can help further the understanding of SBE interaction with the weather enterprise. By gaining a better understanding of how weather impacts people and how they respond to it, the NWS can better meet their mission by protecting life and property.

Throughout this report, we made specific recommendations within each chapter that includes nuanced details about how to improve each data collection method. These suggestions are meant to improve current processes in existing practices without much additional resources. By adopting these details into the functions NWS already has will strengthen their efforts for each individual process and the agency overall. To conclude this report, this chapter discusses overall findings about how the NWS can make small but impactful system wide changes that will improve SBE data collection throughout all of their efforts.

Collect SBE data as a primary focus in addition to physical meteorological data.

The focus for NWS has primarily been on collecting physical meteorological data through in-situ instrumentation, such as temperature and pressure sensors, and remote sensing equipment, such as satellites and radars. This type of data collection takes intensive processing power, expertise, and funding. Similarly, SBE research needs adequate time, expertise, and funding. In order to fully embrace SBE research within NWS, equal amounts of resources should be afforded to both types of data collection. This can be accomplished by hiring additional SBE scientists with appropriate academic or practical training, moving more SBE research in-house rather than hiring contractors, and affording additional financial resources.

Moving beyond data collection, similar amounts of attention needs to be paid to analysis. There was some evidence of attention to SBE data collection across all four initiatives explored in this report; however, analysis of SBE data was lacking. In Chapter 1, Service Assessments sometimes collected SBE data, but seldom moved beyond a description of public experiences or direct quotes. Only in a few cases, that included SBE trained experts, were there advanced analysis of the data collected. The Customer Satisfaction Survey, as seen in Chapter 2, collects perceptions of partners including the public, but is only used to rank the agency within executive meetings. The data it holds is not used to further understand human behavior and how individuals make decisions around the weather. The Quick Response Surveys, as Chapter 3 explores, are an additional tool that can be used by NWS to collect a deeper look at public perceptions and behavior after key events. Unfortunately, it was underutilized due to the resources required for implementation. It is not clear how data that was collected from these methods has been analyzed and used to better our understanding of human behavior around extreme events. Chapter 4 illustrates the great depth of data NWS and NOAA has at their disposal. The data has been used widely for SBE research by outside entities for a variety of SBE research projects. There is great opportunity for NWS to use this data, in conjunction with other data collection efforts, to better understand public perceptions and behavior. Through proper data

analysis, NWS can better understand their customers and tailor products to better meet their needs.

Use SBE methodological approaches to data collection.

As seen in the last four chapters, there is a wide range in the methods NWS uses to collect SBE data. It seems the majority of these methods are not developed by SBE researchers and are not designed in line with stringent SBE practices. That is why this recommendation is mentioned several times throughout the report and at least once in every chapter. In order to collect data that is reliable and valid, it is important to use tried and tested methods. To take this recommendation one step further, SBE researchers are also needed to conduct this type of data collection. In the way a sociologist should not be responsible for creating and analyzing an atmospheric sounding profile, meteorologists should not be responsible for designing, conducting, and analyzing SBE research. In order to strengthen this kind of research, NWS needs to hire experts to oversee data collection. With their experience and expertise, they can ensure SBE data collection methods are in line with industry standards.

Standardized some SBE data collection processes to allow for easy comparisons over time.

Several chapters within this report noted the importance of having comparable data to see how data changes over time. This includes perceptions and behaviors of the public, satisfaction with NWS products, and NWS accuracy metrics. Currently, there is little standardization on the methods NWS uses when collecting SBE data. Atmospheric measurements have been standardized over time and there are strict guidelines on how instrumentation should be set up and calibrated. This has allowed climatologists to observe temperature changes over time. The same is needed for SBE research. It is difficult to determine if perceptions, behaviors, or satisfaction is changing if the metrics used to measure them change frequently. Researchers or staff trained in SBE research methods should oversee this process in order to standardize their collection efforts. It will allow NWS to better understand their operations over time and make better decisions to meet the needs of consumers and achieve their mission.

These three overall recommendations are not specific actions NWS should take to improve a specific operation, but rather promote a shift in mindset for the entire organization. By recognizing the importance of SBE research and data collection, which has been provided in countless studies and previous reports, such as the National Academies Report (2018), NWS can make progress towards understanding how their customers utilize their products. Small but wide-spread structured changes to the agency will promote the benefits, importance, and legitimacy of SBE research and make the data collection and analysis process a priority rather than an extra initiative. This shift is needed at all levels of the agency to realize the potential for SBE research within the National Weather Service.

Appendices

Appendix A: Customer Satisfaction Surveys

NWS 2020 Quarterly Internet Panel Customer Satisfaction Survey_Q1 FY20 (08/29/19)

Introduction

Note: Section headers will not be included in online survey. Items in **BOLD AND CAPS** are programmer instructions. Response options will be randomized, except when sequential. All rated questions will include a "Don't Know" and/or "NA" option. When a "RANDOMIZE" instruction is provided, any "Other," "Don't Know," "NA," or "None" style of response will be forced to the bottom of the response set.

Introduction

The National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) is committed to serving the needs of all of its users. The NWS is undertaking research on how satisfied users are and would appreciate your feedback. The purpose of this research, conducted in partnership with the federal government as part of the American Customer Satisfaction Index, is to help the NWS improve its services for you and others like you.

Your answers are voluntary, but your opinions are very important for this research. Your responses will be kept completely confidential, and you will never be identified by name. CFI Group, a third-party research and consulting firm, is administering this survey via a secure server. The time required to complete this survey will depend on how certain questions are answered, but will likely take about 10 minutes. This survey is authorized by Office of Management and Budget Control No. 1090-0007, which expires September 30, 2021.

Please click on the "Next" button below to begin the survey.

Screeners

Q1. Are you familiar with the watches and warnings issued by the NWS as they relate to hazardous flooding and tropical storms/hurricanes?

Yes, both hazardous flooding and tropical storms/hurricanes	1	
Hazardous flooding only	2	**[SKIP TO FLOOD SECTION]**
Tropical storms/hurricanes only	3	**[AFTER TROP STORM/HURRICANE Q'S, SKIP TO CSI]**
Neither hazardous flooding nor tropical storms/hurricanes	4	**[THANK AND TERMINATE]**

Use of NWS Information

Q2. What methods do you use to check the weather? Select all that apply. **[MULTI-SELECT]**

Personal computer (i.e., laptop, desktop)	1
Television	2
NOAA Weather Radio/All Hazards	3
Commercial Radio Broadcast	4
Smartphone	5
Tablet	6

Q2.1 Which of these selected is your most preferred method?

[PN: Prepopulate Q2.1 with responses selected in Q2]

Q3. Which of the following websites have you visited in the past month for weather information? Select all that apply.

Weather.gov (the official website for the National Weather Service)	1
Weather.com	2
Accuweather.com	3
Yahoo!	4
Google	5
Wunderground.com	6
WeatherBug	7
Intellicast	8
Local news/radio website	9
None of the above	10

Weather Hazard Preparedness

Q15. Do you have a safety plan and/or a safety kit for coping with any of the following hazard types? Select all that apply (**PN: include "Neither" as an option)**

	Safety Plan (e.g., evacuation, shelter, communication)	**Emergency Preparedness/Safety Kit/ Disaster Supply Kit**
Hazardous Flooding		
Tornadoes		
Tropical Storms/Hurricanes		
Tsunamis		
Wildland Fires		
Hazardous Winter Weather		

NWS Information for Tropical Storms/Hurricanes

Q4. Please think about the information you receive from the NWS regarding **tropical storms/hurricanes**. Using a scale from 1 to 10 where 1 is "Poor," and 10 is "Excellent," please rate **NWS** on the following:

(Select one for each row)

	Poor 1	2	3	4	5	6	7	8	9	Excellent 10	Don't Know/NA
Ease of finding tropical storm/hurricane forecast information specific to your geographic area of interest											
Accuracy of information for tropical storms/hurricanes											
Explaining the threat and expected impacts of tropical storms/hurricanes											
Providing information to help you make decisions relative to tropical storms/hurricanes (e.g., remaining indoors, evacuating, sheltering pets/livestock)											

Q5. **[If "providing information to help you make decisions…" <6]**
Please indicate what the NWS should change to better help you in making decisions when tropical storms/hurricanes are forecasted. **(Open End)**

Contribution to Understanding of Tropical Storms/Hurricanes

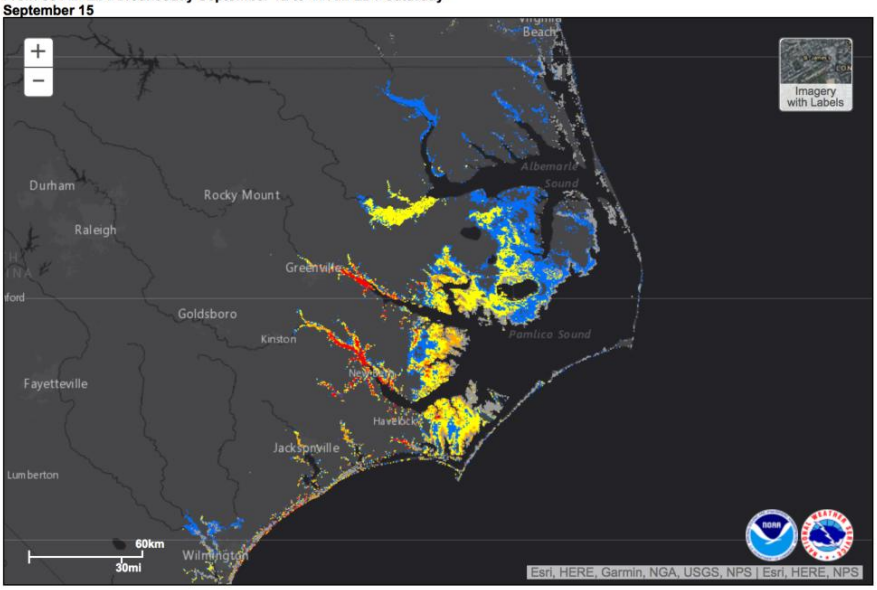
Q6. How would you rate your **current knowledge of tropical storms/hurricanes** using a 10-point scale in which 1 means "Not at all knowledgeable" and 10 means "Very knowledgeable"?

Q7. Now please rate the extent to which the information provided by the NWS has **contributed to your understanding of the dangers of tropical storms/hurricanes,** using a 10-point scale in which 1 means "Not at all" and 10 means "Significantly."

Storm Surge

Q8. The NWS National Hurricane Center provides an online graphic called a Potential Storm Surge Flooding Map, which shows potential storm surge inundation levels from tropical storms and hurricanes. An example of this tool is pictured below. Have you ever referred to this online resource?

NHC Potential Storm Surge Flooding Map
Hurricane FLORENCE (2018) Advisory 52
From 05 AM EDT Wednesday September 12 to 11 AM EDT Saturday September 15



Potential Storm Surge Flooding*

- Intertidal Zone/Estuarine Wetland
- Greater than 1 foot above ground
- Greater than 3 feet above ground
- Greater than 6 feet above ground
- Greater than 9 feet above ground

Map Layer Options:

Inundation Layer Only | Inundation with Intertidal Layer

Map Opacity Slider

Download GIS data *(Instructions)*	Inundation Layer Only	Inundation with Intertidal Layer

*Displayed flooding values indicate the water height that has about a 1-in-10 (10%) chance of being exceeded.

Yes	1

CFI Group

No	2
Not sure	3

Q9. When you used the **Potential Storm Surge Flooding Map** how did you interpret the results in terms of the predicted magnitude of flooding?

[PN: ASK Q9 ONLY IF Q8 = 1]

Reasonable worst case scenario (the greatest amount of flooding)	1
Reasonable best case scenario (the least amount of flooding)	2
Most likely scenario (the most likely amount of flooding)	3
Not sure	4

Q10. **[This question will be on a new page in the online survey]**
The Potential Storm Surge Flooding Map is intended to show the reasonable worst-case scenario for the depicted areas. Please provide any feedback you would like to share about how we may make this feature most useful for you. **[Open End]**

NWS Information for Hazardous Flooding

Q11. Now consider the information you receive from the NWS regarding **hazardous flooding**. Using a scale from 1 to 10 where 1 is "Poor," and 10 is "Excellent," please rate **NWS** on the following:

(Select one for each row)

	Poor 1	2	3	4	5	6	7	8	9	Excellent 10	Don't Know/NA
Ease of finding hazardous flooding forecast information specific to your geographic area of interest											
Accuracy of information for hazardous flooding events											
Explaining the threat and expected impacts of hazardous flooding events											
Providing information to help you make decisions relative to hazardous flooding (e.g., avoiding flooded roadways, evacuating, moving personal property, moving to higher ground)											

Q12. **[If "providing information to help you make decisions…" <6]**
Please indicate what the NWS should change to better help you in making decisions when hazardous flooding is forecast. **(Open End)**

Contribution to Understanding of Hazardous Flooding

Q13. How would you rate your **current knowledge of hazardous flooding** using a 10-point scale in which 1 means "Not at all knowledgeable" and 10 means "Very knowledgeable"?

Q14. Now please rate the extent to which the information provided by the NWS has **contributed to your understanding of the dangers of hazardous flooding,** using a 10-point scale in which 1 means "Not at all" and 10 means "Significantly."

Customer Satisfaction Index (CSI)

Q16. Now, please consider all your experiences with the **NWS**. Using a 10-point scale where 1 means "Very Dissatisfied" and 10 means "Very Satisfied," how satisfied are you with the **NWS**?

	Very Dissatisfied 1	2	3	4	5	6	7	8	9	Very Satisfied 10
Overall Satisfaction with the NWS										

Q17. **[If Overall Satisfaction <6]**
Please indicate what the NWS should change to improve your satisfaction. **(Open End)**

Q18. Using a 10-point scale where 1 now means "Falls Short of your Expectations" and 10 means "Exceeds Your Expectations," to what extent has the **NWS** fallen short of or exceeded your expectations?

	Falls Short Of Your Expectations 1	2	3	4	5	6	7	8	9	Exceeds Your Expectations 10
How well the NWS has met your expectations										

Q19. Now, imagine what an ideal organization providing weather information would be like. Using a 10-point scale where 1 means "Not Very Close to the Ideal," and 10 means "Very Close to the Ideal," how well do you think the **NWS** compares with that ideal weather information provider?

	Not Very Close to the Ideal 1	2	3	4	5	6	7	8	9	Very Close to the Ideal 10
NWS compared to an ideal weather information provider										

Desired Outcomes

Q20. Using a scale from 1 to 10 where 1 means "Not at All Likely" and 10 means "Very Likely," please indicate how likely you are to:

	Not at All Likely 1	2	3	4	5	6	7	8	9	Very Likely 10	Don't Know
Take action based on the information you receive from the NWS											
Use the NWS as a source of weather information in the future											
Recommend the NWS to a colleague or a friend											

Q21. Please share with us any final thoughts about your experience with NWS, including how we can improve our services to you and what you value most about our services. **(Open End)**

Demographics and Additional Background

[PN: Program demographics/background questions as optional]

We're almost done! We would like to ask you just a few more questions:

Q22. Please enter your zip code **(Text Box)**

Q23. What is your gender?

Male	1
Female	2
Prefer not to answer	3

Q24. What is your age?

Under 15	1	
15-24	2	
25-34	3	
35-44	4	
45-54	5	
55-64	6	
65+	7	

Q25. What is your race or origin? **(PN: Randomize order of selections)**

White/Caucasian	1
Black/African American	2
Hispanic or Latino	3
Native Hawaiian or Other Pacific Islander	4
Asian	5
American Indian or Alaska Native	6
Other (please specify)	7
Prefer not to answer	8

Q26. What is the highest degree or level of education that you have completed?

12th grade or less (no diploma)	1
High school diploma or GED	2
Some college, no degree	3
Associate or technical degree	4
Bachelor's degree	5
Graduate/Professional degree	6
Don't know	7
Prefer not to answer	8

Q27. What was your household income last year?

Less than $20,000	1
Between $20,000 and $29,999	2
Between $30,000 and $39,999	3
Between $40,000 and $49,999	4
Between $50,000 and $59,999	5
Between $60,000 and $79,999	6
Between $80,000 and $99,999	7
$100,000 or more	8
Don't know	9
Prefer not to answer	10

Close

Those are all the questions we have. Please click "Submit" below to finalize your responses. Thank you for your participation!

NWS 2020 Quarterly Pop-up Customer Satisfaction Survey_Q1 FY20 (08/29/19)

Introduction

Note: Section headers will not be included in online survey. Items in **BOLD AND CAPS** are programmer instructions. Response options will be randomized, except when sequential. All rated questions will include a "Don't Know" and/or "NA" option. When a "RANDOMIZE" instruction is provided, any "Other," "Don't Know," "NA," or "None" style of response will be forced to the bottom of the response set.

Introduction

The National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) is committed to serving the needs of all of its users. The NWS is undertaking research on how satisfied users are and would appreciate your feedback. The purpose of this research, conducted in partnership with the federal government as part of the American Customer Satisfaction Index, is to help the NWS improve its services for you and others like you.

Your answers are voluntary, but your opinions are very important for this research. Your responses will be kept completely confidential, and you will never be identified by name. CFI Group, a third-party research and consulting firm, is administering this survey via a secure server. The time required to complete this survey will depend on how certain questions are answered, but will likely take about 10 minutes. This survey is authorized by Office of Management and Budget Control No. 1090-0007, which expires September 30, 2021.

Please click on the "Next" button below to begin the survey.

Screeners

Q1. What is your age?

Under 15	1	**[THANK AND TERMINATE]**
15-24	2	
25-34	3	
35-44	4	
45-54	5	
55-64	6	
65+	7	

Q2. Are you familiar with the watches and warnings issued by the NWS as they relate to hazardous flooding and tropical storms/hurricanes?

Yes, both hazardous flooding and tropical storms/hurricanes	1	
Hazardous flooding only	2	
Tropical storms/hurricanes only	3	
Neither hazardous flooding nor tropical storms/hurricanes	4	**[THANK AND TERMINATE]**

Sources of Weather Information

Q3. What methods do you use to check the weather? Select all that apply. **[MUTLI-SELECT]**

Personal computer (i.e., laptop, desktop)	1
Television	2
NOAA Weather Radio/All Hazards	3
Commercial Radio Broadcast	4
Smartphone	5
Tablet	6

Q3.1 Which of these selected is your most preferred method?

[PN: Prepopulate Q3.1 with responses from Q3]

Weather Hazard Preparedness

Q15. Do you have a safety plan and/or a safety kit for coping with any of the following hazard types? Select all that apply **(PN: Include "Neither" as an option)**

	Safety Plan (e.g., evacuation, shelter, communication)	**Emergency Preparedness/Safety Kit/ Disaster Supply Kit**
Hazardous Flooding		
Tornadoes		
Tropical Storms/Hurricanes		
Tsunamis		
Wildland Fires		
Hazardous Winter Weather		

NWS Information for Tropical Storms/Hurricanes

Q4. Please think about the information you receive from the NWS regarding **tropical storms/hurricanes**. Using a scale from 1 to 10 where 1 is "Poor," and 10 is "Excellent," please rate the NWS on the following:

[PN: ONLY ASK TROPICAL STORMS/HURRICANES SECTION IF Q2 = 1 or 3]

(Select one for each row)

	Poor 1	2	3	4	5	6	7	8	9	Excellent 10	Don't Know/NA
Ease of finding tropical storm/hurricane forecast information specific to your geographic area of interest											
Accuracy of information for tropical storms/hurricanes											
Explaining the threat and expected impacts of tropical storms/hurricanes											
Providing information to help you make decisions relative to tropical storms/hurricanes (e.g., remaining indoors, evacuating, sheltering pets/livestock)											

Q5. **[If "providing information to help you make decisions…" <6]**
Please indicate what the NWS should change to better help you in making decisions when tropical storms/hurricanes are forecasted. **(Open End)**

Contribution to Understanding of Tropical Storms/Hurricanes

[PN: ONLY ASK CONTRIBUTION TO UNDERSTANDING OF TROPICAL STORMS/HURRICANES SECTION IF Q2 = 1 or 3]

Q6. How would you rate your **current knowledge of tropical storms/hurricanes** using a 10-point scale in which 1 means "Not at all knowledgeable" and 10 means "Very knowledgeable"?

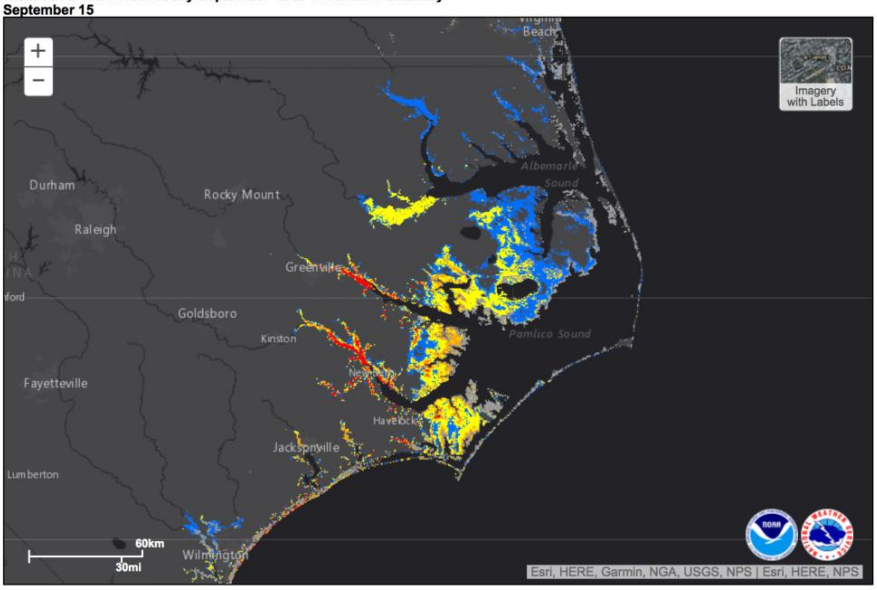
Q7. Now please rate the extent to which the information provided by the NWS has **contributed to your understanding of the dangers of tropical storms/hurricanes,** using a 10-point scale in which 1 means "Not at all" and 10 means "Significantly."

Storm Surge

[PN: ONLY ASK STORM SURGE SECTION IF Q2 = 1 or 3]

Q8. The NWS National Hurricane Center provides an online graphic called a Potential Storm Surge Flooding Map, which shows potential storm surge inundation levels from tropical storms and hurricanes. An example of this tool is pictured below. Have you ever referred to this online resource?

NHC Potential Storm Surge Flooding Map
Hurricane FLORENCE (2018) Advisory 52
From 05 AM EDT Wednesday September 12 to 11 AM EDT Saturday September 15



Potential Storm Surge Flooding*

- Intertidal Zone/Estuarine Wetland
- Greater than 1 foot above ground
- Greater than 3 feet above ground
- Greater than 6 feet above ground
- Greater than 9 feet above ground

Map Layer Options:

Inundation Layer Only | Inundation with Intertidal Layer

Map Opacity Slider

Download GIS data *(Instructions)*	Inundation Layer Only	Inundation with Intertidal Layer

*Displayed flooding values indicate the water height that has about a 1-in-10 (10%) chance of being exceeded.

Yes	1

CFI Group

No	2
Not sure	3

Q9. When you used the **Potential Storm Surge Flooding Map** how did you interpret the results in terms of the predicted magnitude of flooding?

[PN: ASK Q9 ONLY IF Q8 = 1]

Reasonable worst case scenario (the greatest amount of flooding)	1
Reasonable best case scenario (the least amount of flooding)	2
Most likely scenario (the most likely amount of flooding)	3
Not sure	4

Q10. **[This question will be on a new page in the online survey]**
The Potential Storm Surge Flooding Map is intended to show the reasonable worst-case scenario for the depicted areas. Please provide any feedback you would like to share about how we may make this feature most useful for you. **[Open End]**

NWS Information for Hazardous Flooding

[PN: ASK Q11 & Q12 ONLY IF Q2 = 1 or 2]

Q11. Now consider the information you receive from the NWS regarding **hazardous flooding**. Using a scale from 1 to 10 where 1 is "Poor," and 10 is "Excellent," please rate the NWS on the following:

(Select one for each row)

	Poor 1	2	3	4	5	6	7	8	9	Excellent 10	Don't Know/NA
Ease of finding hazardous flooding forecast information specific to your geographic area of interest											
Accuracy of information for hazardous flooding events											
Explaining the threat and expected impacts of hazardous flooding events											
Providing information to help you make decisions relative to hazardous flooding (e.g., avoiding flooded roadways, evacuating, moving personal property, moving to higher ground)											

Q12. **[If "providing information to help you make decisions…" <6]**
Please indicate what the NWS should change to better help you in making decisions when hazardous flooding is forecast. **(Open End)**

Contribution to Understanding of Hazardous Flooding

[PN: ASK Q13 & Q14 ONLY IF Q2 = 1 or 2]

Q13. How would you rate your **current knowledge of hazardous flooding** using a 10-point scale in which 1 means "Not at all knowledgeable" and 10 means "Very knowledgeable"?

Q14. Now please rate the extent to which the information provided by the NWS has **contributed to your understanding of the dangers of hazardous flooding,** using a 10-point scale in which 1 means "Not at all" and 10 means "Significantly."

Customer Satisfaction Index (CSI)

Q16. Now, please consider all your experiences with the NWS. Using a 10-point scale where 1 means "Very Dissatisfied" and 10 means "Very Satisfied," how satisfied are you with the NWS?

	Very Dissatisfied 1	2	3	4	5	6	7	8	9	Very Satisfied 10
Overall Satisfaction with the NWS										

Q17. **[If Overall Satisfaction <6]**
Please indicate what the NWS should change to improve your satisfaction. **(Open End)**

Q18. Using a 10-point scale where 1 now means "Falls Short of your Expectations" and 10 means "Exceeds Your Expectations," to what extent has the NWS fallen short of or exceeded your expectations?

	Falls Short Of Your Expectations 1	2	3	4	5	6	7	8	9	Exceeds Your Expectations 10
How well the NWS has met your expectations										

Q19. Now, imagine what an ideal organization providing weather information would be like. Using a 10-point scale where 1 means "Not Very Close to the Ideal," and 10 means "Very Close to the Ideal," how well do you think the NWS compares with that ideal weather information provider?

	Not Very Close to the Ideal 1	2	3	4	5	6	7	8	9	Very Close to the Ideal 10
NWS compared to an ideal weather information provider										

Desired Outcomes

Q20. Using a scale from 1 to 10 where 1 means "Not at All Likely" and 10 means "Very Likely," please indicate how likely you are to:

	Not at All Likely 1	2	3	4	5	6	7	8	9	Very Likely 10	Don't Know
Take action based on the information you receive from the NWS											
Use the NWS as a source of weather information in the future											
Recommend the NWS to a colleague or a friend											

Q21. Please share with us any final thoughts about your experience with the NWS, including how we can improve our services to you and what you value most about our services. **(Open End)**

Demographics and Additional Background

[PN: Program all demographics/background questions "optional"]

We're almost done! We would like to ask you just a few more questions:

Q22. Please enter your zip code **(Text Box)**

Q23. What is your gender?

Male	1
Female	2
Prefer not to answer	3

Q24. What is your race or origin? **(PN: Randomize selections)**

White/Caucasian	1
Black/African American	2
Hispanic or Latino	3
Native Hawaiian or Other Pacific Islander	4
Asian	5
American Indian or Alaska Native	6
Other (please specify)	7
Prefer not to answer	8

Q25. What is the highest degree or level of education that you have completed?

12th grade or less (no diploma)	1
High school diploma or GED	2
Some college, no degree	3
Associate or technical degree	4
Bachelor's degree	5
Graduate/Professional degree	6
Don't know	7
Prefer not to answer	8

Q26. What was your household income last year?

Less than $20,000	1
Between $20,000 and $29,999	2
Between $30,000 and $39,999	3
Between $40,000 and $49,999	4
Between $50,000 and $59,999	5
Between $60,000 and $79,999	6
Between $80,000 and $99,999	7
$100,000 or more	8
Don't know	9
Prefer not to answer	10

Close

Those are all the questions we have. Please click "Submit" below to finalize your responses. Thank you for your participation!

Appendix B: Quick Response Surveys

OMB Approval No. 0648-0342 / Expires: 05/31/2018

Paperwork Reduction Act Statement

Public reporting burden for this collection of information is estimated to average 7 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other suggestions for reducing this burden to Chris Ellis, NOAA National Ocean Service, at Chris.Ellis@noaa.gov, or contact him at 843-740-1195.

Respondents are not identified on their questionnaires, and any reports will present data in aggregate form only. Notwithstanding any other provisions of the law, no person is required to respond to, nor shall any person be subjected to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number.

Severe Thunderstorm Survey Questions

There was a severe thunderstorm event that occurred in your area on the (morning, afternoon, evening) of (month) (date), (year). The National Weather Service is looking to receive feedback on the weather information you may have received during this event. We would appreciate it if you answered the following questions regarding that specific severe thunderstorm event. Feedback collected from this survey will help the NWS improve products and services with future events in your area.

The following questions have to deal with the information you may have received ***before the severe thunderstorm event*** and the actions you may have taken.

1. People rely on various sources of information when making a decision to prepare for hazardous weather events. Please indicate how the following sources influenced your decisions on how to prepare ***before this severe thunderstorm event occurred***.

Source Type	No Influence At All	Very Little Influence	Some Influence	A Lot of Influence	I Have No Access
Local Television Broadcast (e.g., ABC, NBC, CBS, FOX, etc.)	o	o	o	o	o
National Television Broadcast (e.g., Weather Channel, CNN, FoxNews, MSNBC, etc.)	o	o	o	o	o
NOAA Weather Radio Broadcast	o	o	o	o	o
Commercial Radio Broadcast (e.g., AM, FM, HD, Satellite Radio, etc.)	o	o	o	o	o
Print Media (e.g., local newspapers)	o	o	o	o	o
National Weather Service Website	o	o	o	o	o

(i.e., Weather.gov)					
Other Websites / Social Media (e.g., Weather.com, Facebook, Twitter, etc.)	o	o	o	o	o
Wireless Emergency Alerts (WEA) via cellphone	o	o	o	o	o
Siren / Community Alerting (e.g., sirens, Reverse 911, vehicle messaging signs, etc.)	o	o	o	o	o
Word of Mouth from Friends/Family	o	o	o	o	o
Word of mouth from Government Officials (e.g., Mayor, Governor, President, etc.)	o	o	o	o	o
Word of mouth from Emergency Management (e.g., police, fire department, emergency managers, etc.)	o	o	o	o	o
Word of mouth from Faith Leaders (e.g., Pastors, Priest Imam, etc.)	o	o	o	o	o

2. How far in advance were you made aware that a severe thunderstorm would be possible for your area?
    - Less than an hour before
    - Between 1 hour and 6 hours before
    - Between 7 hours and 24 hours before
    - Between 1 and 2 days before
    - Between 3 and 4 days before
    - 5 or more days before
    - I was not aware a severe thunderstorm would be possible for my area

3. Based on the information you were given, what did you feel the threat(s) from the severe thunderstorm would be? (Please select all that apply)
    - Damaging winds
    - Destructive hail
    - Flash flooding
    - Frequent lightning
    - Funnel clouds
    - Heavy rains
    - Tornadoes

4. What, if any, special preparations did you take in the days and hours before the severe thunderstorm event? (Please select all that apply)
    - Purchased extra water/food

- Filled prescription(s)
- Filled vehicle(s) with gas
- Got extra cash from the bank
- Purchased/borrowed a generator
- Increased communication with friends/relatives
- Allowed more time for travel
- Cancelled or adjusted scheduled plans, appointments, and/or activities
- Purchased/created/updated an emergency survival kit
- I did not take any special preparations
- Other (please specify)

The following questions pertain to the actions you took ***once the severe thunderstorm warning was issued for your area***. If you feel you were unwarned, please skip to question #8.

5. Did you take any of the following actions when you received the severe thunderstorm warning?

Action	**Yes**	**No**	**I Do Not Remember**
Did you seek shelter?	o	o	o
Did you seek additional information via various media outlets (e.g., TV, Radio, Internet)?	o	o	o
Did you attempt to drive out of the severe thunderstorm threat area?	o	o	o
Did you attempt to figure out if your specific location was in the warning?	o	o	o
Did you secure your property (e.g., put lawn chairs in storage)?	o	o	o
Did you continue previous activities?	o	o	o

6. Which of the following actions was the ***first*** action you took when you received the severe thunderstorm warning?

Action	**My First Action**
Sought shelter	o
Sought additional information via various media outlets (e.g., TV, Radio, Internet)	o
Tried to drive out of the severe thunderstorm threat area	o
Tried to figure out if my specific location was in the warning	o
Secured my property (e.g., put lawn chairs in storage)	o
Continued previous activities	o
Other (Please state action)	o
I did nothing	o

7. If you sought shelter during the severe thunderstorm warning, please answer Part A. If you did not seek shelter during the severe thunderstorm warning, please answer Part B.

a. What led to your decision to seek shelter during the severe thunderstorm warning? (Please choose the answer that best applies to your situation.)
    - I typically take cover immediately after receiving a severe thunderstorm warning issued for my area.
    - Other information source(s) (e.g., TV, Radio, Internet, Friends/Family, etc.) confirmed that threatening weather was approaching my area
    - Friends and family urged me to seek shelter
    - I could see the threatening weather outside
    - Previous experiences I had with severe thunderstorm led me to believe I could be in danger.
    - Other (Please state why)
b. What led to your decision to not seek shelter during the severe thunderstorm warning? (Please choose the answer that best applies to your situation.)
    - I typically do not take action immediately after receiving a severe thunderstorm warning issued for my area
    - I did not believe I would be impacted by the severe thunderstorm (Please state why)
    - I could not see threatening weather outside
    - Previous experiences I had with severe thunderstorms led me to believe I was not in danger.
    - I did not trust the accuracy of the warning
    - Other (Please state why)

The following question pertains to the information you may have received ***during the severe thunderstorm warning*** and the actions that you may have taken.

8. People rely on various sources for information during hazardous weather events. Please indicate how the following sources influenced your ***decisions as this severe thunderstorm warning was ongoing***.

Source Type	**No Influence At All**	**Very Little Influence**	**Some Influence**	**A Lot of Influence**
Local Television Broadcast (e.g., ABC, NBC, CBS, FOX, etc.)	o	o	o	o
National Television Broadcast (e.g., Weather Channel, CNN, FoxNews, MSNBC, etc.)	o	o	o	o
NOAA Weather Radio Broadcast	o	o	o	o
Commercial Radio Broadcast (e.g., AM, FM, HD, Satellite Radio, etc.)	o	o	o	o

Print Media (e.g., local newspapers)	o	o	o	o
Websites / Social Media (e.g., Weather.com, Facebook, Twitter, etc.)	o	o	o	o
National Weather Service Website (i.e., Weather.gov)	o	o	o	o
Word of Mouth from Friends/Family	o	o	o	o
Wireless Emergency Alerts (WEA) via cellphone	o	o	o	o
Siren / Community Alerting (e.g., sirens, Reverse 911, vehicle messaging signs, etc.)	o	o	o	o
Government Officials (e.g., Mayor, Governor, President, etc.)	o	o	o	o
Emergency Management (e.g., police, fire department, emergency managers, etc.)	o	o	o	o
Faith Leaders (e.g., Pastors, Priest Imam, etc.)	o	o	o	o

The following question pertains to the information and services you received from the National Weather Service and whether you understood the information and services. For instance, if you visited a National Weather Service website (e.g., Weather.gov) or used a NOAA Weather Radio, then please answer the following questions. If you feel did not receive your information from the National Weather Service, please skip to question #10.

9. Please rate your level of satisfaction with the information and services you received from the National Weather Service during this particular severe thunderstorm.

	Very Dissatisfied	**Dissatisfied**	**Neither Dissatisfied nor Satisfied**	**Satisfied**	**Very Satisfied**
Quality of the information or service received	o	o	o	o	o
Timeliness of the information or services received	o	o	o	o	o
Accuracy of information or services received	o	o	o	o	o
Format of the information or services received	o	o	o	o	o
Degree to which the information or services received helped you in decision making	o	o	o	o	o
Degree in which the information or services received explained the severe thunderstorm threat and	o	o	o	o	o

expected impacts					
Overall satisfaction with information or services received	o	o	o	o	o
Overall satisfaction compared with services/data obtained from other weather information industries (e.g., media, private weather companies, etc.)	o	o	o	o	o

10. In a few short words, please explain your understanding of a Severe Thunderstorm Watch.

11. In a few short words, please explain your understanding of a Severe Thunderstorm Warning.

12. Based on your understanding of the National Weather Service's severe thunderstorm watch and severe thunderstorm warnings, how likely are you to take protective action?

Product	**Not Likely At All**	**Somewhat Likely**	**Likely**	**Very Likely**	**Unsure**
Severe Thunderstorm Watch	o	o	o	o	o
Severe Thunderstorm Warning	o	o	o	o	o

13. When the National Weather Service issues a severe thunderstorm watch or severe thunderstorm warning for your area, how likely do you think it is that you will experience a severe thunderstorm near you location?

Product	**Not Likely At All**	**Somewhat Likely**	**Likely**	**Very Likely**	**Unsure**
Severe Thunderstorm Watch	o	o	o	o	o
Severe Thunderstorm Warning	o	o	o	o	o

14. What is your gender?
    a. Male
    b. Female

15. What is your age?
    a. 18 - 29
    b. 30 - 39
    c. 40 - 49
    d. 50 - 59
    e. 60 - 69
    f. 70+

16. What is your race?
    a. African American
    b. Asian
    c. Caucasian
    d. Hispanic
    e. Other (please specify) _____

17. What is your education level?
    a. Elementary School Only
    b. Some High School, but Did Not Finish
    c. Completed High School
    d. Some College, but Did Not Finish
    e. Two Year College Degree/A.A./A.S. or equivalent
    f. Four Year College Degree/B.A./B.S. or equivalent
    g. Some Graduate Work
    h. Completed Masters or Professional Degree
    i. Advanced Graduate Work/Ph.D

18. What is your household income?
    a. Under $25,000
    b. $25,000 - $39,999
    c. $40,000 - $49,999
    d. $50,000 - $74,999
    e. $75,000 - $99,999
    f. $100,000 - $124,999
    g. $125,000 - $149,999
    h. Over $150,000

The National Weather Service sincerely thanks you for your participation in this survey. We will be sure to use your feedback in our continued efforts to improve our products and services that help protect lives and property. Thank you for your time.

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Paperwork Reduction Act Statement

Public reporting burden for this collection of information is estimated to average 7 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other suggestions for reducing this burden to Chris Ellis, NOAA National Ocean Service, at Chris.Ellis@noaa.gov, or contact him at 843-740-1195.

Respondents are not identified on their questionnaires, and any reports will present data in aggregate form only. Notwithstanding any other provisions of the law, no person is required to respond to, nor shall any person be subjected to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number.

Flash Flood Survey Questions

There was a flash flood event that occurred in your area on the (morning, afternoon, evening) of (month) (date), (year). The National Weather Service is looking to receive feedback on the weather information you may have received during this event. We would appreciate it if you answered the following questions regarding that specific flash flood event. Feedback collected from this survey will help the NWS improve products and services with future events in your area.

The following questions have to deal with the information you may have received ***before the flash flood event*** and the actions you may have taken.

1. People rely on various sources of information when making a decision to prepare for hazardous weather events. Please indicate how the following sources influenced your decisions on how to prepare ***before this flash flood event occurred***.

Source Type	No Influence At All	Very Little Influence	Some Influence	A Lot of Influence	I Have No Access
Local Television Broadcast (e.g., ABC, NBC, CBS, FOX, etc.)	o	o	o	o	o
National Television Broadcast (e.g., Weather Channel, CNN, FoxNews, MSNBC, etc.)	o	o	o	o	o
NOAA Weather Radio Broadcast	o	o	o	o	o
Commercial Radio Broadcast (e.g., AM, FM, HD, Satellite Radio, etc.)	o	o	o	o	o
Print Media (e.g., local newspapers)	o	o	o	o	o
National Weather Service Website	o	o	o	o	o

(i.e., Weather.gov)					
Other Websites / Social Media (e.g., Weather.com, Facebook, Twitter, etc.)	o	o	o	o	o
Wireless Emergency Alerts (WEA) via cellphone	o	o	o	o	o
Siren / Community Alerting (e.g., sirens, Reverse 911, vehicle messaging signs, etc.)	o	o	o	o	o
Word of Mouth from Friends/Family	o	o	o	o	o
Word of mouth from Government Officials (e.g., Mayor, Governor, President, etc.)	o	o	o	o	o
Word of mouth from Emergency Management (e.g., police, fire department, emergency managers, etc.)	o	o	o	o	o
Word of mouth from Faith Leaders (e.g., Pastors, Priest Imam, etc.)	o	o	o	o	o

2. How far in advance were you made aware that a flash flood would be possible for your area?
    - Less than an hour before
    - Between 1 hour and 6 hours before
    - Between 7 hours and 24 hours before
    - Between 1 and 2 days before
    - 3 or more days before
    - I was not aware a flash flood would be possible for my area

3. Based on the information you were given, what did you feel the threat(s) from the flash flood would be? (Please select all that apply)
    - Heavy rains
    - Swift water moving through dry creeks or normally dry areas
    - Rapid rise in streams, creeks and rivers
    - Washed out roads
    - Flooded roadways / closure of roads
    - Other (please specify)

4. What, if any, special preparations did you take in the days and hours before the flash flood event? (Please select all that apply)
    - Purchased extra water/food
    - Filled prescription(s)
    - Filled vehicle(s) with gas
    - Got extra cash from the bank

- Purchased/borrowed a generator
- Increased communication with friends/relatives
- Allowed more time for travel
- Cancelled or adjusted scheduled plans, appointments, and/or activities
- Purchased/created/updated an emergency survival kit
- I did not take any special preparations
- Other (please specify)

The following questions pertain to the actions you took ***once the flash flood warning was issued for your area***. If you feel you were unwarned, please skip to question #8.

5. Did you take any of the following actions when you received the flash flood warning?

Action	**Yes**	**No**	**I Do Not Remember**
Did you retreat to a safer location / higher ground?	o	o	o
Did you seek additional information via various media outlets (e.g., TV, Radio, Internet)?	o	o	o
Did you attempt to drive out of the flash flood threat area?	o	o	o
Did you attempt to figure out if your specific location was in the warning?	o	o	o
Did you secure your property (e.g., move car out of a low lying area)?	o	o	o
Did you continue previous activities?	o	o	o

6. Which of the following actions was the ***first*** action you took when you received the flash flood warning?

Action	**My First Action**
Retreated to a safer location / higher ground	o
Sought additional information via various media outlets (e.g., TV, Radio, Internet)	o
Tried to drive out of the flash flood threat area	o
Tried to figure out if my specific location was in the warning	o
Secured my property (e.g., move car out of a low lying area)	o
Continued previous activities	o
Other (Please state action)	o
I did nothing	o

7. If you retreated to a safer location / higher ground during the flash flood warning, please answer Part A. If you did not retreat to a safer location / higher ground during the flash flood warning, please answer Part B.
    a. What led to your decision to retreat to a safer location / higher ground during the flash flood warning? (Please choose the answer that best applies to your situation.)

- I typically retreat to a safer location / higher ground after receiving a flash flood warning issued for my area.
- Other information source(s) (e.g., TV, Radio, Internet, Friends/Family, etc.) confirmed that threatening weather was approaching my area
- Friends and family urged me to retreat to a safer location / higher ground
- I could see the threatening weather outside
- Previous experiences I had with flash flood led me to believe I could be in danger.
- Other (Please state why)

b. What led to your decision to not retreat to a safer location / higher ground during the flash flood warning? (Please choose the answer that best applies to your situation.)
   - I typically do not take action immediately after receiving a flash flood warning issued for my area
   - I did not believe I would be impacted by the flash flood (Please state why)
   - I could not see threatening weather outside
   - Previous experiences I had with flash floods led me to believe I was not in danger.
   - I did not trust the accuracy of the warning
   - Other (Please state why)

8. If you were driving or planning to drive, how did modify your driving behaviors due to the flash flood warning?
   a. I was not driving or planning to drive
   b. I was driving but decided not to modify my driving behavior
   c. I decided not to drive
   d. I changed my original driving route
   e. I was driving, saw a "Turn Around Don't Drown" sign or other high water sign and decided to turn back
   f. I drove more carefully
   g. I drove to a safer location/higher ground

The following question pertains to the information you may have received ***during the flash flood warning*** and the actions that you may have taken.

9. People rely on various sources for information during hazardous weather events. Please indicate how the following sources influenced your ***decisions as this flash flood warning was ongoing***.

Source Type	No Influence	Very Little Influence	Some Influence	A Lot of Influence

	At All			
Local Television Broadcast (e.g., ABC, NBC, CBS, FOX, etc.)	o	o	o	o
National Television Broadcast (e.g., Weather Channel, CNN, FoxNews, MSNBC, etc.)	o	o	o	o
NOAA Weather Radio Broadcast	o	o	o	o
Commercial Radio Broadcast (e.g., AM, FM, HD, Satellite Radio, etc.)	o	o	o	o
Print Media (e.g., local newspapers)	o	o	o	o
Websites / Social Media (e.g., Weather.com, Facebook, Twitter, etc.)	o	o	o	o
National Weather Service Website (i.e., Weather.gov)	o	o	o	o
Word of Mouth from Friends/Family	o	o	o	o
Wireless Emergency Alerts (WEA) via cellphone	o	o	o	o
Siren / Community Alerting (e.g., sirens, Reverse 911, vehicle messaging signs, etc.)	o	o	o	o
Government Officials (e.g., Mayor, Governor, President, etc.)	o	o	o	o
Emergency Management (e.g., police, fire department, emergency managers, etc.)	o	o	o	o
Faith Leaders (e.g., Pastors, Priest Imam, etc.)	o	o	o	o

The following question pertains to the information and services you received from the National Weather Service and whether you understood the information and services. For instance, if you visited a National Weather Service website (e.g., Weather.gov) or used a NOAA Weather Radio, then please answer the following questions. If you feel did not receive your information from the National Weather Service, please skip to question #11.

10. Please rate your level of satisfaction with the information and services you received from the National Weather Service during this particular flash flood.

	Very Dissatisfied	Dissatisfied	Neither Dissatisfied nor Satisfied	Satisfied	Very Satisfied
Quality of the information or service received	o	o	o	o	o
Timeliness of the information or services received	o	o	o	o	o
Accuracy of information or services received	o	o	o	o	o
Format of the information or	o	o	o	o	o

services received					
Degree to which the information or services received helped you in decision making	o	o	o	o	o
Degree in which the information or services received explained the flash flood threat and expected impacts	o	o	o	o	o
Overall satisfaction with information or services received	o	o	o	o	o
Overall satisfaction compared with services/data obtained from other weather information industries (e.g., media, private weather companies, etc.)	o	o	o	o	o

11. In a few short words, please explain your understanding of a Flash flood Watch.

12. In a few short words, please explain your understanding of a Flash flood Warning.

13. Based on your understanding of the National Weather Service's flash flood watch and flash flood warnings, how likely are you to take protective action?

Product	**Not Likely At All**	**Somewhat Likely**	**Likely**	**Very Likely**	**Unsure**
Flash flood Watch	o	o	o	o	o
Flash flood Warning	o	o	o	o	o

14. When the National Weather Service issues a flash flood watch or flash flood warning for your area, how likely do you think it is that you will experience a flash flood near you location?

Product	**Not Likely At All**	**Somewhat Likely**	**Likely**	**Very Likely**	**Unsure**
Flash flood Watch	o	o	o	o	o
Flash flood Warning	o	o	o	o	o

15. What is your gender?
    a. Male
    b. Female

16. What is your age?
    a. 18 - 29
    b. 30 - 39
    c. 40 - 49
    d. 50 - 59
    e. 60 - 69
    f. 70+

17. What is your race?
    a. African American
    b. Asian
    c. Caucasian
    d. Hispanic
    e. Other (please specify) _____

18. What is your education level?
    a. Elementary School Only
    b. Some High School, but Did Not Finish
    c. Completed High School
    d. Some College, but Did Not Finish
    e. Two Year College Degree/A.A./A.S. or equivalent
    f. Four Year College Degree/B.A./B.S. or equivalent
    g. Some Graduate Work
    h. Completed Masters or Professional Degree
    i. Advanced Graduate Work/Ph.D

19. What is your household income?
    a. Under $25,000
    b. $25,000 - $39,999
    c. $40,000 - $49,999
    d. $50,000 - $74,999
    e. $75,000 - $99,999
    f. $100,000 - $124,999
    g. $125,000 - $149,999
    h. Over $150,000

The National Weather Service sincerely thanks you for your participation in this survey. We will be sure to use your feedback in our continued efforts to improve our products and services that help protect lives and property. Thank you for your time.

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