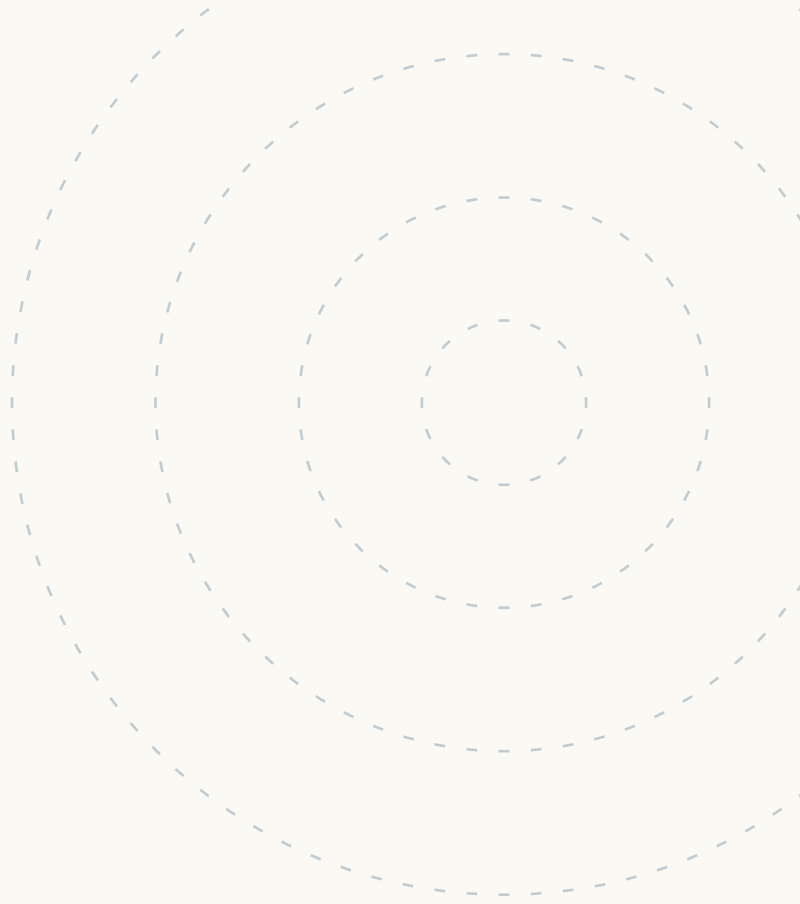




# Optimizing Tropical Cyclone Information

An NOAA Hurricane Website  
User Experience Study from  
a Public Perspective



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**Funding Agency**

National Oceanic and Atmospheric Administration – Office of Oceanic and Atmospheric Research

**Grant Period**

09/01/2019 - 08/31/2021

**Federal Grant Award Number**

NA19OAR0220127

**Recipient organization**

University of Washington  
Campus Box 352315, Seattle, WA 98195

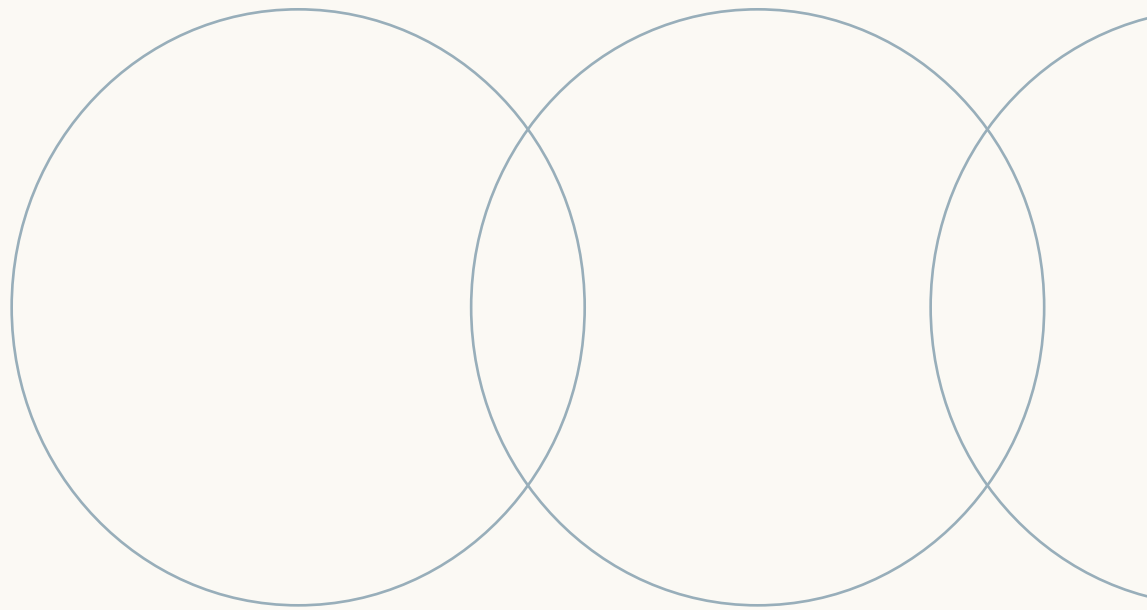
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# Executive Summary





# Project Background

Hurricanes.gov is the primary web presence of the NHC and CPHC<sup>1</sup>. Upon the threat of an approaching tropical storm, and especially in well-populated areas with internet readily available, the site receives a significant amount of web traffic. Understanding the context, role, and relative influence of NHC's website within the scope of its current and future users is necessary to derive effective recommendations for its improvement.

This report presents the findings of two years of human-centered design research into improving and modernizing the web-based delivery of hurricane risk information to better meet the needs of the public.

Year 1 of the project focused on background research including several dozen interviews with hurricane experts, NOAA and NHC staff, and members of the public. We also conducted an analysis of web traffic, literature review of tropical storm risk communication, and an evaluation of the current NHC web-

site according to best practices in user experience and weather risk communication.

Years 2 focused on four specific areas of further research and design chosen in collaboration with NOAA and NHC staff. These included 1) Developing user personas and user journey maps for the NHC website; 2) Reviewing the information architecture of the website; 3) Evaluating the relationship between the NHC website and regional Tropical Forecast Office site; and 4) Identifying opportunities for localization of the website.

The results of this work provide NOAA with a broad foundation for modernizing their web-based hurricane risk communication products and services based on research-based evidence and a repeatable process. The intended long-term outcome of this project is a public that is better informed about tropical cyclones, and better equipped to make more informed decisions before, during, and after hurricanes.

<sup>1</sup> In most cases, when NHC is referred to in this document, CPHC is also included because hurricanes.gov provides operational forecasts from CPHC.



# Key Findings

- The “public” is not a monolithic entity. Members of the public have a significant range of needs, abilities, and contexts in which they might use hurricane risk information. This means it is comparably more complicated to design for the public than for experts.
- In general, the public does not view hurricanes.gov as a destination. While they report high levels of trust, they perceive the site and its content as being designed for experts.
- The public has less patience and is overall less motivated to use the NHC site than core partners. They want to quickly find answers to their questions without having to click through to multiple pages or read large amounts of text. They have been accustomed to higher standards of UX than the current hurricanes.gov site provides.
- Language and use of jargon are important design considerations. The site relies heavily on technical terms that are unfamiliar to most members of the public, drastically reducing its usability to this audience. By providing easier handholds, such as contextual definitions of complex terms, NHC can help users learn some of the complex concepts behind hurricane forecasting while meeting their information needs.
- The public expects the site to work on mobile platforms, where the site does not perform well. Mobile-first design strategies can improve this situation significantly, without requiring the development of a dedicated mobile app.
- Improved UX design on hurricanes.gov will help both the public and experts. Anything the NHC does to improve visual design, accessibility, or otherwise conform to modern web design standards will be useful to all users.



# Future Process Recommendations

The NHC website has historically not received the necessary investments, including hiring specialized staff, needed to build and maintain a modern website that communicates the work of the organization on a level that is commensurate with the expertise the NHC deploys in its forecasting work. If direct communication with the public via hurricanes.gov is a priority for NHC, larger investments in this resource are necessary.

Any further developments to the website would be enhanced by being part of an overall public communications strategy that includes traditional channels as well as social media and the website, and accounted for expert audiences and core partners as well as the general public.

A public communications strategy should, amongst other things, situate NHC activities within the wider hurricane risk information ecosystem that includes other government agencies, the media, and the private sector.

A clear mission statement for the NHC website, along with targets for measuring success, would help the organization to justify investments needed for modernization and future maintenance, help prioritize amongst competing opportunities for improvement, and track progress over time.

The NHC should explore simple, so-called “discount” usability methods for testing changes to the website and gaining more feedback from members of the public. The web team at NHC has proved willing to experiment with changes to the site based on feedback from core partners and made real improvements with relatively few resources.



# Next Steps

## **Increase investment in the site and internal capacity**

In order to design, develop, and maintain a modern website capable of meeting the complex and varied information needs of the public, NOAA will need to both increase the amount of investment beyond current state and hire or develop more internal capacity in web design, user research, and web development. There are relatively few quick, low-cost, low-effort changes available to accomplish the needed structural changes and maintenance. Significant and sustained investment is necessary to create a digital presence for the public that effectively communicates the tremendous expertise of the NHC and the critical information they produce.

## **Internally socialize findings of the report**

The research produced during this project should be disseminated and discussed with NOAA and NHC staff to develop shared understanding around its findings and recommendations. Discussions or workshops should be facilitated to review and prioritize report recommendations. Final priorities can only be determined internally based on specific and evolving legal, budget, personnel, technological, and time constraints.

## **Promote human-centered design within NHC and across NOAA and the NWS**

Research done using human-centered design stands to improve other NHC risk communication products beyond hurricanes.gov. This project can serve as a positive example for how human centered design can help government entities evaluate how to best communicate their work to the public. Future research should examine how the NHC, NWS, and NOAA, units within a broader government structure can align design efforts and provide more unified user experience across the organizational structure. Increasing the consistency and predictability of how different entities deliver content will improve the user experience of each platform.

## **Adopt contemporary visual design standards**

The role of effective visual design in communicating a sense of trust and authority to the public was repeatedly raised in conversations with NOAA staff and public interviewees. As described in Appendix 12, relatively simple changes including modern typography, an updated color palette, and consistent page layouts would improve the site, even absent any additional changes.





### **Build for mobile**

Over half of site visitors during major tropical storms use mobile devices and tablets. Our interviews with members of the public, as well as nearly two decades of research in crisis informatics, confirmed that mobile phones are a primary means of accessing information during emergencies. The NHC would benefit from “mobile first” design strategies that ensure online resources are usable regardless of which technologies are used to access them.

### **Ongoing accessibility review & designing for different audiences**

There is a great diversity of current and potential users for the site. Given the responsibilities that NOAA and NHC have in delivering information to these users, an accessibility review should be part of any future design work for hurricanes.gov. Accessibility should be considered beyond Section 508 or WCAG 2.0 guidelines and include targeted content strategy based on different information needs of different audiences including, for example, elderly populations or people who speak English as a second language.

### **Develop a digital communication & content strategy**

Future web development should be guided by a clear digital communication strategy that is integrated with NHC’s overall communication approach. The information NHC is mandated to produce is highly complex, as are the needs of the great diversity of audiences it intends to reach. A new digital communication strategy should include a clear vision for

what the role of NHCs digital presence is in regards to the overall organizational mission, main user groups and communities that it is meant to serve. It should also lay out methods and metrics for evaluating whether the NHC is accomplishing its goals in this area.

### **Further Research Opportunities**

The project also identified a number of high priority areas for future research into topics including strategic combination of text and graphics, localizing NHC products, evaluating social media usage, improving the use of web analytics to monitor impacts of design changes and evaluate success of NHC’s digital communication strategy, communicating potential storm impacts, and strategic use of APIs and raw data sharing to broaden access to NHC information.



# Optimizing Tropical Cyclone Information

An NOAA Hurricane Website  
User Experience Study from  
a Public Perspective

# Purpose & Objectives

This report describes the findings and outcomes of a two-year design research project supporting the National Oceanic and Atmospheric Administration's (NOAA) National Hurricane Center (NHC) and Central Pacific Hurricane Center (CPHC) effort to update and modernize NOAA's hurricane web presence.

The purpose of this project is to help make NOAA's hurricanes.gov web ecosystem more accessible, useful, and usable for the public to access real-time, operational hurricane information. The project sought to deliver recommendations on improvements from a public perspective that can be made to the Hurricanes.gov ecosystem and related web-based risk information operated by the NHC.

The objectives of these recommendations are to assist the NHC to better meet the needs of the public (as opposed to core partners), adhere to best practices of user experience design, and integrate existing risk communication research. Outputs of the project include written research guided recommendations, design heuristics, user-experience design tools, low- and moderate fidelity design artifacts, and suggestions for future research and operations.

The results of this work provide NOAA with a broad foundation for modernizing their web-based hurricane risk communication products and services based on research-based evidence and a repeatable process. The intended long-term outcome of this project is a public that is better informed about tropical cyclones, and better equipped to make more informed decisions before, during, and after hurricanes.

# Background

Hurricanes.gov is the primary web presence of the NHC and CPHC<sup>2</sup>. Upon the threat of an approaching tropical storm, and especially in well-populated areas with internet readily available, the site receives a significant amount of web traffic.

The NHC website is a single node in a network of publicly and privately provided web-based hurricane risk information. Understanding the context, role, and relative influence of NHC's website within the scope of its current and future users is necessary to derive effective recommendations for its improvement.

Many of NHC's core partners in the weather and emergency management communities depend on the site for use in their work. Historically, these core partners have been the most important audience for the site, and the audience which has provided the most feedback into its design.

This consideration drove many past content and design decisions for hurricanes.gov. In recent years, the general public has become a larger share of overall site traffic. One reason for this is NOAA's promotion of the site via social media and public adoption of social media as a channel to access risk information.

The public is also finding the site through internet search. In the 2017 storm season, for example, a majority of users accessed the website through Google search. Meanwhile direct access, via typing in the URL, declined over 10% in the prior three years.

Despite this growth, the NHC's website is not currently optimized to meet the information needs of public users. For example, the site doesn't function well on mobile phones, tablets, or for low-bandwidth devices, each of which are common means of public access of NHC's information. Therefore, one of the central concerns of this project is to help the NHC evaluate how they might serve the needs of the public without detracting from the needs of their core partners.

Our team undertook two years of usability research to capture the past experiences and information needs of the public, as well as to evaluate the extent to which the NHC website currently meets these needs.

<sup>2</sup> <https://www.iso.org/obp/ui/#iso:std:iso:13407:ed-1:v1:en>

# Approach

This project utilized a human-centered design approach. As defined by the International Organization for Standardization<sup>3</sup> (ISO):

*Human-centered design is an approach to interactive systems development that aims to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors ergonomics, and usability knowledge and techniques.*

Such approaches have been deployed elsewhere in the US Federal Government and many of the key concepts are outlined on [usability.gov](https://www.usability.gov). The project approach was organized to be compatible with the project structure proposed by usability.gov:

1. Plan
2. Analyze
3. Design
4. Test and refine

These 4 steps were conducted in two one-year phases. Phase one consisted of plan and analyze. Design, test and refine took place in phase two.

<sup>3</sup><https://www.iso.org/obp/ui/#iso:std:iso:13407:ed-1:v1:en>



# Phase One: Plan & Analyze

The aim of phase one was to develop a shared understanding of the problem space among members of the project team and to identify opportunities for in-depth design research during phase two.

## Plan

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At the start of the project, an advisory panel, composed of NHC and NOAA staff, was convened to provide support in the form of input into a detailed project plan, flagging relevant past work and necessary design principles, as well as feedback on milestones and final recommendations. The project plan was revisited regularly and refined based on any insights from intermediate project findings.

## Analyze

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During the remainder of the first year of the project, we conducted various research activities including an analysis of web traffic, literature review of tropical storm risk communication, an evaluation of the current NHC website using a heuristic evaluation process, and semi-structured interviews with members of the public who had experience with hurricanes.



# Phase Two: Design, Test & Refine

The aim of phase two was to produce evidence-based design recommendations to inform future work on hurricanes.gov and suggestions for that work.

## Design

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Based on the research conducted during phase one, we updated the problem definition and identified a number of ‘design opportunities, or areas for in-depth design research and improvements. With the NOAA advisory panel, four opportunities were chosen for further exploration based on input from a broader group of NHC staff.

For each opportunity, we developed specific design research activities. These activities were accomplished via design sprints with both external experts and the project team. We also re-synthesized information from phase one to be specific for each design opportunity. The activities resulted in low-fidelity prototypes and provisional tools to assist future design work.

## Test and Refine

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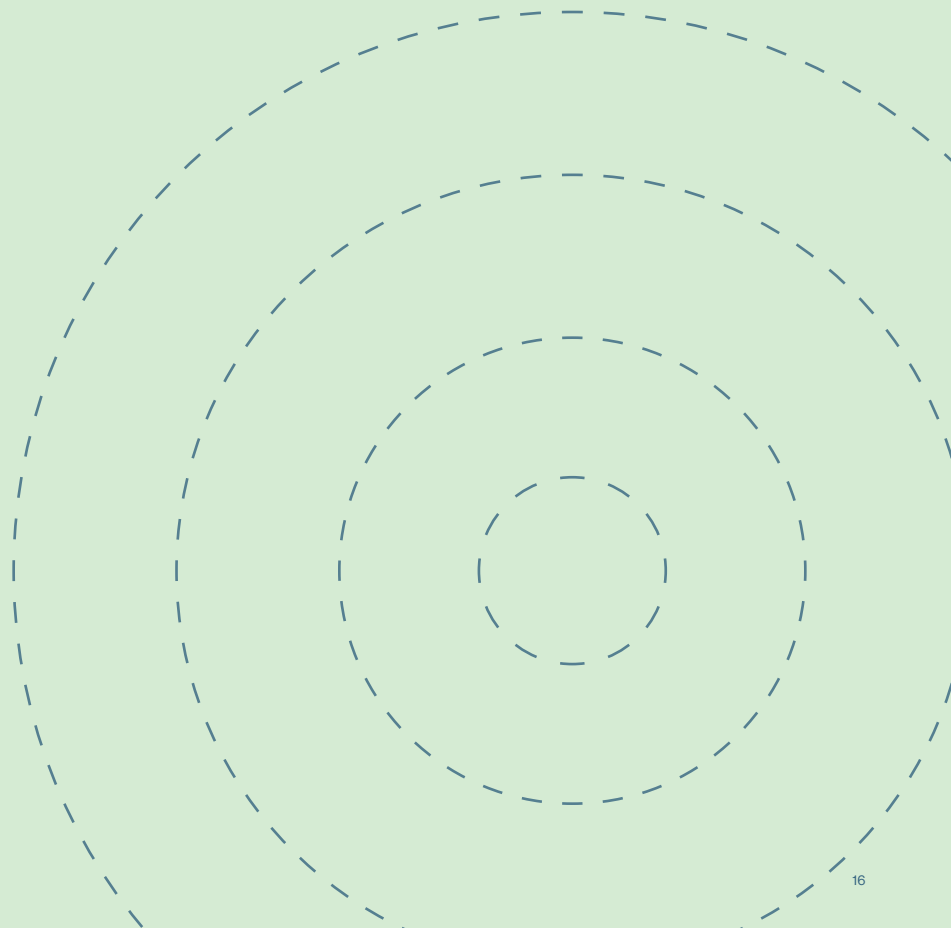
We conducted additional user interviews, a structured design survey, and advisory panel feedback sessions to evaluate the prototypes and design tools. We analyzed and synthesized the data from these tasks to inform further iterations, as well as form recommendations for future work.

The next two sections of this report describe phase one activities and key findings, as well as phase two activities and outputs.

# Phase One: Plan & Analyze

For brevity, only the analyze step of the phase one is described in this section. Outputs of the plan step included meeting minutes, presentation slides, and revised project documents.

Five activities were conducted for the analyze step: expert interviews, web and social media analytics, literature review, user interviews, and heuristics evaluation.







# Expert Interviews

We conducted interviews with seven participants from academia and the private sector who were experts in design, hurricane risk communication, and disaster research.

The open-ended interviews aimed to elicit information about applicable scholarly research, pre-existing recommendations, relevant best practices, and advice on the design and execution of the project.

We also interviewed staff and experts at the NHC and NOAA. In total, 18 one-hour in-

terviews were conducted. Questions asked during the interviews elicited information about hurricanes.gov background, history, uses, users, existing design, broader ecosystem, critiques, and needs for improvement. Thematic analysis was applied to the qualitative data gathered from the NHC staff interviews.

## Key Findings

1. The “public” is not a monolithic entity. Members of the public have a significant range of needs, abilities, and contexts in which they might use hurricane risk information. This means it is comparably more complicated to design for the public than for experts.
2. In general, the public does not view hurricanes.gov as a destination.

While they report high levels of trust, they perceive the site and its content as being designed for experts.

3. The public has less patience and is overall less motivated to use the NHC site than core partners. They want to quickly find answers to their questions without having to click through to multiple pages or read large amounts of text. They have been



accustomed to higher standards of UX than the current hurricanes.gov site provides.

4. Language and use of jargon are important design considerations. The site relies heavily on technical terms that are unfamiliar to most members of the public, drastically reducing its usability to this audience.
5. By providing easier handholds, such as contextual definitions of complex terms, NHC can help users learn some of the complex concepts behind hurricane forecasting while meeting their information needs.
6. The public expects the site to work on mobile platforms, where the site does not perform well. Mobile-first design strategies can improve this situation significantly, without requiring the development of a dedicated mobile app.
7. Improved UX design on hurricanes.gov will help both the public and experts. Anything the NHC does to improve visual design, accessibility, or otherwise conform to modern web design standards will be useful to all users.



# Web & Social Media Analytics

NOAA staff provided the project team with a range of web and social media analytics data about hurricanes.gov.

Provided data included Google Analytics data, website access statistics, pageview statistics, user paths, and user search keywords. Data described incoming traffic, user behavior, accessibility, and relationships with other websites

(e.g, local weather forecast office pages). Some data were associated with specific hurricanes (e.g. Florence and Dorian). We worked with NOAA staff and synthesized these data to understand current access and usage of the site.

## Key Findings

1. In line with NHC's recognition of a growing percentage of the site traffic coming from the general public, there is a declining share of traffic from .gov domains and direct entry, and a corresponding increased share of traffic from search engines. Most users now arrive via a Google search.
2. Social media is a small, but growing source of traffic for the NHC website.
3. Mobile technologies such as cellphones and tablets are used by a significant percentage of site visitors, and during some recent storms more than 50% of visitors were using mobile devices.
4. First-time users tend not to read documentation, or spend as much time on the site as return visitors.
5. Graphics, and in particular the cone of uncertainty, are the most popular content. This raised concerns for some NHC staff as this particular graphic can be difficult to interpret for some users.



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## Key Findings

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1. Many NHC and NOAA staff were concerned about the organization of important content on the website. Staff felt that the site hosted so much information that it was sometimes difficult for people, even those familiar with the site, to find what they were looking for.
2. Many interviewees noted that NHC products and communication strategies could be better tailored towards supporting particular decisions and communicating impact to the public. Others felt that NHCs core strength was its forecasting expertise and that should remain the priority.



3. There was a strong recognition for the need to identify ways to localize and personalize information for users.
4. In various ways, staff and experts highlighted the need for modernizing the NHC website. This included updates to the look and feel, taking advantage of the possibilities offered by interactive graphics, and improving user experience of the site on mobile devices and tablets.



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# Literature Review

In order to ensure our design research was informed by academic research in tropical storm risk communication, we undertook an extensive literature review in this area. We used a narrative review process to document the most recent (circa 2010) academic findings on tropical storm communication, and included older articles which were cited frequently.

The rationale is that recent advances in technology, such as smartphones and access to wireless internet, have significantly changed the way people seek and find information. Our review of over 65 peer-reviewed articles, was guided by four overarching questions:

- What are the specific decisions made by the general public that experts seek to influence during the predictive phase of tropical storms (ie. before landfall)?
- What factors do people base these decisions on?
- What channels do members of the public use to get specific information?
- What do we know about how to present this information?

We synthesized the analyses of each article with short memos. These memos summarized the overall findings of the literature in regards to each of these questions. Using these memos, a set of themes were identified to inform the project's heuristic evaluation, which is described below. A fuller description of the Literature Review process and results can be found in Appendix.



## Key Findings

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# User Interviews

We interviewed 38 members of the general public who had prior experience with hurricanes. The goal of these interviews was to understand the particularity of each interviewee's experience and information needs as a way of expanding our understanding of the design space.

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Participants were recruited through convenience sampling, snowball outreach, and postings on Facebook groups in four areas that had experienced one or more hurricanes in recent years: New York, Houston, New Orleans, and North Carolina (Outer Banks).

Three members of our team conducted thematic analysis to evaluate interview transcripts around four sensitizing questions:

- What were the key decisions that interview respondents made related to hurricane risk or safety?
- What information sources did they turn to in order to help inform this decision?
- What factors influenced their analysis or interpretation of the information they received?
- What other factors, besides information, influenced their decision-making?

## Key Findings

---

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	<b>Low storm experience / limited local network</b>	<b>High storm experience / strong local network</b>
<b>Multi-faceted information ecosystem (tech savvy)</b>	<p>Decisions are made by triangulating between multiple sources of information (online, personal contacts, experience).</p> <p>Most accessed information from NOAA indirectly through social media, news, or other websites.</p>	<p>Decisions are made based on information available through a refined set of trusted information sources in combination with knowledge from past hurricane experience.</p> <p>NOAA is considered a trustworthy source of information. Many participants accessed the site directly, while others looked to trusted local experts to distill the information</p>
<b>Narrow information ecosystem</b>	<p>Decisions are based on current lived experience - watching the storm approach and talking with family, friends and neighbors.</p> <p>Besides personal contacts, social media was the main channel of information for this subset.</p>	<p>Decisions are based on knowledge of past hurricanes and current experience - watching the storm approach and talking with family, friends and neighbors.</p> <p>Generally news media is not considered trustworthy in this subset; yet, they took evacuation orders seriously.</p>

*Table 1: Decision Process by Characteristics of the Public*



# Heuristic Evaluation

We ended phase one with a design research method called a heuristic evaluation<sup>4</sup>, whereby designers independently review existing tools against a set of best practices for improving user experience, then come together to discuss their ratings and form a final position.

Based on guidelines from both user experience design and the literature review on tropical storm risk communication research, we developed a novel set of eight heuristics:

- Hurricane information should be communicated clearly and concisely
- Communicate tropical cyclone impact(s) as well as attributes
- Hurricane information should be relevant and localized
- Hurricane information should be trustworthy and credible
- Task orientation & functionality
- Navigation & information architecture
- Effective written content
- Effective visual design

Together, these heuristics are a tool that NHC and similar stakeholders can use for future user experience and usability studies for improving hurricane risk information.

We then recruited six designers and risk communication experts (covering meteorology, design, emergency management, risk communication, and disaster research) and asked them to systematically score hurricanes.gov using the new heuristics. After individual evaluations were completed, the experts were brought together to discuss and synthesize their findings to establish common insights and key uncertainties.

<sup>4</sup> <https://www.nngroup.com/articles/how-to-conduct-a-heuristic-evaluation>



## Key Findings

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1. For all eight heuristics, the experts scored hurricanes.gov with less than 50% of the possible points for the evaluation. The absolute scores are not meaningful. Instead the relative scores first provided a basis for discussion among the experts and next offered insight into priorities for improving hurricanes.gov. Scores are provided in Table 2.
2. We found particularly strong opportunities for improvement in the heuristics categories (C) Hurricane information should be relevant and localized and (F) Navigation and information architecture. However, items from each of the eight categories were included in the design opportunities presented to NHC at the end of phase one.



HEURISTIC	INDIVIDUAL EXPERT <sup>7</sup> SCORES						POSSIBLE POINTS	SCORED POINTS	PERCENTAGE OF POINTS
Communicating hurricane information clearly and concisely	5	6	4	7	8	7	84	37	44%
Communicating storm impact as well as attributes	2	2	4	5	3	4	48	20	42%
Storm information is relevant & localized	4	4	6	7	3	6	84	30	36%
Trustworthy & credible	4	6	6	6	8	5	84	35	42%
Task orientation & functionality	5	9	8	8	20	12	144	62	43%
Navigation & IA	4	4	8	7	10	8	120	41	34%
Written content	2	7	6	3	5	3	84	36	43%

Table 2: Heuristic Evaluation Table



# Identification & Selection of Design Opportunities

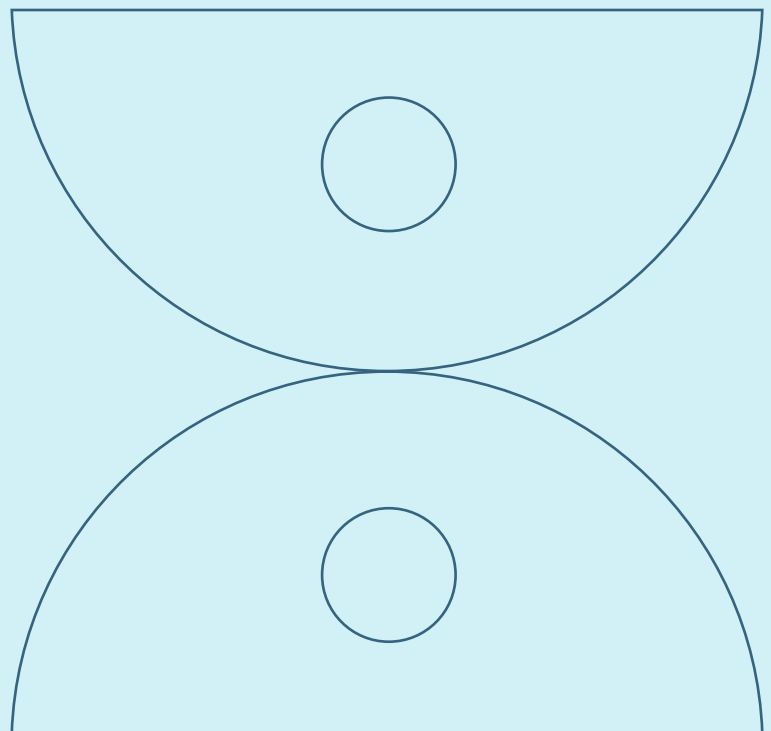
Based on the findings of phase one, a list of 36 potential design opportunities were synthesized by the project team. This list was consolidated to 11 opportunities in consultation with the NOAA advisory panel. These 11 opportunities were presented to a larger group of NOAA staff for feedback.

Based on the solicited feedback, the advisory panel and project team collectively chose four design opportunities to focus on during phase two, indicated in bold.

1. Communication of impacts or vulnerability
2. Simplifying language
3. **Reorient the site around user's location**
4. APIs for private sector weather apps
5. Social media strategy review
6. **Integration with regional forecast office sites**
7. Design all products and info to be shareable
8. **Persona development and user-journey mapping**
9. **Information architecture review**
10. Mobile-first design
11. Accessibility review

# Phase Two: Design, Test & Refine

The activities of phase two explored the four design opportunities selected at the end of phase one.







# User Personas & Experience Map

The goal of this design opportunity was to develop tools that help the NHC think through the needs of public users in ways that are simple and practical. Personas and experience maps are common methods of capturing and communicating insights from user research. They are used by designers and product teams as a way of understanding and staying connected to the people they are building for.

## Persona Cards

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Personas are detailed and realistic fictional representations of users of a tool or service

<sup>5</sup>. Personas help designers think through the goals, capabilities, and limitations of users, as well as the context of use.

When creating personas, a careful balance must be struck between accurate representation and ease of use. Instead of the static documents frequently created for personas, we opted for a more modular and lightweight approach — one that could be both used and updated by NHC staff without needing to rely on external expertise.

<sup>5</sup> <https://www.usability.gov/how-to-and-tools/methods/personas.html>



## Characteristics & Tasks

Inspired by the Cards for Humanity project<sup>5</sup>, a set of tools used broadly in the design industry, we created a set of ‘persona cards’ to represent important details that should be considered when designing for general users.

The set contains two types of cards – characteristic and task. Characteristic cards describe a user trait or context. Task cards describe a goal or desired outcome. The front of each card includes a persona name, age and short statement of their characteristic or task. On the back is a description and examples of possible responses. Examples are provided in Figure 2.

<sup>5</sup> <https://cardsforhumanity.idean.com>

## Application

The underlying purpose of these cards is to help teams understand their users and encourage them to explore ways they could support them, and they can be used in several ways:

- Characteristic cards can be paired with task cards to create a range of lightweight user personas. These can be used to assess current products and services, or to identify opportunities for future ones.
- The cards can be used individually as lenses for quickly examining specific aspects of current or proposed designs.
- Teams or team members can adopt a specific task-characteristic persona, becoming responsible for understanding their needs and advocating for them during subsequent design decisions.
- Characteristic cards can be used with the experience map to develop a more nuanced picture of the end-to-end user experience.



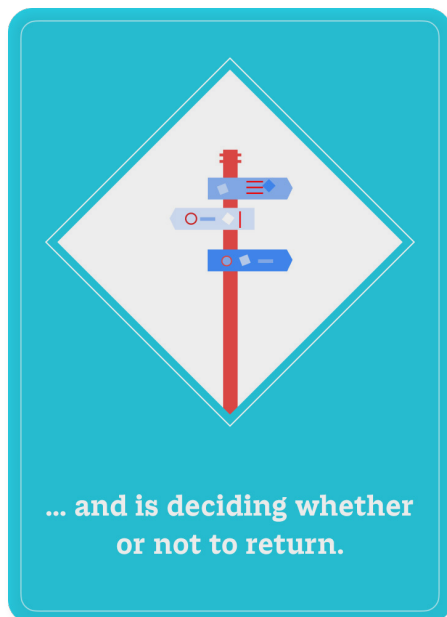
#### Consider

Some people will need to coordinate with partners and other family members. They may have more than the need to organise and require more time to prepare.

#### Example responses

Tailoring learning and preparation material to people's different contexts.

Making it easy for people to share storm information with partners and loved ones.



#### Consider

Making the decision to return home after evacuating can be as difficult as deciding to leave.

#### Example responses

Providing information on local, post-storm conditions.

Sharing updates on/from local utilities and other services.

Linking to social media content from local residents or services.

Figure 2. Persona card examples



# User Personas & Experience Map

## Experience Map

User experience maps visualise the end-to-end experience that an average person goes through to accomplish a goal<sup>7</sup>.

Where customer journey maps — another common type of UX mapping — focus on the user experience of a particular product or service, experience maps provide a high-level view of general human behaviour. The defining characteristic of experience maps is that they are product and service-agnostic.

Experience maps help teams develop a baseline understanding of their potential users when they are not using the product in question. They are useful for examining how current designs meet users' needs and for informing future design decisions.

### Phases & goals

This experience map, pictured in Figure 3, describes the general timeline of people's engagement with storm information throughout a hurricane or significant weather event.

It outlines user experience across four broad phases, each with a different set of goals:

1. First awareness — when people learn of a storm for the first time. Before hearing about a new storm, few people have explicit hurricane-information goals
2. Gather information — people seek to inform themselves of current events, finding out what they need to know and choosing sources of information they feel they can trust.
3. Assessing — people attempt to understand how they will be affected, making assessments of risk and impact and making informed decisions about the actions they will need to take.
4. Monitoring — people continue to observe the situation, and adjust their earlier decisions as they need to and can.

It should be noted that these are not distinct steps that people move through in a completely linear manner. In reality, people move

<sup>7</sup> <https://uxmag.com/articles/how-to-build-an-experience-map>



back and forth between phases depending on how their specific situations and subsequent information needs change over time.

**Application**

Beyond helping teams understand general users, there are several ways experience maps, both independently and together with the persona cards, can be used at the NHC.

- Comparing the needs and experiences of the public against those of the current NHC target audience to identify gaps and overlaps.
- Identifying which phase or phases of users' experience the NHC should concentrate on supporting.
- Assessing how well current content and services meet users' needs.
- Exploring new applications of NHC content, expertise and resources.
- Create proxy user journeys by leveraging the persona cards to explore how the NHC might support specific user needs.

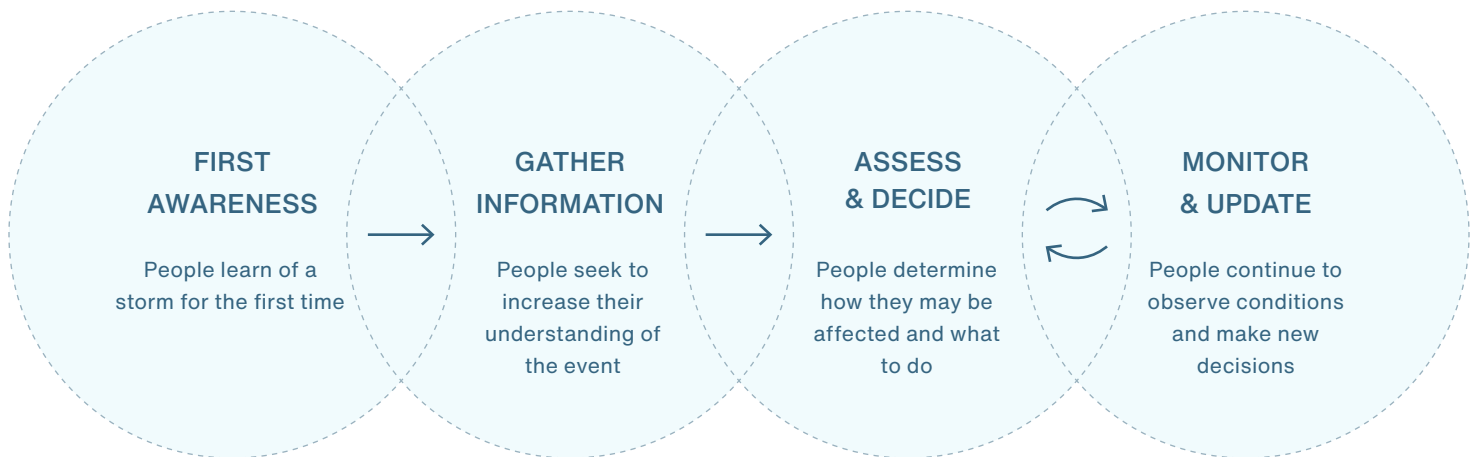


Figure 3: User Journey Map Headings



# Information Architecture Review

Information architecture (IA) of a website consists of the content organization, labelling, navigation, search functionality, and content management.

The NHC website was not originally designed as a destination for the general public despite having content that they want. The jargon used on the NHC website is difficult for general users to understand and can create confusion when attempting to find content

The heuristic evaluation we conducted raised several immediate issues that the NHC can and should seek to address. The most prominent include:

- Inconsistent page layout
- Typography that misrepresents the hierarchy of importance of information
- Ambiguous link and button labels
- Logos in the header of the website that link to National Weather Service and NOAA websites
- Links to offsite pages in the primary (horizontal) navigation menu

In addition to the heuristic evaluation, we performed an open card sort with 14 study participants using a selection of the content on the NHC website.

Card sorting is a design method for evaluating the IA of a website or user interface<sup>8</sup>. In an open card sort the content of the website is put onto cards – analog or digital. Participants are instructed to cluster cards into categories that they provide names for. This method is used for defining categories of content based on an understanding of users' mental models.

Using online surveying tools, we recruited 14 participants from the United States and who had varying levels of prior experience with hurricanes.

For this project, cards were created to represent the majority of menu options and links on the front page of hurricanes.gov relevant to the public. In some instances the actual labels were revised to be simpler or jargon-free. The advisory panel reviewed and approved 28 cards for use in the card sorting study, listed in Table 2.

<sup>8</sup> <https://www.usability.gov/how-to-and-tools/methods/card-sorting.html>



About the National Hurricane Center	Current storms	Current tropical cyclones	Contact
Frequently Asked Questions	5-day forecast	Current marine forecast	Forecast models used by the NHC
Map Data	Glossary	All marine weather products	Publications
Marine Forecast Graphics	Hurricane Hazards	Sign up for alerts / Sign up for NHC news	Tropical cyclone climatology
Marine Forecast Maps	Hurricane Safety	Tropical weather details	Tropical Weather Outlooks
Marine Forecasts Text	Latest News	Wind scales and how they work	Current weather forecast
Education & outreach resources	Satellite photos / imagery	Tropical weather products	Learning opportunities

*Table 2: Card labels used in open card sort*



# Information Architecture Review

## Key Findings

1. The results of the card sort revealed multiple issues in the information architecture of the website. Participants tended to organize the content by the perceived subject of the content, but did not do so consistently. This indicates significant lack of clarity on the part of end-users about the meaning of content labels. Overall, two primary groupings emerged:
  - Forecasts and weather-related content
  - Background resources and other less time-sensitive information
2. Other groupings users produced through the card sort included:
  - Forecast information
  - Marine content
  - Educational content
  - Current weather information
3. Content that was organized together under the same navigation menu heading on the NHC website was not always organized together by participants. For example, “Frequently Asked Questions”, “Glossary”, and “Forecast models used by the NHC” content is under the same menu heading on the NHC site, but was not grouped together often by participants.
4. Participants were able to group similarly named content together such as all the “marine” content. However, content that was less clearly defined by the content label was often not organized into one grouping in particular by participants. An example of this is that “Map Data” and “Sign up for alerts / Sign up for NHC news” were sorted together by half of the participants, but do not overlap in terms of content or language.
5. When key content is kept across multiple domains it negatively affects user experience, reduces the performance and search engine optimization, complicates content management, and obscures the site objectives.





An example of this is the Hurricane Preparedness content being listed separately on the NWS and NHC websites:

Educational Resources (NHC) > Be Prepared! NWS Hurricane Prep Week (NHC) > Hurricane Preparedness (NWS) > Hurricane Safety (NWS) > Hurricane Hazards (NHC).

However, once leaving the NWS/NHC website there is no simple way back as the

main/sub navigation model changes when navigating to the different pages/websites.

This example shows how when navigating to “Surge Products” on the Storm Surge Resources page, the sub-navigation menu changes, preventing the user from easily navigating back to the previous page.

Storm Surge > Surge Products > Home Page

## Recommendations

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Based on the findings from phase one, the IA assessment, and card sort study findings, we offer several recommendations to improve the information architecture of hurricanes.gov.

### Develop a simplified content strategy

Content on the site should be simplified and prioritized according to a content strategy that encompasses key audiences, main messages, and staff responsibilities for producing and maintaining web and social media content. A more simplified and targeted approach to content will facilitate ease of organization and recognition by users.

### Establish visual hierarchy

Typography and other aspects of visual design (e.g. whitespace, layout) should be used to establish a clear hierarchy of importance for various components of page content. A more consistent page layout across different parts of the site will also facilitate user wayfinding.

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### Remove external links from header

The header and primary horizontal navigation should be redesigned such that users aren't inadvertently taken off-site. It should be clearly indicated when a link takes a user to a non-NHC website. The number of off-site links should be minimized, particularly in the horizontal navigation menu.



### **Utilize plain English**

Content labels and navigational menu items should be written in plain English, without reliance on technical language or jargon. Revised labels should be tested with target user groups.

### **Consolidate search options**

Consider limiting search results to the hurricanes.gov website and presenting them in a more predictable manner. Search is an essential, if often overlooked, aspect of information architecture. At present, use of the search bar offers results from NWS and NOAA.

### **Incorporate lateral navigation to help user move across site**

Lateral navigation can be used in addition to reorganizing content underneath different headings. Here links to related content can be placed in context, next to or underneath the primary content of that page, without needing to create new pages or restructure the website.



# Localization

To kick off the localization work, we organized a two-day online design sprint with designers, disaster researchers, and risk communication experts. During the workshop, participants discussed user needs during tropical cyclone warning periods, considered various user groups amongst the general public, and explored different concepts for providing localized hurricane information via the internet

The concepts that emerged from the workshop included:

- Storm summaries to give users easy access to critical storm information.
- Expanding content to give users access to more detailed information when they need it without cluttering the interface when they don't.
- Local area maps to display graphical storm information with the contextual information users need to quickly orientate themselves.
- Local vulnerability information to help users understand the storm risks their local area is susceptible to.
- A dashboard that enables users to monitor storm information for multiple locations.
- Customisable notifications that allow users to choose the information most useful to them.
- Community feeds that use social media to help users contextualise storm information.
- Aggregating third-party content to give users easy access to local news, weather and traffic headlines.

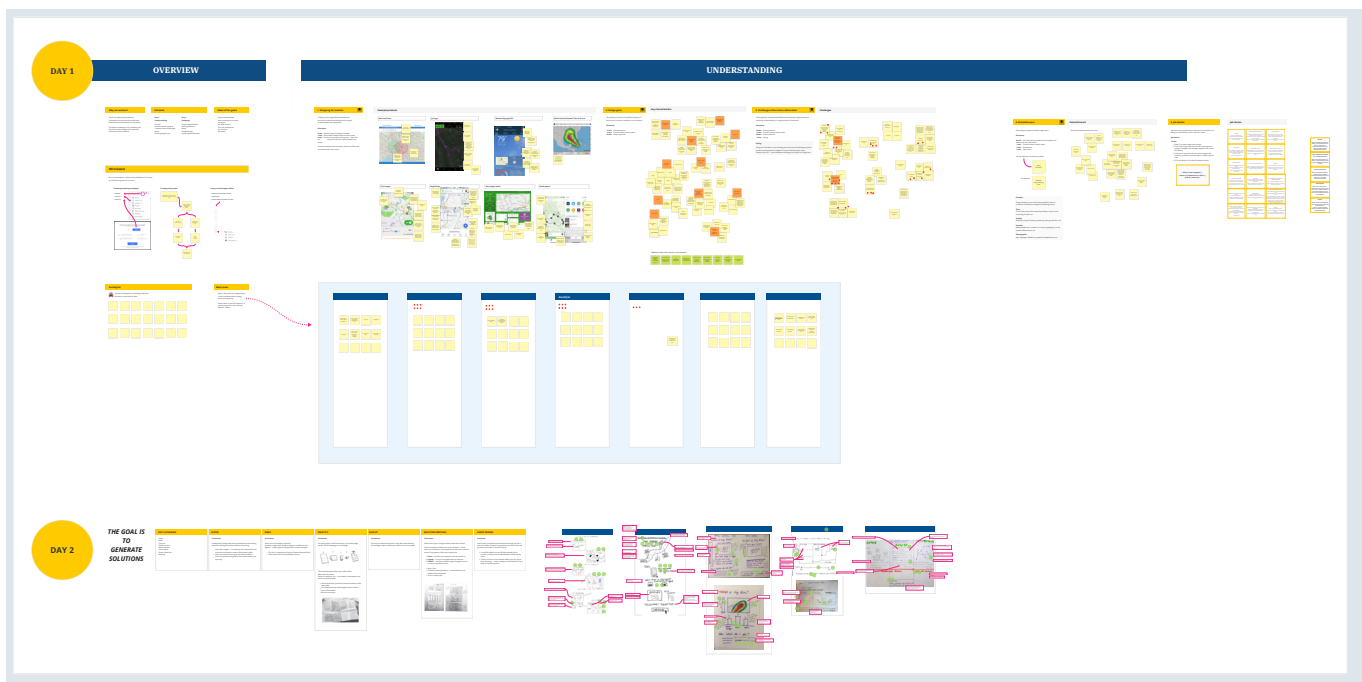
To validate these concepts further, our team created a series of mockups to explore during semi-structured interviews with 14 members of the general public who had varying levels of prior experience with hurricanes. The goal of these interviews was to understand participants' expectations and gain feedback on design concepts for the NHC website based on localization.

Participants were recruited through convenience sampling of US-based university students and through reaching out to members of the public who were previously interviewed during phase one. Interviews were guided by five key questions:



- What is the minimum amount of high value information that people want?
- What is the role/value of local information and local hazards?
- Of the local information they prioritize, how would, or do, they get it now?
- Would people return to this site, monitor other locations, sign up for alerts, etc? How often?
- Interviews were transcribed and analyzed using thematic analysis.

## Key Findings



*Design Workshop Artefacts*



Overall, users found the further localization of NHC content useful because it assisted decision making and increased the value of NHC products to the participants. Here we highlight some of the findings from the interviews and participants' reaction to the presented mockups:

### **Subscriptions to location specific alerts**

Participants were interested in and comfortable with receiving localized push alerts via text or email from the NHC. Many were familiar with such notifications and had registered to receive them from other organizations. Allowing users to subscribe to multiple locations and have multiple options in terms of how to choose locations (e.g. zipcode, city or county name, etc) would facilitate user control. Giving users the ability to customize and control the geographic relevance of hurricane information they receive may increase engagement with and perceived value of hurricanes.gov.

### **Trusted third-party content**

There is a wealth of other credible information available through application programming interfaces (API) to information published by other organizations in government or core partners, in other automated means that would add value to core NHC products. Users mentioned that certain information would improve the utility of the NHC website, such as information on road traffic, dangerous or impassable roads, road and airport closures, local weather forecasts, and news and alerts from local governments.

### **Interactive local-scale maps**

Many users have come to expect modern interactive maps and the ability to pan, zoom, and choose information to display on websites that provide geographic information. Participants noted that the regional-scale maps currently offered on hurricanes.gov did not provide enough context to be usable at a local level. Improving the mapping functionality and scale on the NHC website, while ensuring simple defaults for those who still struggle to use maps, could significantly add to user experience.

### **Local emergency management resource and organizational directory**

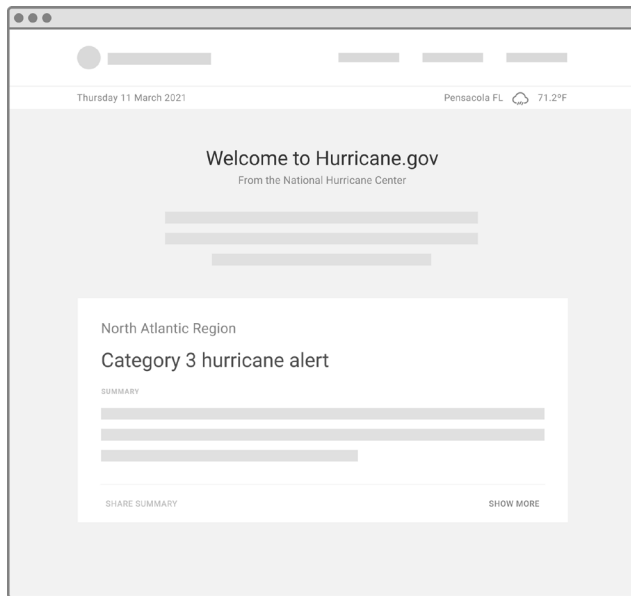
Maintaining directories of local or regional links, resources, and organizations alongside NHC hurricane products would deliver additional benefits to users and make NHC information more actionable. Participants noted the value of this information and the convenience of having it collected in one place. In addition, sharing this information may help improve users' understanding of, and relationships with, relevant local organizations.

### **Community Feeds**

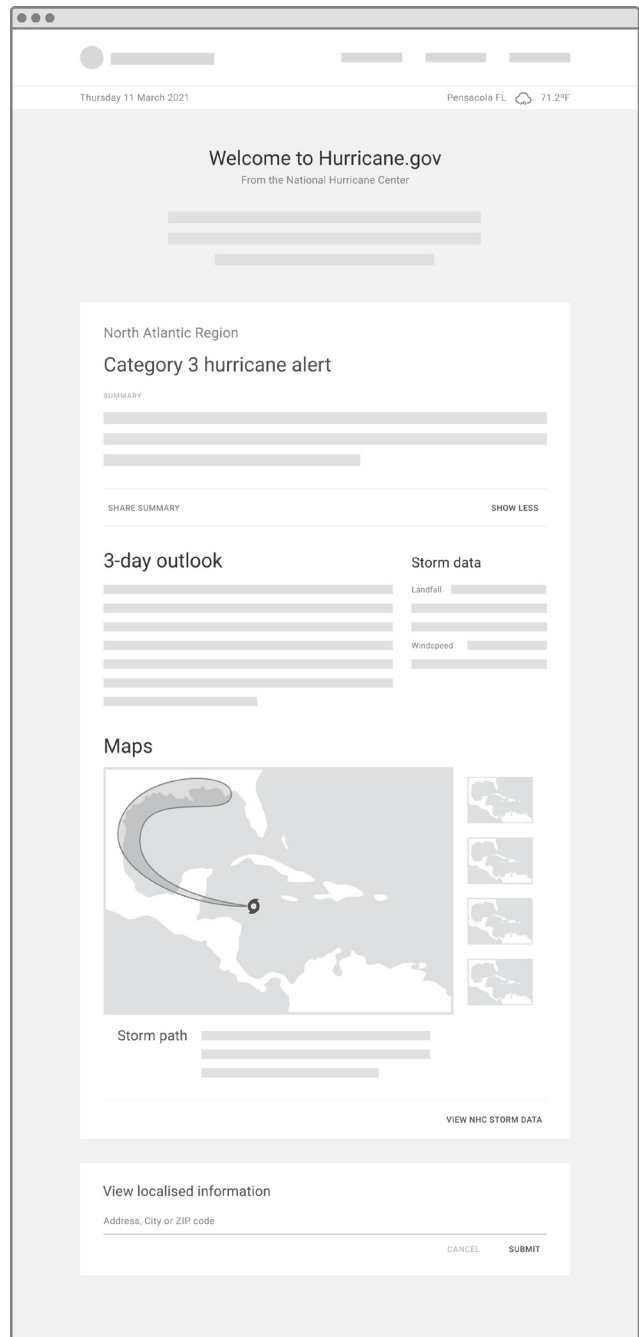
Social media is a major source of risk information for many members of the public and allows users to share relevant and valuable information that the NHC is not well positioned to create, such as timely photos of conditions or impacts. Careful curation of community produced social media content during storm events can add value to the NHC's digital presence.



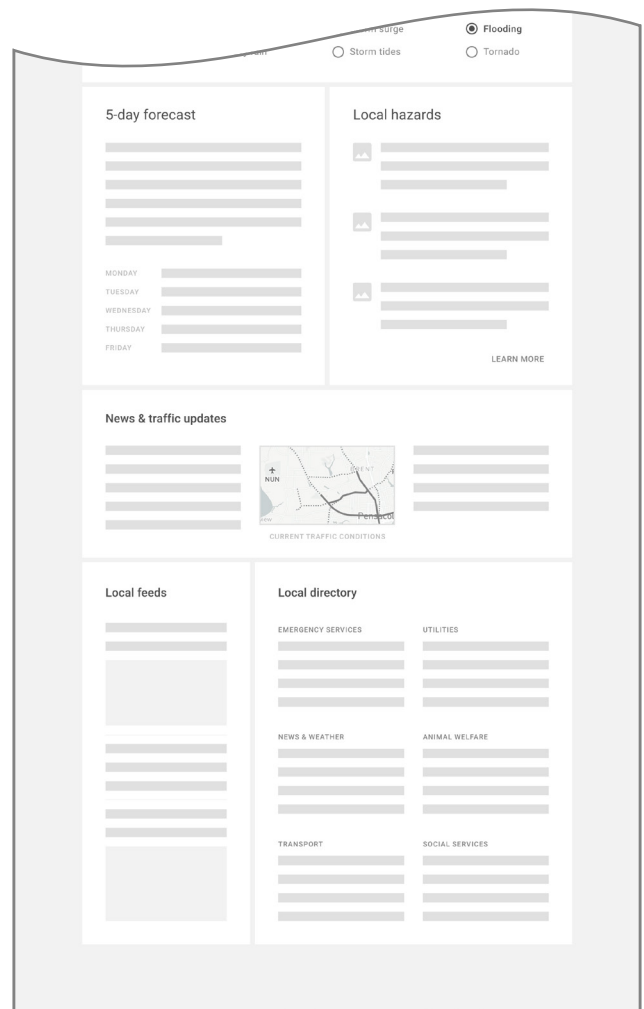
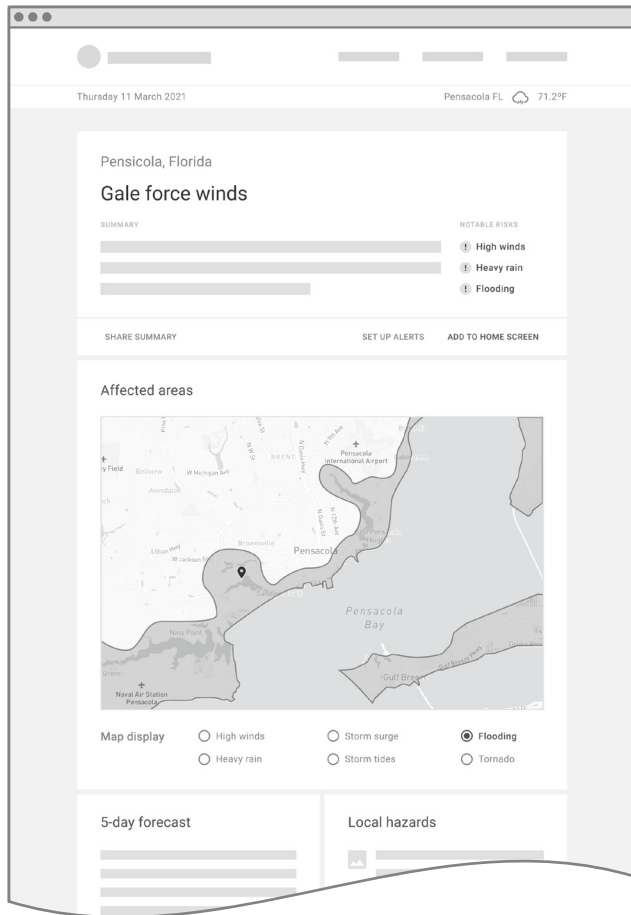
# Wireframes



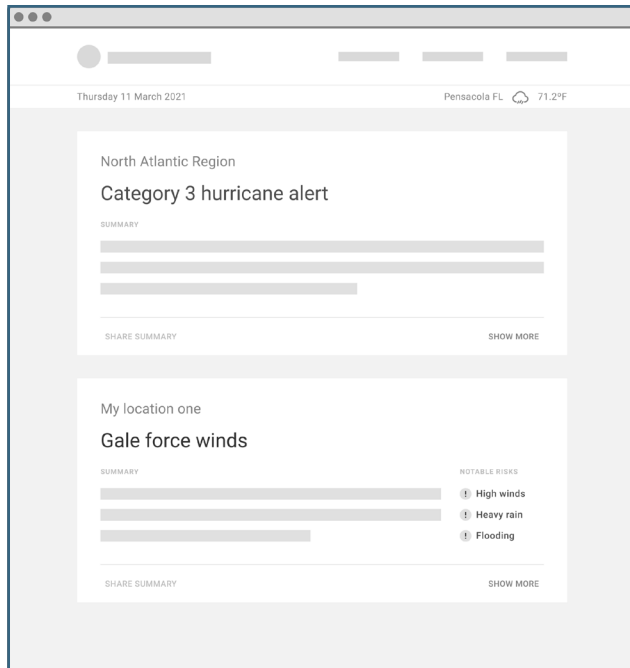
Home – Region Summary



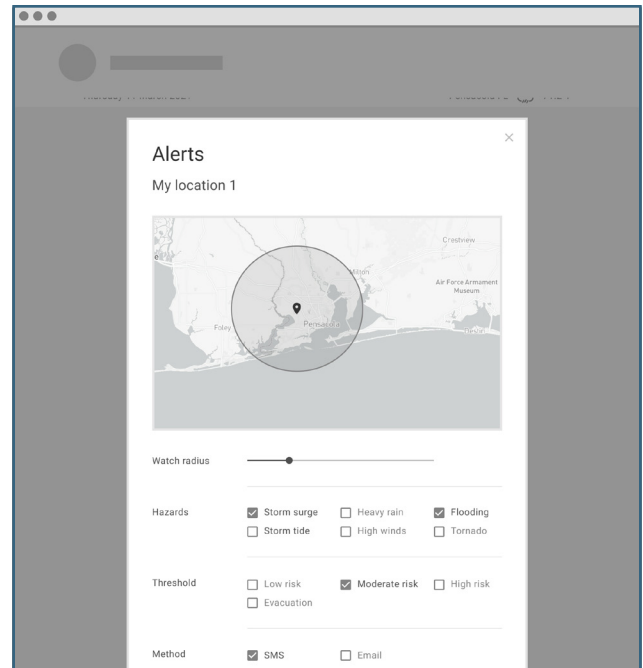
Home – Region Full



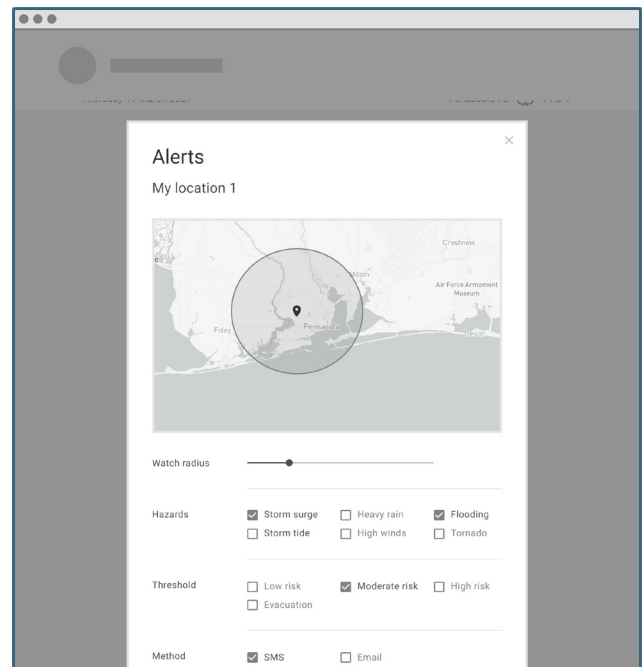
Localised Content



Home – Customised



Home – Evacuation Notification



Custom Notifications





# Integration with Weather Forecast Office Sites

The National Weather Service operates 122 weather forecast offices that provide forecasts and severe weather warnings for a specific geographic area. Each weather forecast office (WFO) has a dedicated page on the NWS website, many of which contain information that is potentially valuable to NHC audiences.

The purpose of this activity was to explore how WFO pages or content might be integrated into a broader NHC user experience. This was done in 3 parts.

1. Interviews with NWS staff involved in the design and operation of the WFO pages.
2. A review of the WFO content and pages
3. Prototyping of localized content and functionality, discussed in the previous section.

## Key Findings

### **Much of the WFO-specific information contained on these sites was seen as valuable**

Users reported that information on local disaster preparedness resources, localized threat and impact graphics, and other content would be useful. This reinforces similar findings that arose from the literature review.

### **Current user experience limits value**

As with [hurricanes.gov](https://hurricanes.gov), the WFO sites have been designed and built without reference to modern web design standards or user experience best practices. Although the WFO sites were designed for the general public, users were not involved in their development. As a result, the WFO websites and the tropical forecast page within them fall short of the interfaces and user experience today's audiences expect.



### A lack of discoverability limits access

The WFO tropical sites are not easy to find through Google search, which is the most common way that people accessed hurricanes.gov, and, at present, localized information in-

cluded in the WFO site is not easily accessible or discoverable from hurricanes.gov. Thus, integration between the sites is functionally very limited. These WFO are similarly difficult to discover within the current NWS architecture.

## Recommendations

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The WFO websites could potentially become helpful platforms for the NWS and NHC content people are seeking. However, to get them to this stage would require significant investment. In the meantime, there are additional pathways worth considering to meet the public's needs for localized storm and hazard-related information. Below we present several options for how NHC might approach the integration of hurricanes.gov with regional WFO sites. These options are not mutually exclusive, and in fact recommend that NHC develop a strategy that combines several of these.

### Improve the design and SEO of the WFO sites

As noted, WFO pages do not currently meet the standards expected by modern audiences. However, many improvements could be made with the application of standard interface design, UX, and communication best practice. In particular, efforts to improve page consistency, visual hierarchy, and reduce clutter would improve user experience. Improved SEO for these sites would help drive awareness and traffic.

### Defer integration between the two sites

There are several reasons why the NHC may not wish to significantly depend on the WFO sites for delivering localized hurricane information, even improved versions of these sites. First, regional sites are organized administratively, or according to the NWS regions, which likely does not align with users' mental models for regional groupings of the United States.

Second, many of the usability challenges that the NHC website is currently seeking to address are replicated on the regional forecast sites, and the NHC has less ability to influence these. Finally, given search engine rankings and social media, members of the public are more likely to find themselves on hurricanes.gov than the regional sites, where delivering usable and localized content to them as quickly as possible should be a priority.

As an alternative to tight integration with regional sites, NHC may choose to focus on improving the localization of content on hurricanes.gov, as discussed earlier in the report.



**Develop a process by which local content produced by regional teams is also featured on hurricanes.gov**

This could involve automatic propagation via API or manual sharing. Given the effort spent by WFO staff on developing the local threat and impact graphics and other localized resources and information hosted on the regional tropical forecast and their potential value to the public, the NHC may consider featuring this content on hurricanes.gov. Manual sharing of this content is possible, though may be labor intensive to ensure that it is kept up to date with changing information on the regional sites.

Another option, afforded by the use of the same CMS across each regional site would be automated updating through web-scraping or (if available) direct API access. This would not require significant programming expertise and may allow hurricanes.gov to share the latest information made available on the WFO Tropical Web Portal sites.



## NATIONAL WEATHER SERVICE

LOCAL FORECAST BY: San Angelo TX

News Headlines: New Hydro Hazard Simplification, New 24-hourly weather quality rating classes being added, Latest Hurricane Nicholas Post-Tropical Cyclone Report, Double-de LA Nina Entries, New Local Climate Site (short video on what to expect)

### NWS Forecast Office Houston/Galveston, TX

Today: Far (76°F), High: 81°F, Low: 43°F

Weather Map: Houston/Galveston TX, Nov 18, 2021 4:32 PM CST

### Current Weather Observations

Location	Time (CST)	Weather	Wind (MPH)	Temp (°F)	Dewpt (°F)	Hum. (%)	Wind (mph)	Wind Chill (°F)	Heat Index (°F)	Pres. (in)
Galveston	15:35	Clear	10	82	62	51	S 12018	-	-	29.85
Galveston Station	15:53	Mostly Clear	10	83	62	49	S 14023	-	-	29.84
Humble	15:53	Partly Cloudy	10	83	60	46	S 10	-	-	29.96
Brownsville	15:55	Clear	10	83	62	48	S 12017	-	-	29.86
Conroe	15:53	Clear	10	82	60	47	S 12	-	-	29.87
Cleveland	15:50	Partly Cloudy	10	80	65	60	S 7	-	-	30.00
Houston Airport	15:53	Misty Clear	10	83	60	48	S 8029	-	-	29.86
Intercontinental Airport	15:53	Mostly Clear	10	82	62	50	SSE 12	-	-	29.87
Houston Hobby Airport	15:53	Partly Cloudy	10	83	66	56	SSE 13	-	-	29.96
Springfield	15:53	Partly Cloudy	10	84	63	48	S 18	-	-	29.86
Wichita	15:55	Mostly Cloudy	10	82	62	50	S 15	-	-	29.87
Pearland	15:53	Clear	10	80	67	64	SSE 12020	-	-	30.00
Edinburg Field	15:50	Misty Clear	10	80	66	61	SSE 13	-	-	29.96
Arcadia/Lake Jackson	15:53	Mostly Cloudy	10	80	67	64	SSE 10	-	-	29.99
Galveston	15:52	Partly Cloudy	10	79	68	71	SSE 13	-	-	30.01
Bay City	15:50	Partly Cloudy	10	79	68	68	S 12	-	-	29.96
Pasadena	15:53	Clear	7	81	69	67	SSE 12	-	-	29.86

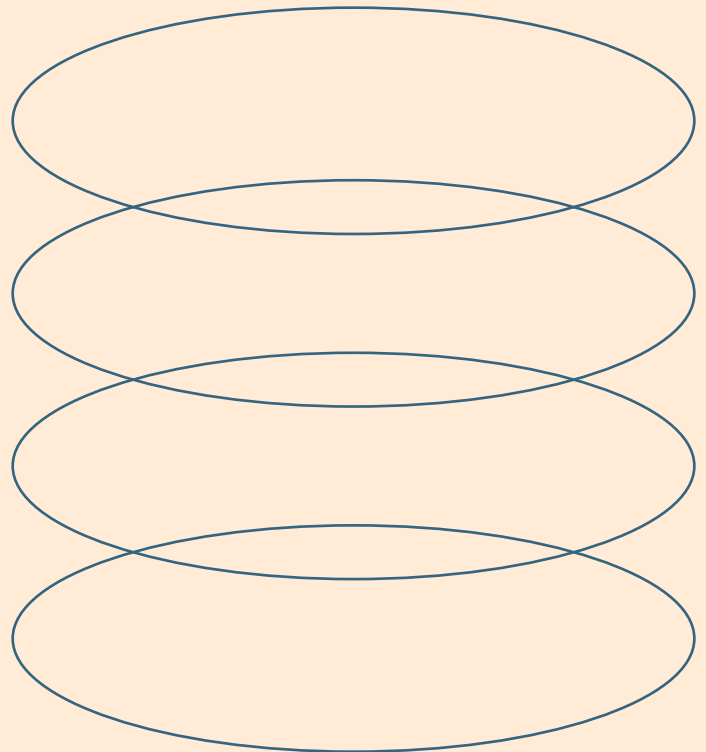
### November 18th

Today in Weather History

In 2007, A localized heavy rain affected parts of Austin county. Flash flooding near the community of Industry swept three cars off a road. 5.56 inches of rain fell in Bellville during this rain event.

NWS Houston Weather Forecast Office website

# Overarching Insights & Recommendations





# Constraints & Limitations

In addition to federal guidelines, including Section 508 compliance on accessibility, and those from the National Weather Service and NOAA, we considered (or encountered along the way) several major constraints in this project.

- First, there is a misalignment between what best practices in weather risk communication research suggests in terms of the information and communication needs of the public during storm warning period, and what the NHC, as a single entity with a limited mandate, is currently able to offer. Crucial information such as evacuation warnings or projections of local impacts are either not available in a uniform manner across NHCs service area or created and maintained by other entities.
- Second, there has been a historic under-investment in the website overall. The majority of the work on the design and maintenance of the site has been, and continues to be, done in-house. The NHC's staff are leading experts in their field, but do not currently possess strong capacities in modern web development.
- Third, at present the NHC doesn't have a comprehensive, cross-platform (i.e. including traditional media, relationships with technical partners, social media, and web) strategy for communicating forecast information to the public.
- Finally, one limitation of this research process is that we have focused exclusively on the public. This has had several ramifications, including the extent to which we can advise on tradeoffs regarding how specific design decisions may affect public and core partners and limiting the sections of the site considered for the information architecture review.



# Considerations When Designing for the Public

Several considerations surfaced through this research that the NHC could take into account in any pivot of the site's design or focus to the public.

## **The “public” is not a monolithic entity**

Members of the public have a significant range of needs, abilities, and contexts in which they might use hurricane risk information. This means it is comparably more complicated to design for the public than for experts.

## **The public does not view hurricanes.gov as a destination**

While they report high levels of trust, they perceive the site and its content as being designed for experts. When they do visit the site, many arrive on the site via search or social media and don't necessarily land on the homepage. This increases the need for intuitive and explanatory information architecture and the adherence to overall good user experience design.

## **The public has less patience and is overall less motivated to use the NHC site than core partners**

They want to quickly find answers to their questions without having to click through to multiple pages or read large amounts of text. They have been accustomed to higher standards of UX than the current hurricanes.gov site provides.

## **Language and use of jargon are important design considerations**

This is especially true given that the design of the current website is text heavy both in terms of its content and how various navigation options are offered to users. The site relies heavily on technical terms that are unfamiliar to most members of the public, drastically reducing its usability to this audience.



### **NHC has the opportunity to educate the public about the science of hurricane forecasting**

The prior point notwithstanding, the NHC has the opportunity to educate the public about the science of hurricane forecasting. By providing easier handholds, such as contextual definitions of complex terms, NHC can help users learn some of the complex concepts behind hurricane forecasting while meeting their information needs.

### **The public expects the site to work on mobile platforms**

According to the web statistics analysis, over half of the current site's traffic during recent storms was on a mobile phone or tablet, where the site does not perform well. Mobile-first design strategies can improve this situation significantly, without requiring the development of a dedicated mobile app.

### **Improved UX design on hurricanes.gov will help both the public and experts**

Anything the NHC does to improve visual design, accessibility, or otherwise conform to modern web design standards will be useful to each of its audiences.





# Process Recommendations

- As noted above, the NHC website has historically not received the necessary investments, including hiring specialized staff, needed to build and maintain a modern website that communicates the work of the organization on a level that is commensurate with the expertise the NHC deploys in its forecasting work. If direct communication with the public via hurricanes.gov is a priority for NHC, larger investments in this resource are necessary.
- Any further developments to the website would be enhanced by being part of an overall public communications strategy that includes traditional channels as well as social media and the website, and accounted for expert audiences and core partners as well as the general public. This overall strategy would help prioritize future investments and facilitate decisions about website content and organization.
- A public communications strategy should, amongst other things, situate NHC activities within the wider hurricane risk information ecosystem that includes other government agencies, the media, and the private sector. Efforts to develop partnerships or jointly funded projects between different actors in the ecosystem around topics such as standardized evacuation warnings or local impact predictions could help improve cohesion across the ecosystem and allow NHC to focus on its core competencies while still ensuring that the public’s information needs are met.
- A clear mission statement for the NHC website, along with targets for measuring success, would help the organization to justify investments needed for modernization and future maintenance, help prioritize amongst competing opportunities for improvement, and track progress over time. Furthermore, it would allow the various teams and units across the NHC to establish a shared understanding of how the website fits into the overall goals of the organization.
- The NHC should explore simple, so-called “discount” usability methods for testing changes to the website and gaining more feedback from members of the public. The web team at NHC has proved willing to experiment with changes to the site based on feedback from core partners and made real improvements with relatively few resources. The NHC can seek input from other audiences on topics ranging from terminology to page layout, without requiring large contracts to external consultants. Getting feedback from users is often faster, less expensive, and more illuminating than is often assumed.



# Next Steps

## **Increase investment in the site and internal capacity**

In order to design, develop, and maintain a modern website capable of meeting the complex and varied information needs of the public, NOAA will need to both increase the amount of investment beyond current state and hire or develop more internal capacity in web design, user research, and web development. There are relatively few quick, low-cost, low-effort changes available to accomplish the needed structural changes and maintenance. Nor should these be the focus if the needs of the public is the first priority going forward.

Real, sustained investment is necessary to create a digital presence for the public that effectively communicates the tremendous expertise of the NHC and the critical information they produce.

## **Internally socialize findings of the report**

The research produced during this project should be disseminated and discussed with NOAA and NHC staff to develop a shared understanding around its findings and recommendations. Discussions or workshops should be facilitated to review and prioritize report recommendations. Final priorities can only be determined internally based on specific and evolving legal, budget, personnel, technological, and time constraints.

## **Promote human-centered design within NHC and across NOAA and the NWS**

Research done using human-centered design stands to improve other NHC risk communication products beyond hurricanes.gov. This project can serve as a positive example for how human centered design can help government entities evaluate how to best communicate their work to the public.

Future research should examine how the NHC, NWS, and NOAA, units within a broader government structure can align design efforts and provide more unified user experience across the organizational structure. Increasing the consistency and predictability of how different entities deliver content will improve the user experience of each platform. In addition, dissemination of these results of this project across the weather community could help sensitize design research methods and processes, with benefits for the space overall.



### **Adopt contemporary visual design standards**

The role of effective visual design in communicating a sense of trust and authoritativeness to the public was repeatedly raised in conversations with NOAA staff and public interviewees. As described in Appendix 12, relatively simple changes including modern typography, an updated color palette, and consistent page layouts would improve the site, even absent any additional changes.

### **Build for mobile**

Over half of site visitors during major tropical storms use mobile devices and tablets. Our interviews with members of the public, as well as nearly two decades of research in crisis informatics, confirmed that mobile phones are a primary means of accessing information during emergencies. The current site does not perform well on mobile devices based on results from multiple publicly available evaluation tools.

The NHC would benefit from ‘mobile first’ design strategies that ensure online resources are responsive and usable regardless of which technologies are used to access them. Such an approach will necessarily improve the design of the site when accessed using personal computers.

### **Ongoing accessibility review & designing for different audiences**

There is a great diversity of current and potential users for the site. Given the responsibilities that NOAA and NHC have in delivering information to these users, an accessibility review should be part of any future design work for hurricanes.gov.

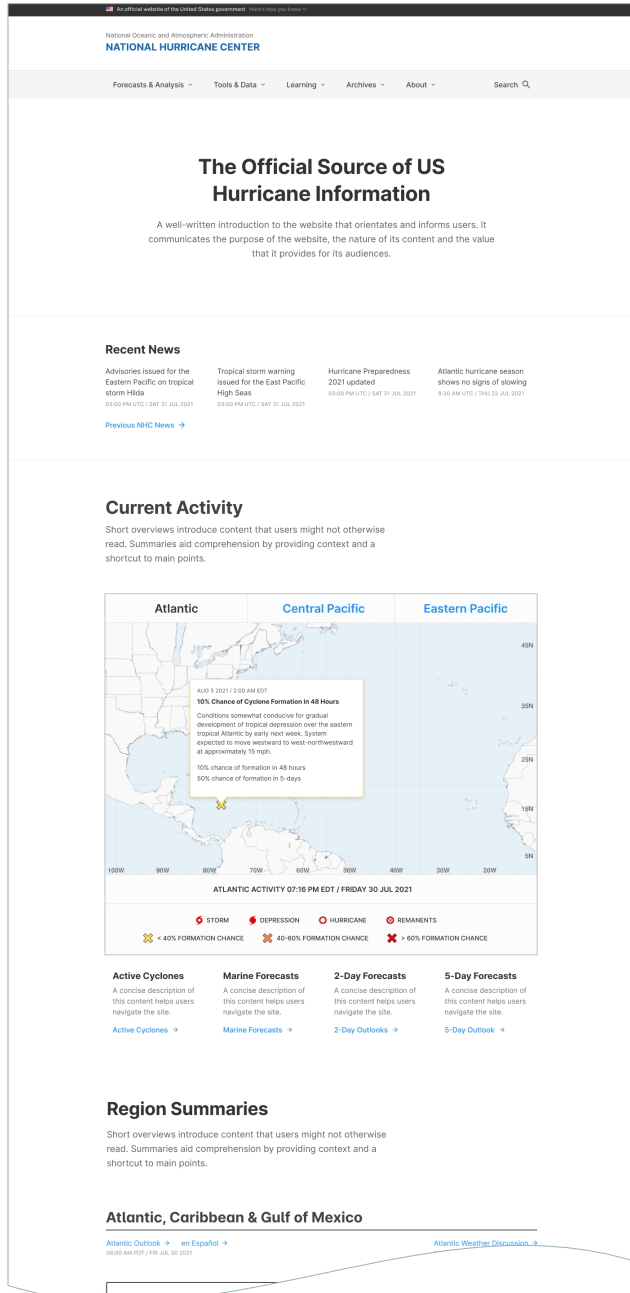
The impacts on accessibility should be weighed when considering any future changes to the website. Accessibility here should be considered beyond the technical formulation provided by Section 508 or WCAG 2.0 guidelines. It should include targeted content strategy based on different information needs of different audiences including, for example, elderly populations or people who speak English as a second language.

Similar to a mobile-first design approach, improving accessibility for more diverse users will improve the design in general.

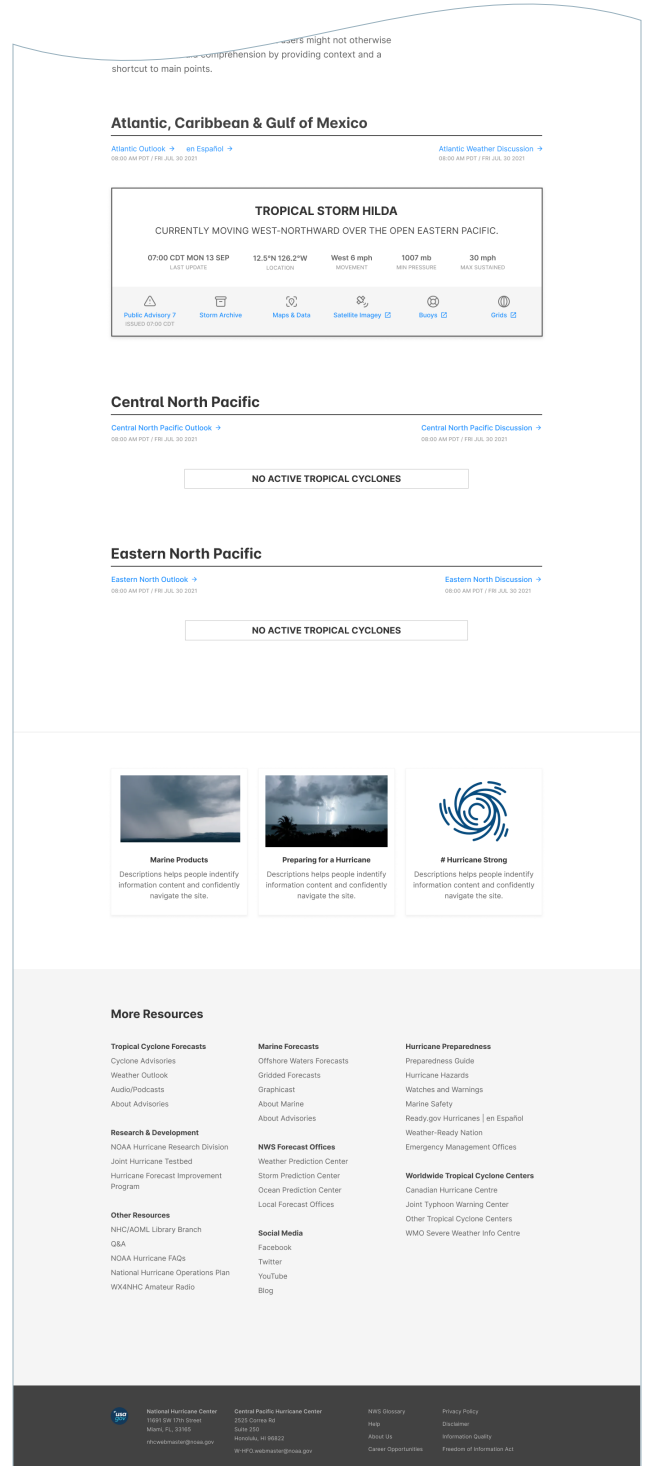
### **Develop a digital communication & content strategy**

Future web development should be guided by a clear digital communication strategy that is integrated with NHC’s overall communication approach. The information NHC is mandated to produce is highly complex, as are the needs of the greatly diverse audiences it intends to reach. Therefore, an overall strategy is needed in order to help set priorities and guide design decisions for NHC’s digital presence.

Good design work necessarily requires making tradeoffs and difficult decisions about what content to feature and how it is presented. A new digital communication strategy should include a clear vision for what the role of NHCs digital presence is in regards to the overall organizational mission, main user groups and communities that it is meant to serve. It should also lay out methods for evaluating whether the NHC is accomplishing its goals in this area.



Mockup of NHC homepage with modern UI design





# Further Research

## **Taking advantage of people’s interest in graphics, but prioritize text**

Research in weather risk communication has repeatedly found that people’s eyes and attention are drawn to graphical forms of information. Yet research subjects consistently struggle to interpret common graphics such as the cone of uncertainty or spaghetti plots. There is a design research opportunity in this contradiction that may build on work already done at the NHC around colocating “Key Message” content with time of arrival and cone graphics. Further research through design could help refine and build this strategy.

## **Localizing NHC Products**

The localization research undertaken by this project was focused on redesign of the site structure and the addition of further content. It revealed a clear demand from the public for more locally- and personally-specific information. There is future work to do regarding the localization of individual products through more inclusion of contextual information and presenting even coarse model results in a more localized fashion. There are a range of user behaviors that require further investigation, such as whether users can be encouraged to be repeat visitors and so, for example, gain value

from having personal accounts, which would enable a wider range of localized features.

## **Develop a Social Media Strategy**

Social media is an important, and growing, source of traffic for the NHC website. There is significant research in the crisis informatics and risk communication literature that provides guidance on how official and authoritative sources can effectively use social media. Engaging with this literature, as well as conducting analysis of prior social media use by the National Hurricane Center, A/B testing and other means of experimentation should be part of further developing NHC’s overall digital communications work.

## **Improved Analytics for Better Understanding Site Traffic and User Behaviour**

The background research we conducted with the NHC website’s social media analytics was exploratory. It was largely based on prior work conducted by NOAA and NHC staff. There is ample room to go deeper into this data, collect additional data, analyze trends in site traffic sources, and characterize user behavior in more ways. Furthermore, such research could provide NHC immediate benefits with development of a suite of site-specific analytics and evaluation meth-



ods. These can be used to operationally evaluate site performance and efficiently understand the influence of future design and outreach work.

### Communicating Impacts

Weather risk communication research and best practices argue that communicating storm impacts increases the value of risk information and increases the trust and seriousness with which the public interprets it. In our interviews, members of the public reported that seeing images of storm impacts on the news and social media helped them to contextualize risk information. Further design research, building off of the threat and impact graphics produced by NWS, is necessary in order to prototype and evaluate how best to accomplish this.

ly-delivered weather information to improve the value of such integration. And the organization of hackathons or app development contests to promote NHC data and develop creative or innovative applications that incorporate it.

### API and Raw Data Sharing

A number of organizations incorporate NHC graphics and data into their own applications, analyses, and visualizations that are then delivered to the public from other media. It is important that the NHC understands who, what, and how this occurs to understand what value it creates with respect to the NHC’s mission.

Interviews can be done with core partners to gain insight into how they share content from hurricanes.gov, what effect this has, and how it can be optimized. Interviews can be done with potential users of data-sharing APIs to better understand and meet the needs of these groups. Analysis of the growing private sector tech ecosystem can be done to characterize how information from hurricanes.gov is integrated with private-

# Appendices

## Phase One

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1. Literature Review Summary.docx
2. Themes from NHC Interview Notes
3. Summary of Public Interview Analysis
4. Heuristics Process and Description
5. Example Heuristics Worksheet
6. Summary of Heuristic Evaluation Results

## Phase Two

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7. Design Opportunities Slide Deck
8. Design Workshop Outcomes
9. User Persona Cards
10. Journey Map
11. Localization Insights
12. Localization Testing Wireframes
13. Information on Regional Tropical Forecast Sites (Idealized)
14. Visual Design Standards